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Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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The Broadening Field of the Engineer's Services.

The right of the engineer in his professional capacity to an official place in the direction of all public works and services has been cried in this journal to the point, we think sometimes, of tiresomeness. It is encouraging, therefore, when one can listen to another sounding the call, particularly when it is sounded so effectively as it is in the address of Interstate Commerce Commissioner W. M. Daniels to the Washington (D. C.) Society of Engineers. This address may not be given here in full but the feature that distinguishes it that we wish to emphasize is capable of being presented in the short quotation which follows:

> It is interesting to note that in its evolution from the status of an exceptional employment to that of a recognized profession, engineering has been forced, little by little, to take account of other laws and forces than those of mathematics and physical science. Primarily designed to effect certain well defined technological results, it has increasingly had to take account of economic and social considerations, of the fluctuation of prices and price levels, and of varying rates of pecuniary return. Besides mathematics, it has had to study markets; besides excavation, it has had to study sanitation; besides strength of materials, it has had to study strength of motives to save and invest; and thus eventually engineering has been forced to embrace within its horizon the age-long problem of the Sphinx—the ascertainment and the quantitative appraisal of matters relating to justice and equity between man and man.
>
> This last demand which has been imposed upon the engineer has been particularly manifest where engineering has been enlisted in problems of public administration. First, this was shown in the simple problems involving condemnation proceedings, where private property was taken by the state under the law of eminent domain, where the engineer was called upon to make his estimate in order to protect against confiscation the individual whose property was taken.
>
> Next in order, the engineering profession has been called upon to afford, in the more complex problems of tax appraisals and assignments, a verdict to determine the relative measure of tax obligations as between individual taxpayers in their entirety on the one hand, and great corporations on the other.
>
> Going one step farther, in the domain of government regulation of public utilities, the engineer has been called upon to furnish a just basis on which to predicate the approval of security issues. Here the respective interests of the corporation, the consumer, and the investor have been weighed in the engineering scales.
>
> And last of all and most important of all, we have had to resort to the engineer for the data indispensable in the fixing of just and reasonable rates for the service rendered to the public by various public utilities.
>
> In all this varied and complex matter of public administration the engineering profession has evidenced its ability to grasp these problems of public equity and justice. Nor do I know of any justifiable basis for the allegation that the engineering profession has shown evidence of a bias in its solution of these problems by reason of the prevailing employment of the engineer in earlier days mainly by private interests. The most frequent, the most painstaking and the most illuminating discussions of these very problems involving relative claims of the public as against corporate interests are to be found in engineering literature, engineering reports, and engineering discussions. The economist certainly has no monopoly of vision into the just relationship between public and private interests, and certainly is not warranted in assuming an attitude of Olympian infallibility and graciously extending to the engineer the permission to act as a satellite and humble retainer.

There has been no development in the history of engineering so fraught with possibilities as the development of the engineer from a technician to the positions of administrator and manager of public utilities and of arbiter between these utilities and the public which they serve. But the development has come about little by little and is yet only partially recognized. It has been the work of only a comparatively few members of the engineering profession and they have worked only as individuals. Organized engineering—clubs, societies, associations, institutes of engineers, with here and there an exception—still clings to the old doctrine that engineering is, as Mr. Daniels puts it, an exceptional employment taking cognizance only of the laws and forces of mathematics and physical science. Organized engineering has done little directly to aid the engineer to attain the position of service to society and state which Mr. Daniels so highly commends.

Road Construction in the United States in 1915.

The bright spots in the rather gloomy fields of engineering and contracting at the present time are the opportunities for work in road construction and municipal improvement during the coming year. Engineers and contractors are truly children of prosperity—blood kin in that respect—and improvements in conditions that affect one no less surely affect the other. The past year has been one full of activity in the fields named. What has the coming year in store for us?

Looking back over the work accomplished a number of the problems of road building appear to have crystallized, so that we can see a path to follow during the year to come. The importance of economic studies, prior to extensive road construction to determine the roads to be improved and the economic type of improvement has been emphasized. The adoption of concrete, brick and bituminous concrete pavements for use on country roads has been quite general in those localities where traffic is heavy. It has become the general policy to let large contracts rather than many small ones—a most obvious method of saving money. The various states in which road construction is largely supervised by road commissions have in most cases emphasized the great need of efficient maintenance. Also they have perfected local organizations in counties so that contractors may bid on road work in the counties of those states having highway commissions, with some degree of assurance that they will not be at the mercy of a politically able engineer.

With reference to methods of construction, a vast amount of new and improved plant has been developed for the use of road builders. Special types of concrete paving mixers have been perfected and many smaller items of equipment introduced. Hauling with motor trucks and trailers has been extended to include many fields of construction and the use of industrial railways and car unloading devices has come into vogue. Small plants for the preparation of bituminous materials have been devised for the benefit of road contractors.

During the coming year present conditions indicate a material increase in the amount of pavement construction. It is authoritatively estimated by the sales department of a large cement company that 60 per cent more Portland cement will be used in road construction than was used during the past year, and a large bituminous paving company states it has 33⅓ per cent more work in sight than at the same time last year. The excellent condition of the market for municipal and county securities as compared with the market for other types of financial investments, coupled with the easy condition of the money market and the excellent opportunity afforded of accomplishing construction work at a low cost due to the plentiful supply of labor will undoubtedly influence favorably the undertaking of many large public improvement projects during the coming year.

It is probable that in the near future some form of national supervision or aid in the construction of certain types of roads will be adopted by the federal government. The form that this will assume we do not venture to predict, but the success that has attended the supervision of the construction of post roads by the Office of Public Roads of the U. S. Department of Agriculture leads us to believe it will be an extension of this work.

In street paving and the construction of suburban roads by municipalities increased activity is apparent daily. The need for this work is great and the present time is most favorable for its prosecution. For the most part construction of this type should open up in March. On the whole those interested in this class of work can well afford to be optimistic.

What Will Be the Effect on Business of the Five Per Cent Rate Increase?

Transmuted into dollars the five per cent rate increase—with limitations—allowed the railways by the modified ruling of the Interstate Commerce Commission, gives from $15,000,000 to $20,000,000. These are comfortable sums but it is obvious that alone they permit no great extra expenditure for railway construction and renewal. The promise of benefit to business which lies in the new ruling is found elesewhere than in the figures named.

This will be seen better if we analyze the decision. First, the material facts are these: The present ruling is a supplemental ruling. Based on last year's volume of business, estimates of increased revenue coming from the latest ruling range from $15,000,000 to $20,000,000; with the advances allowed in Central Freight Association territory by the original ruling, the entire increase is estimated at from $30,000,000 to $35,000,000. The original ruling gave privilege of increased passenger rates and established added rates on reconsignment and diversion service, and the advantage taken of these rights increases still further the amounts named. The full effect of the two rulings may be, according to published estimates, an increased revenue to the railways of $50,000,000.

The increase of $50,000,000 in railway income means of course a corresponding increase in the ability of the railways to buy. This is the least benefit of the Interstate Commerce Commission ruling. Its greatest benefit comes from the fact that any disposition of the Commission to oppress the railways is denied, and confidence in railway investments is strengthened. The result will be beneficial to business; the railways may be expected to do a reasonable amount of buying from now on; with farming prosperous and financial conditions improving, increased buying will assuredly follow. As an act of expediency the ruling of the Interstate Commerce Commission seems justified. As a solution of the broad problem of railway management economics it counts for little.

The Cost to the U. S. Reclamation Service of Draining Over-Irrigated Lands.

Editorially in our issue of Oct. 28, 1914, we inadvertantly promulgated an error in crediting the Reclamation Service with only 40,000 acres of overirrigated land reclaimed by its expenditure of about $2,500,000 for drainage works. The area given was quoted from the "Reclamation Record" which has since been found to have been in error. The accompanying table, showing conditions as of July, 1914, gives, as will be seen, 143,462 acres as the area reclaimed. This figure makes the cost far different than that commented on in our issue of Oct. 28. As a matter of fact the area reclaimed by the constructed drains and drains planned within the estimated cost of $2,500,000 will be 187,462 acres; the cost per acre being $13.34 instead of $62.50 derived from the erroneous figure of 40,000 acres. It is due to the Reclamation Service to credit it with this very reasonable cost of drainage and it is also due to the Service to emphasize that the faults in using water which have led to the necessity of drainage have been repeatedly exposed and protested against by the engineers of the Service.

	Drains, length, miles.				Area, acres.			Est. cost per acre.	
	Constructed.		Authorized (incl. const'd.)						
	Open.	Closed.	Open.	Closed.	Waterlogged and injured by seepage.	Protected by constructed drains.	To be protected. including all drains authorized.	Constructed drains for area protected.	All drains authorized.
Arizona—Salt River	....	.....	.....	.....	....	....	....	.....	.....
Arizona—Cal. Yuma	11.2	4.0	11.2	4.0	1,250	10,000	10,000	$10.00	$10.00
California—Orland		....	......	.....	....	....	....	.....	......
Colorado—Grand Valley		....	.....	.....	....	....	....	....	......
Colorado—Uncomphgre Valley		.....	......	.....	....	....	....	.....	......
Idaho—Boise	20.0	0.25	38.0	0.25	10,500	4,000	7,500	25.00	25.00
Idaho—Minidoka	97.0	.....	102.5	....	5,568	30,000	33.200	18.61	19.31
Kansas—Garden City		...	.....	..	....	......	..	.....	.....
Montana—Blackfeet		.....	..	..	...	....		..	..
Montana—Flathead		..	.		..	.	...	....	....
Montana—Fort Peck		....	.....	....	....	..	....	.....	.....
Montana—Huntley		20.6	....	31.7	1,000	10,000	16,000	13.75	17.50
Montana—Milk River	56.0	.	65.	.....	....	30,000	40,000	3.00	3.00
Montana—Sun River	...	...	....	.	1,912	....	....	......	......
M.-N. D.—Lr. Yellowstone	2.0	0.4	2.0	5.3	880	75	2,200	10.20	30.00
Nebraska-Wyoming—North Platte	6.0	8.6	7.2	9.4	5,000	3,200	3,700	21.36	22.26
Nevada—Truckee-Carson	174.1	3.0	174.1	4.1	1,700	20,000	23,000	10.00	10.00
New Mexico—Carlsbad	1.8	2.97	4.75	2.97	3,260	1,065	3,065	25.95	15.00
New Mexico—Hondo	.....	......	.....	.....	......	....	......	......	......
New Mexico-Texas—Rio Grande	...	......	......	.	....	......	....	......	......
North Dakota—North Dakota Pumping	15.0	.....	15.		337	3,797	3,797	1.90	1.90
Oregon—Umatilla	10.0	..	10.	..	200	2,000	2,000	27.50	27.50
Oregon-California—Klamath	19.6	......	48.	....	1,437	19,000*	25,000	7.71	10.00
South Dakota—Belle Fourche	12.0	.....	12.	..	1,800	2,000	5,000	1.81	15.00
Utah—Strawberry Valley	..	....	.....	.	....	....	....	......	......
Washington—Okanogan	1.0	..	1.		22	22	....	28.50	28.50
Washington—Yakima-Sunnyside		...	.....		....	....	....	......	......
Washington—Yakima-Tieton		..	...	.....	....	....	....	.....	......
Wyoming—Shoshone	9.3	30.0	9.8	31.1	4,100	8,600	13,000	33.75	28.10
Total	437.0	69.82	500.55	92.12	38,966	143,759	187,462	.	......

*Drains must be deepened for full protection.

Capable Men as Public Commissioners.

To get the best men on our ever-increasing list of public commissions is a problem which merits the attention of all public-spirited men. Obviously, the amount of time and energy which a man should give to public affairs without direct compensation cannot be expressed in the form of a general equation, as the variables are too numerous. In a measure it should increase with the benefits which society as a whole confers upon the man. Unquestionably this depends to a very great extent upon the man's capacity and zeal for work. The problem is one of particular interest to engineers, as their training is such as to make them especially well equipped for service on public commissions of various kinds. Broad educational work in public affairs, as one of the functions of our colleges and universities, should do much toward making attractive positions on these commissions, but the matter must be considered as a personal one in the end. Whether better men will be attracted by requiring that they devote their entire time to the business of the commission, or only a part of it, remains to be determined. In this connection the following extracts from a letter accompanying the resignation of George W. Anderson as a member of the Massachusetts Public Service Commission are of interest. The quoted comments are based mainly on the legislative requirement that each member of this commission shall devote all of his time to the work of the commission. Mr. Anderson gives as the reason for his resignation the fact that he *cannot* qualify in the class of men living easily on inherited or acquired wealth, and *will not* qualify in the class dependent for livelihood, present and future, upon the emoluments of public office. He says, in part:

> The inevitable tendency of this legislation is to limit the commonwealth to filling places upon such commissions with men drawn from two classes:
>
> 1. From those who by virtue of inherited or acquired wealth are financially independent. From this class some very excellent public servants have in the past been obtained; doubtless it will be so in the future. But (political parties deleted as not pertinent.—Editors) would not look with equanimity upon a public service commission—charged with the duty of regulating great corporations—dominated by men living easily upon inherited or acquired wealth.
>
> 2. The commonwealth may draw in abundant numbers from men whose demonstrated earning capacity is less than the salary now paid public service commissioners. From this class also excellent service has been and will be obtained.
>
> But men dependent entirely upon the emoluments of office for the livelihood of themselves and of their families are almost certain to be constant, conscious (or unconscious) candidates for reappointment; they cannot live and act in an atmosphere of independence and freedom. They are, almost necessarily, continuously measuring forces which make for or against their own continuance in office.
>
> The mere fact that the salary paid public service commissioners is as much as that paid to superior court judges makes the situation no better. Appointments to judgeships are for life, with pensions provided for disability and old age. But the bench is a great career, and many of our ablest lawyers prefer it—with its honor, dignity, freedom from strife and from either poverty or riches—to the struggle and possibly larger prizes of the bar. But these short-lived appointments on commissions must necessarily be but episodes in the careers of men of real force and ambition.
>
> The importance of permitting this class of public servants to retain some outside business or professional work is not that such servants may have, during office, a larger income—it is that they may be independent—not anxious for reappointment—ready on any necessary and proper occasion to risk their official lives in defense of their convictions of what public duty requires.
>
> To get a strong public service commission, the state must either appoint for life or for long terms—as judges are appointed—or the field must be kept open, as it has hitherto been kept open, for those who retain outside business in order not to be over-anxious for reappointment.
>
> Your new policy magnifies the importance of clerkly observance of office hours and minimizes the importance of vision, of sense of public need and public right, of independence of control of financial interests. It disregards the vital distinction between places in which mediocre administrative fidelity is the essential, and places which call for the best there is in our best men. It would be far better to reduce the salaries one-half and keep the field open to men of genuine public spirit and independent earning capacity, rather than, by making the salary substantial, to increase the avidity and number of the job-hunters.

Mr. Anderson strikes the keynote when he says: "But these short-lived appointments on commissions must necessarily be but episodes in the careers of men of real force and ambition." As long as the appointments to important commissions are political and are for short terms they do not offer a career to men of force and ability. We do not believe that the other points brought out in the letter are so pertinent, provided, of course, the compensation is sufficient to permit a really capable man to maintain his proper position in society, and provided further that the man is subject to some form of recall.

Portland Cement Production in 1914.—According to preliminary returns from all the operating mills in the United States except one it is estimated by Ernest F. Burchard, of the United States Geological Survey, that the quantity of Portland cement manufactured in the United States in 1914 was approximately 88,514,000 barrels, compared with 92,097,131 barrels in 1913, a decrease of about 3,583,000 barrels, or nearly 4 per cent. The estimated shipments of Portland cement during 1914 were 86,715,000 barrels, compared with 88,689,377 barrels in 1913, a decrease of about 1,975,000 barrels, or 2.2 per cent. On account of the surplus of production over shipments stocks of cement at the mills apparently increased more than 14 per cent.

SEWERAGE

Recommended Tests for Use in Laboratory Control of Sewage Works Operation.

In ENGINEERING AND CONTRACTING of Dec. 16, 1914, we published an article entitled: Recommended General Procedure in Sewage Works Operation. As stated in the article it was from the report of the Committee on Sewage Works Operation and Analytical Methods to the Sanitary Engineering Section of the American Public Health Association. The present article deals wholly with the second portion of the report, that is, with analytical methods. This is a progress report.

The latest edition of "Standard Methods of Water Analysis" of the American Public Health Association supplies sanitary engineers, chemists and bacteriologists with a nearly complete set of analytical procedures, many of which are of assistance to sewage works operators; they do not, however, state which of the many tests described are most useful for the practical purpose of sewage works operation.

(a) For Sewage Treatment Works Primarily Designed to Prevent Nuisance.

TYPE OF WORKS.	TESTS FOR OPERATING CONTROL AND DETERMINATION OF EFFICIENCY.					Tests to Determine Sufficiency cf Treatment.
	Influent and effluent of preliminary processes.	Sludge drawn from		Effluent of oxidation process.	Final effluent as discharged into the receiving body of water.	Receiving body of water.
		One story tanks	Two story tanks.			
Works consisting of preliminary processes only such as fine screens or sedimentation.	1 Test for the avidity for oxygen called X in text 2 Test for suspended matter called Y in text.	1 Specific gravity. 2 Percentage moisture in wet sludge. 3 Percentage of dry residue that is volatile. 4 Reaction of wet sludge.			1 Test for avidity for oxygen called X in text. 2 Test for suspended matter called Y in text.	1 Dissolved oxygen. 2 Test for avidity for oxygen called X in text.
Works consisting of preliminary and oxidation processes such as contact beds or percolating filters.				1 Nitrogen as nitrates 2 Test for avidity for oxygen called X in text. 3 Dissolved oxygen 4 Relative stability.*	1 Test for avidity for oxygen called X in text. 2 Nitrogen as nitrates. 3 Dissolved oxygen. 4 Test for suspended matter called Y in text. 5 Relative stability.*	

(b) For Sewage Treatment Works Primarily Designed to Protect Sources of Water Supply.

TYPE OF WORKS.	TESTS FOR OPERATING CONTROL AND DETERMINATION OF EFFICIENCY					Tests to Determine Sufficiency of Treatment.
	Influent and effluent of preliminary processes.	Sludge drawn from		Effluent of oxidation process.	Final Disinfected effluent as discharged into the receiving body of water.	Receiving body of water.
		One story tanks	Two story tanks			
Works consisting of preliminary processes and disinfection.	1 Test for the avidity for oxygen called X in text 2 Test for suspended matter called Y in text.	1 Specific gravity. 2 Percentage moisture in wet sludge. 3 Percentage of dry residue that is volatile 4 Reaction of wet sludge.			1 Presumptive test for B. Coli 2 Test for avidity for oxygen called X in text. 3 Test for suspended matter called Y in text	1 Presumptive test for B. Coli 2 Dissolved oxygen 3 Test for avidity for oxygen called X in text
Works consisting of preliminary and oxidation processes and disinfection.				1 Nitrogen as nitrates 2 Test for avidity for oxygen called X in text 3 Dissolved oxygen 4 Relative stability	1 Presumptive test for B. Coli. 2 Test for avidity for oxygen called X in text. 3 Nitrogen as nitrates 4 Test for suspended matter called Y in text. 5 Relative stability 6 Dissolved oxygen	

*In small plants not provided with a laboratory [illegible]

Fig. 1. Diagram of Recommended Tests for Purposes of Operating Control and for Determining Efficiency and Sufficiency of Treatment in Sewage Treatment Works of the Two General Classes.

Certain tests are, therefore, submitted herewith and their use and relative value are commented upon. The following outline of recommended tests has been prepared in the light of modern sewage investigations rather than by following established practice in water analysis; it is the result of careful thought, based on experience in the actual operation of sewage treatment works.

Different works obviously require the use of different sets of tests for their study and control, based upon peculiar needs and conditions and, therefore, no definite set of tests can be laid down to suit all conditions. For example, a plant for preliminary treatment only, such as fine screening or sedimentation, might well be operated without any consideration of the amount of nitrate present in the sewage at any stage; but in the operation of bacterial processes, such as sprinkling filters, the formation of nitrate is of prime importance to indicate the efficiency of the filter. Hence, the outline of tests submitted is to be considered as broadly suggestive and not as a specification for every conceivable condition.

Laboratory facilities are frequently limited and help lacking, so that it is impossible to carry on extensive investigations. The tests recommended are, therefore, limited to the most important and useful, realizing that where opportunity exists other work will be carried on, as in the case of testing stations.

COLLECTION OF SAMPLES.

Due to its heterogeneous nature, the composition of crude sewage is very variable and chance samples taken at short intervals of time will, upon analysis, yield very different results; but when the sewage is submitted to increasing refinements of treatment, this variability in composition is lessened. It is, therefore, advisable for all tests in which the samples can be properly kept for a time before analysis, to obtain a composite sample made up of a number of small portions and thus automatically obtain an average sample for analysis. To do this properly, the size of the individual portions should be proportional to the rate of flow of sewage at the time of sampling, but it is recognized that with the class of labor usually available at sewage treatment works, this ideal cannot be realized. The frequency of sampling will largely depend upon the available force at the plant. Crude sewage should be sampled at more frequent intervals than effluents of refined processes of treatment.

It is of great importance for the proper interpretation of published data, that in connection with reported analyses a statement be made of the frequency of sampling and whether the figures given are, for instance, the average of certain chance samples or the averages of continuous composite sampling.

COMMENTS ON TESTS RECOMMENDED.

Test X. By this designation is meant a test for measuring by incubation the avidity of the sample of sewage or effluent for dissolved oxygen or its equivalent. The Royal Commission on Sewage Disposal developed a technique for such a test (see Sec. 2, Vol. 11, Appendix 8th Report 1913, or Engineering Record Oct. 25, 1913, page 453). Another method was developed by Mr. C. E. Hoover and is in use at the sewage treatment works at Columbus, Ohio (see Engineering News May 28, 1914, page 1187) and still another has been devised by Dr. Arthur Lederer and is in use in the laboratories of the Sanitary District of Chicago (see Journal Infectious Diseases, May, 1914). At present, a Committee of the Laboratory Section is about to propose a provisional procedure for such a test.

This test is considered to be of prime importance; but as there is, as yet, no definitely recognized technique nor name it is here indefinitely designated by the symbol X.

For the present it is *urgently* recommended that some form of the test be used even though all workers may not agree on the exact procedure to adopt.

Test Y. By this designation is meant a test for measuring not only the amount but also the condition and physical characteristics of the suspended matter in sewage.

Suspended matter was first determined by the difference in the weight of the residue upon evaporation of a portion of the sample filtered through paper and another unfiltered. At the present time, the Gooch Crucible is generally used to obtain the weight direct. In both procedures the organic portion of the suspended matter was estimated by determining the loss of weight upon ignition. The Royal Commission on Sewage Disposal attempted to devise a method for determining the amount of suspended matter by means of the centrifuge. In the works of the Emschergenossenschaft a simple field method is in use for determining the bulk of the settleable matter by subsidence in graduated conical glasses.

None of these methods, however, furnish information concerning the size, physical condition or other characteristics so essential to know in the preliminary treatment of sewage. One of the reasons for this, is the small size of the sample examined and the difficulties of obtaining a representative portion for analysis; for the inclusion or exclusion of a large size piece of suspended matter in a small sized sample will cause large variation in the result obtained.

The efficiency of all preliminary processes depends upon the removal of the settleable solids and, therefore, a test to measure them is of great importance. It is, therefore, recommended that in sewage works operation some procedure for the determination of suspended matter be used and that analysis be urged to devise a technique to supply the information required.

Nitrates.—This test is very useful because its place in the interpretation of analyses is well understood and it is a delicate indicator of the activity and efficiency of oxidation processes. Moreover, the results are available within a comparatively short time after the samples are taken.

Dissolved Oxygen.—This test is of great value because of the light it throws on the condition of the receiving body of water. Its use is recommended also in connection with effluents from oxidation processes.

The amount of dissolved oxygen present in a stream at any particular place or time, or in an effluent, should, however, be considered in connection with either the results of the test designated X or relative stability, for the presence in the sample of sufficient decomposable matter might exhaust in a short time the dissolved oxygen found by the analysis.

Relative Stability.—Methylene Blue.—This test has a definite value in connection with the dissolved oxygen and nitrate tests in explaining the records of past operation, but its greatest value is as a control for small works. Obviously, many small works cannot be kept under the continual observation of a trained chemist or engineer and in such cases the relative stability test can be readily made by an attendant incapable of the more elaborate procedures. Under these conditions relative stability is of primary importance and its daily use is strongly recommended in preference to occasional tests of other kinds.

Caution should be used in regard to the relative stability of tank effluents, sterile effluents or effluents containing certain industrial wastes.

Tests of Sludge.—(a) Specific gravity; (b) percentage moisture; (c) percentage of the dry residue that is volatile; (d) reaction—alkalinity or acidity.

These tests made on sludge especially from two-story tanks and separate sludge digestion tanks are of great value in operation, as they interpret the biological digestion of the organic matter. The reaction test is particularly important as an aid in detecting the cause and pointing out the remedy for poor sludge production. It has been found that tanks producing bad sludge can be made to produce good sludge by adjusting the reaction from acid to alkaline. In sludge obtained from fine screening it is advisable to determine the weight per unit volume and percentage moisture.

Bacteria.—Presumptive Tests for B. Coli.—For sewage treatment works intended solely to prevent nuisance in water courses, tests for bacteria are superfluous. They are, however, of the utmost importance in cases where the works are intended to protect sources of water supplies or shell fish layings.

It is unnecessary to carry on the confirmatory tests for B. Coli. used in water works control, as the presumptive tests are much simpler and more conservative. The formation of gas or the red colonies having appearance of B. Coli. on Litmus lactose agar at 37° are both in successful use for this purpose. When used, the test should primarily be made on the receiving body of water and secondarily on the effluents from disinfection processes.

TESTS OF CRUDE SEWAGE FOR COMPARISON.

For the purpose of record and comparison it is advisable to make at intervals tests upon composite samples of the crude sewage received at the works. These tests should indicate the character, condition and strength of the sewage.

It is recommended that at least the following determinations be made: (1) Test for suspended matter called Y above; (2) test for avidity for oxygen called X above; (3) nitrogen as organic; (4) nitrogen as free ammonia; (5) chlorine.

Special cases may require other tests to show the characteristics of the sewage.

Particular attention is called to the notes on Test X, dissolved oxygen and bacteria in connection with the receiving body of water. Tests when applied to sewage and effluents are of value as tools for operating control, but as a measure of sufficiency of treatment they do not always supply adequate information. This is on account of the difficulty of formulating precise standards for effluents discharged into different kinds of receiving bodies of water, and, therefore, the final criterion of sufficiency of treatment must logically rest in the effects produced upon the receiving body of water considered in the light of expediency and local needs. Investigations of the effects of effluents on bodies of water are, therefore, urgently recommended.

For the different purposes of operating control, determination of efficiency and determining sufficiency of treatment, the tests commented upon above are grouped in a diagrammatic table submitted herewith as Fig. 1.

CONCLUSION.

One of the functions of this committee is co-operation with the Laboratory Section. It is therefore recommended that the proper committee of that Section take up for consideration the improvement of the test for suspended matter in sewage called Y in this report and that during the coming year analysts direct their attention to the simplification and standardization of the test for avidity for oxygen called X in this report.

The committee considers this a progress report and request engineers and chemists in charge of sewage treatment works to send their views and criticisms of the outline of tests to the chairman of the committee, Mr. W. L. Stevenson, address 412 City Hall, Philadelphia, Pa., in order that complete data may be collected and a final report submitted next year.

The other members of the committee are Messrs. C. B. Hoover, H. C. McRae, Langdon Pearse and George C. Whipple.

Data and Discussion on the Handling of Sewage Sludge.

The most difficult part of the problem of sewage disposal is the handling of the sludge which results from every known method of treatment. As removed from settling tanks sludge is a dark, slimy mass containing about 90 per cent moisture, and its consistency is such that it cannot be shoveled, but can readily be pumped. Experience with sewage works indicates that upon an average 1,000 persons produce 45 tons of dry solid matter per annum. If this were deposited in tanks as sludge containing 90 per cent moisture it would make 524 cu. yds., but if the sludge contained 95 per cent moisture its volume would be 1,060 cu. yds., or about double the former amount. In other words, every ton of dry solid matter contained in sludge 90 per cent moisture which is removed, requires 9 tons of water to be conveyed with it, and if the sludge contains 95 per cent moisture, it requires 19 tons of water to be handled. One of the most important considerations, therefore, in handling sludge is the percentage moisture which it contains, as this is a controlling factor in its bulk. It is highly desirable to obtain sludge with as low a moisture content as possible.

Of the dry residue in the sludge, approximately one-half is organic and one-half mineral. A large part of the organic matter in freshly deposited sludge is highly putrescent and if improperly handled produces offensive odors. It is, therefore, also of importance that such processes of sludge treatment shall be used that reduce this offensiveness by the destruction of the easily decomposed organic matter.

The final disposal of sludge is accomplished by (a) discharge of wet sludge in the sea; (b) depositing wet sludge on land; (c) the use of partially dried sludge for filling in low waste lands; and (d) where circumstances warrant, the use of sludge as a fertilizer, fertilizer base or as fuel. These methods are here discussed, the matter given being taken from a paper before the American Society of Mechanical Engineers by Mr. George S. Webster, Chief Engineer of the Philadelphia Bureau of Surveys.

DISCHARGE OF WET SLUDGE IN THE SEA.

Large cities located near the ocean dispose of the wet sludge most economically by carrying it to sea in specially constructed tank steamers. The sludge is pumped from the sedimentation tanks to reservoirs on the wharf from which the steamers are filled by gravity. When the boat reaches the dumping ground in the open sea the outlet valves are opened and the sludge diffused in the sea water as the boat moves along.

This method of sludge disposal is used at London, England, where the sewage is collected by sewers to two works located on the banks of the Thames. Chemicals are added to the sewage to form a flocculent precipitate and free it from most of its suspended matter. The sludge thus produced after settlement contains about 92 per cent moisture and is carried by 6 tank steamers 55 miles to Black Deep in the open sea, which is 20 miles below Southend. On an average 8,300 tons of sludge are thus disposed of every week day at a cost of about 9 cts. per ton (including interest and sinking fund charges).

At Manchester, England, the sludge from the septic tanks is similarly carried by a tank steamer to the open sea beyond Mersey Bar. During the last fiscal year 215,082 tons of wet sludge were dumped at sea at a cost of $32,000 or about 15 cts. per ton.

DEPOSITING WET SLUDGE ON LAND.

Cities situated inland are confronted with the problem of reducing the bulk of the sludge by removing the water, either by drainage and evaporation on drying beds or by mechanical processes such as presses and centrifuges and of handling it so as to minimize offense.

The type of sedimentation tank adopted, the use of chemical precipitants or the opportunity afforded for sludge digestion have a marked effect upon the volume of sludge produced on account of the moisture content. Generally speaking it may be said that chemical precipitation will produce between 20 and 25 cu. yds. of wet sludge containing about 92 per cent moisture from each 1,000,000 gals. of sewage treated; plain sedimentation from 4 to 7 cu. yds. between 87 and 93 per cent moisture; septic tanks from 1.5 to 3.0 cu. yds. between 80 and 90 per cent moisture; and Imhoff tanks from 1 to 2.5 cu. yds. between 75 and 85 per cent moisture.

The disposal of wet sludge without prior dewatering may be accomplished by its application to land in several ways. The earliest method used was called lagooning in which case earth embankments were built enclosing an area of suitable land and the wet sludge run into a depth of as great as 10 ft. The clogging of the soil preventing free drainage of the moisture; the scum formation upon the surface retarding evaporation, and the frequent great depth of the sludge, all tend to prevent the sludge from drying. As an example, there are sludge lagoons at Birmingham, in which the sludge deposited many years is practically in the same condition as shortly after being placed except that a heavy crust has formed upon the surface. This method is rapidly being abandoned.

To overcome these objections and to dispose of the sludge more quickly, it was run upon the surface of farm land to form a shallow layer which would dry in a reasonable time and could then be plowed in and the field cultivated. But the gross nuisance created by the exposure of such large areas of foul smelling sludge led to the adoption of what is called trenching. As practiced at Birmingham, England, the trenches were dug about 3 ft. wide and 18 ins. below the surface of the soil, the excavated earth forming banks between the trenches so that they can be filled to a depth of from 24 to 30 ins. with wet sludge, after which the tops of the earth banks are thrown over the sludge to prevent nuisance from smell or flies. The porus earth absorbs the moisture and later the land is plowed across the trenches and placed under cultivation. This process can be repeated at intervals of from 18 months to two years.

The cost of trenching at Birmingham amounted to about 8 cts. per ton of wet sludge. This is exclusive of the cost of sludging tanks, but includes interest on capital outlay at 5 per cent and rent of land. This method is not being used in new plants and is being abandoned in old plants on account of the area required, the interference which is caused in times of heavy storms, the increased difficulty of operating caused by winter weather and the general cumbersomeness of the method.

MECHANICAL PROCESSES FOR DEWATERING SLUDGE.

Among the early mechanical methods of reducing the bulk of the wet sludge by dewatering was pressing in machines which consist of a number of cast iron plates generally 9 sq. ft. in area with corrugated faces and surrounded by a machined rim so that when placed together they form watertight cells 2 ins. thick. A central pipe about 6 ins. in diameter extends through the middle. Over each plate a canvas cloth is placed and sludge forced into the press and subjected to a pressure of from 60 to 75 lbs. per square inch. This squeezes the water out and the resultant cake contains between 50 and 65 per cent moisture and is about one-fifth the bulk of the original wet sludge.

It is necessary to add to the sludge before pressing from ½ to 1 per cent of lime, the fine particles of which facilitate the passage of water, the dissolved lime agglomerating the solids of the sludge. The cost of pressing largely depends on the amount of lime added, the kind of sludge pressed and the magnitude of the works; in large cities the average cost is 10 cts. per ton of wet sludge.

At Worcester, Mass., about 18,000,000 gals. of sewage a day is received at the chemical precipitation works. There are added 55.5 lbs. of lime to each 1,000 gals. of sludge, which contains on an average about 90 per cent moisture when pumped from the tanks. The presses reduce the moisture to about 70 per cent and 0.167 tons of sludge cake are obtained from each cubic yard of the wet sludge. The pressed cake is hauled in electrically propelled cars about a mile and disposed of for filling low waste land.

Another mechanical method of dewatering sludge is by means of centrifuges which occupy less space than presses and do not require the addition of lime to the sludge. Such machines are continuous in action and the work of extracting the moisture consists of two distinct and constantly repeated periods. During the first period the wet sludge is introduced into the machine and by the action of centrifugal force the moisture content reduced. During the second period the sludge thus partly dried is automatically ejected. The final product contains about 60 per cent moisture and occupies about one-eighth the volume of the wet sludge.

The largest installation of these machines is in Frankfort-on-Main, Germany, where the sewage of 400,000 people is subjected to plain sedimentation and about 310 tons of wet sludge 90 per cent moisture obtained per diem. The sludge is pumped to overhead reservoirs and kept agitated by revolving paddles. From thence it is fed to 8 centrifugal driers capable of handling 325 cu. yds. of wet sludge a day of 10 hours; after drying it is carried by a conveyor through a tunnel heated by the exhaust gases from the power station and as a 20 per cent moisture mass resembling soft coal of a gray color is mixed with garbage and both disposed of by destructors, the steam being used for generating electricity for power and lighting.

DIGESTION OF SLUDGE.

In the methods of sludge handling above described efforts were directed toward preventing the dissemination of the foul odors from the wet mass. Within recent years much thought has been given to devise processes of treatment by the digestion of the putrescent matters to produce an inoffensive sludge both as withdrawn from the tanks and during drying.

One of the methods to accomplish this purpose is to remove the freshly deposited sludge from the sewage sedimentation tanks at intervals and place it in separate tanks. Usually a scum forms upon the surface beneath which more or less active fermentation and decomposition develops. New sludge is added and digested sludge withdrawn from time to time and placed upon underdrained sand or cinder beds for drying. On account of the digestion of the sludge it dries more rapidly and is much less offensive than when fresh.

This method is now in use at Baltimore, Md., where the sewage is freed of its settleable solids in large tanks. The accumulated sludge is removed at intervals by centrifugal pumps and discharged into adjacent concrete tanks where considerable digestion occurs, as indicated by the continuous ebulition of gas which is inoffensive. At first the sludge was withdrawn from the digestion tanks and dried upon underdrained sand beds. It could be removed in a much shorter time than undigested sludge and but little offense was created. At the present time, the wet sludge from the digestion tanks is being sold to farmers for use on truck farms. The same method of separate sludge digestion is in use at Birmingham, England, the dried material being used to fill in a deep ravine between railway fills.

For the last 20 years it has been known that the retention of sludge in the tank in which it is deposited, which is known as the septic treatment of sewage, resulted in the reduction of the bulk and offensiveness of the sludge, but experience showed that while the sludge was benefited, the water leaving the tank, known as the effluent was seriously fouled by the decomposition of the organic matter in the sludge. The first attempt to obviate this fouling of the effluent was the digestion of the sludge in a separate tank above described. Another attempt was made by Dr. Travis at Hampton, England, who built a septic tank divided into upper and lower compartments; four-fifths of the sewage was passed through the upper part and the sludge settled through slots into the lower part through which the remaining one-fifth of the sewage flowed. Thus four-fifths of the sewage remained fresh, but when the foully contaminated one-fifth was added to the tank effluent it frustrated the purpose. Furthermore, the passage of sewage through the lower part maintained conditions favorable to the development of sulphur bacteria and produced a malodorous sludge.

The principles involved in the construction of the Imhoff or Emscher tank are familiar to our readers. Thi type of tank was developed to obviate the fouling of the effluent referred to in the preceding paragraph.

When such a tank is first put in operation it is entirely filled with sewage; as there is no flow through the sludge compartment, decomposition develops therein and the putrescent matters in solution and as colloids largely destroyed. The sludge deposited in the lower compartment is, therefore, covered by a water having characteristics different from those of fresh sewage and it is the opinion of some that this is the cause of the inoffensive sludge digestion. The gases evolved under these conditions being principally methane and carbon-dioxide, these cases while in the sludge are under a hydrostatic pressure due to the depth of the tank and when the sludge is withdrawn upon the drying bed the bubbles expand, lightening the mass and aiding in a separation of the water which flows to the bottom and is carried away by the drains of the drying bed. The digestion of the sludge also reduces its sticky tenacious nature and facilitates its parting with the water.

In normal weather sludge from a matured Emscher tank will dry on sand beds in from 3 to 5 days to a consistency fit to remove, while sludge from septic tanks requires at least 2 weeks' time, and sludge from plain sedimentation tanks will require about 8 weeks in summer and at least twice that length of time in winter, to be dry and firm enough to handle.

Dried Emscher sludge is suitable for filling low land or use in agriculture, particularly in lightening heavy soils, as it is very spongy in texture due to the entrained gas. But experience has demonstrated that the use of air-dried sludge from any source will not give results comparable with those obtained from the use of artificial fertilizers.

The rapid drying of sludge digested in Emscher tanks allows of very much smaller sand beds than for other kinds of sludge; in fact, it is usual to provide only 1 sq. ft. of bed for each three persons tributary to the tank.

The ingredients of sludge having value are usually more costly to recover than they are worth. In some cases grease is recovered, fertilizer or fertilizer base prepared and the fuel value partially recovered.

The Adoption of Fine Screening at Daytona, Fla.

In our issue of Dec. 2, 1914, we published an article on the new combined sewage pumping, screening and sterilizing station at Daytona, Fla. The details of the station design were shown and the specifications prepared by the consulting engineer, Mr. George W. Fuller, to govern the design, installation and operation of the screening and sterilizing apparatus were quoted. The following additional information pertaining to this work relates to the considerations which led to the adoption of fine screening and to the operation of the plant.

Daytona is a winter resort city in Florida, on the Halifax River. The permanent population is 6,000, the winter population 10,000.

In the design and construction of clarification apparatus for Daytona, the engineers were confronted with the following conditions and the Riensch-Wurl screen was selected for meeting the conditions in the most economical and sanitary manner.

1. Ample dilution water in the Halifax River, thus not requiring the removal of all the organic matter.
2. Local topography and arrangement of city, suggesting a combination of pumping station built practically in the middle of the city with accompanying screen.
3. Conditions of the soil, quicksand uniformly under the surface a few feet, making tanks of any depth or size very expensive.
4. Local topography, permitting ready and inexpensive means of disposing of fresh screenings by burying them.
5. Convenience of operation afforded, in that a screening and pumping plant could be attended to in a single location while settling tanks would probably require construction and attention in two places.

OPERATION FEATURES

Of the station equipment, the interesting feature is the clarification and disinfection of fresh, raw sewage by the combination of a Reinsch-Wurl sewage screen and automatic chlorine disinfecting apparatus. The effluent from this combination is discharged without further treatment of any kind.

Sewage will enter the disposal station through a 24-in. vitrified sewer and will first pass through a fixed screen having bars ⅜ by 2 ins. on 2½-in. centers. The bar screen is 3 ft. 6 ins. wide, affording an effective open area through the screen with a maximum sewer capacity of approximately 150 per cent of the area of the sewer.

The bar screen will be cleaned manually.

The screenings will be collected in special cans with perforated bottoms to allow them to drain into the influent channel. From the bar screen the sewage will flow onto the screen, 8 ft. in diameter, placed on an inclination of 10° in the sewage, providing a maximum effective screening surface. The total area of the 8 ft. screen is 43 sq. ft. and under maximum flow conditions the subferged effective area is 30 sq. ft., which is about 70 per cent of the total screen area.

The screening plates are made of ⅛-in. monel metal, arranged in sections on the screen frame. The screening plate perforations are 5/64 in. wide by 2 ins. long, staggered. With the above effective area and size of slots, the present capacity of the screen will be about 1,000,000 gals per day, ultimate capacity of about 2,000,000 gals. per day. This is based on 50 per cent run off in eight hours.

The arrangement of the screen varies from German practice inasmuch as no bearings or wearing parts are in the sewage. All screens installed in Germany have had the lower bearing and the driving gear operating in the sewage. American engineers objected to this even in view of the fact that in none of the 55 installations of the Riensch-Wurl screens in Europe has any trouble arisen due to such an arrangement.

The screen will be driven from a countershaft in the station bv oil engines, two being installed, to furnish power for the entire system, including the ejectors, one at each end of the countershaft to provide against emergency. The screen will require about ½ HP. for operating the disc and the cleaning mechanism.

The effluent from the screen will be sterilized by chlorine gas fed by an automatic chlorinator suitable for the treatment of raw sewage. The chlorinator is of such size that it is capable of feeding chlorine gas at any desired uniform rate between the limits of 10 and 150 lbs. in 24 hours. The system is equipped with reducing and regulation control valves, together with gages and all other necessary appurtenances and is piped to allow sterilization, both of raw sewage entering the pumping station and of clarified sewage after passing the screen. From the screen the effluent flows into the pump well from which point it is pumped through the outfall into the Halifax River.

The advantages of this arrangement of pumps and screens are as follows:

1. The screens protect the pumps. 2. With the pumps after the screens the solids are not disintegrated and the maximum cleaning effect is obtained. 2. The pumps provide thorough mixing of the disinfection agent and the effluent.

The screenings from the screen will be discharged into cans which are handled by a small wall hoist and disposed of by burial.

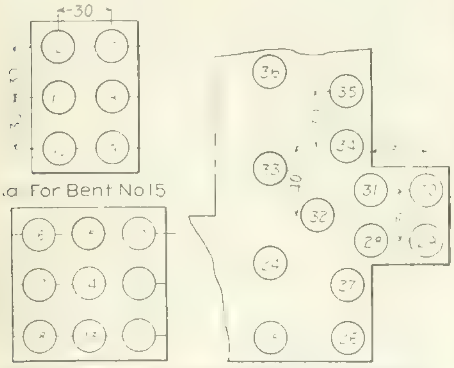
The plans and specifications for the work were prepared by George W. Fuller, Consulting Hydraulic Engineer and Sanitary Expert, New York City. The engineer in charge of the work is C. M. Rogers, Engineer for Board of Public Works, Daytona. The apparatus for fine screening and disinfection is being furnished and installed by The Sanitation Corporation, New York City.

BRIDGES

Construction Features of the Bloomfield Bridge, Pittsburgh, Pa.

Contributed by A. E. Sortore, Assistant Engineer, Division of Bridges, Pittsburgh, Pa.

(In our issues of Sept. 9 and 23, 1914, we published articles on the design of the superstructure, and of the substructure and approaches, respectively, of the Bloomfield Bridge, Pittsburgh, Pa. In these articles we described in detail and gave working drawings of the design features of this important structure. The bridge, which is a highway deck structure, has a total length of about 1,962 ft., the superstructure of which, exclusive of reinforced concrete retaining wall approaches, consists of the following spans: Ten 60-ft. girder spans; three 120-ft. truss spans; and a cantilever system consisting of two 120-ft. anchor arms, two 140-ft. cantilever arms, and a 120-ft. suspended span. On account of the depth of the ravine, the girder and truss spans are supported on steel towers and bents resting on concrete piers, many of which have concrete foundations. The roadway has a clear width of 34 ft., and each cantilevered sidewalk has a width of 8 ft. The bridge is on a 3,907 per cent grade throughout, the curb of the roadway being 185 ft. above the tracks of the Pittsburgh Junction R. R. In the following article the construction features of the work are described.—Editors.)



a For Bent No 15

(b. For Bent No 20

c. In North Abutment

Fig. 1. Locations of Concrete Piles Tested During Construction of Bloomfield Bridge, Pittsburgh, Pa.—Piles Tested Were No. 10 in Bent 15. No. 17 in Bent 20 and No 30 in North Abutment.

PILE FOUNDATIONS.

The abutment at the north (Bloomfield) end of the bridge and the piers as far out as pier No. 12 (which is about 640 ft. from this end of the bridge) are founded on "Simplex" concrete piles, as the soil to a depth of from 30 to 60 ft. is filled material. In this part of the work 235, 16-in. piles, varying in length from 16 to 60 ft., were used. These piles were driven to a penetration of from 4 to 6 ins. in the last ten blows. The pile driver used was of the drop hammer type, the weight of the hammer being 3,200 lbs. and its fall, 15 ft.

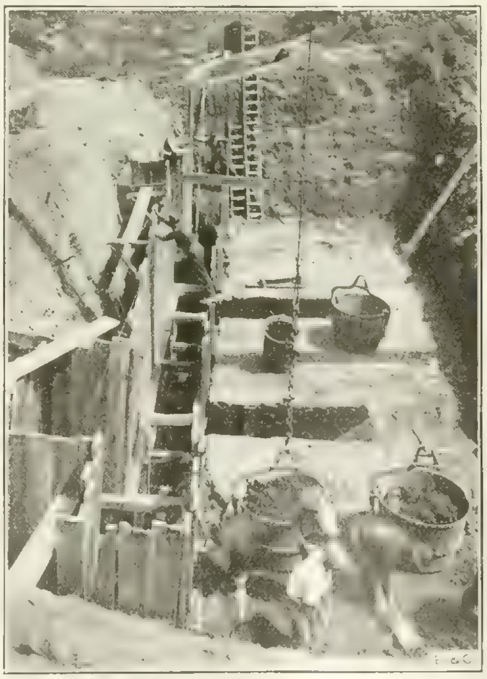


Fig. 2. Shoring and Excavation for South Abutment of Bloomfield Bridge—Toe Wall and Pilaster Bridge Seats Carried to Rock.

After the piles were driven, three of them were tested as follows: A platform 5 ft. square, made up of two layers of 3-in. oak planks, was grouted onto the head of the pile. A load of 30 tons of pig iron was then placed on the platform and allowed to remain 36 hours, when the load was increased to 60 tons and left in place another 36 hours. During the loading and unloading of the pile, readings were taken on a steel dowel grouted into the top of the pile. Nine readings per test were taken. The piles tested were: Pile No. 10, in bent No. 15; pile No. 17, in bent No. 20; and pile No. 30, in the north abutment (see Fig. 1). (A detail drawing of the piers for bent No. 17, together with data on the entire substructure design, are given in our issue of Sept. 23, 1914.—Editors.)

TABLE I.—RESULTS OF LOADING TESTS OF CONCRETE PILES.

No. of reading.	Load on pile, in tons.	Specified time between readings, hours.	Actual time tween readings, hours. —Pile Nos.—			Settlement, in feet. —Pile. Nos—		
			10	17	30	10	17	30
1	0	0	0	0	0	0.000	0.000	0.000
2	30	0	9	9	22	0.015	0.001	0.004
3	30	36	41	39	44	0.010	0.006	0.006
4	40	0	47	27	3	0.015	0.006	0.006
5	50	0	2	3	5	0.019	0.006	0.006
6	60	0	5	4	3	0.019	0.006	0.006
7	60	36	40	38	36	0.020	0.007	0.008
8	30	0	6	8	7	0.016	0.006	0.008
9	0	0	18	42	20	0.011	0.006	0.008

The following data and Table I give essential information on the results of these tests:

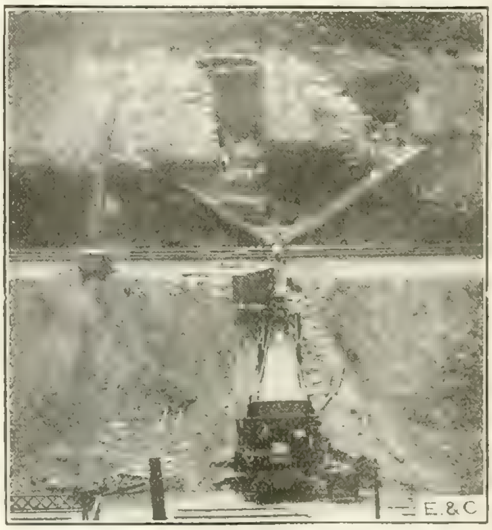


Fig. 3. Excavation and Disposal Equipment for Main Piers Nos. 5 and 6 of Bloomfield Bridge.

Pile No. 10, bent No. 15:
  Order of driving piles, 9, 10, 11, 8, 7, 12.
  Length of pile No. 10, 54 ft. 10 ins.
  Penetration from last 10 blows, 4⅞ ins.
  Penetration from last blow, ¾ in.
Pile No. 17, bent No. 20:
  Order of driving piles, 18, 13, 12, 11, 14, 17, 16, 15, 10.
  Length of pile No. 17, 45 ft. 9 ins.
  Penetration from last 10 blows, 6 ins.
  Penetration from last blow, ½ in.

Pile No. 30, north abutment:
Order of driving piles, 29, 30, 31, 28, 26, 27, 32, 34.
Penetration from last 10 blows, 4 ins.
Penetration from last blow, ¼ in.

It was specified that, in order to be accepted, no test should show a settlement exceeding ¼ in. between the first and third readings, nor more than ½ in. between the first and seventh readings, nor more than ⅜ in. between the first and ninth readings.

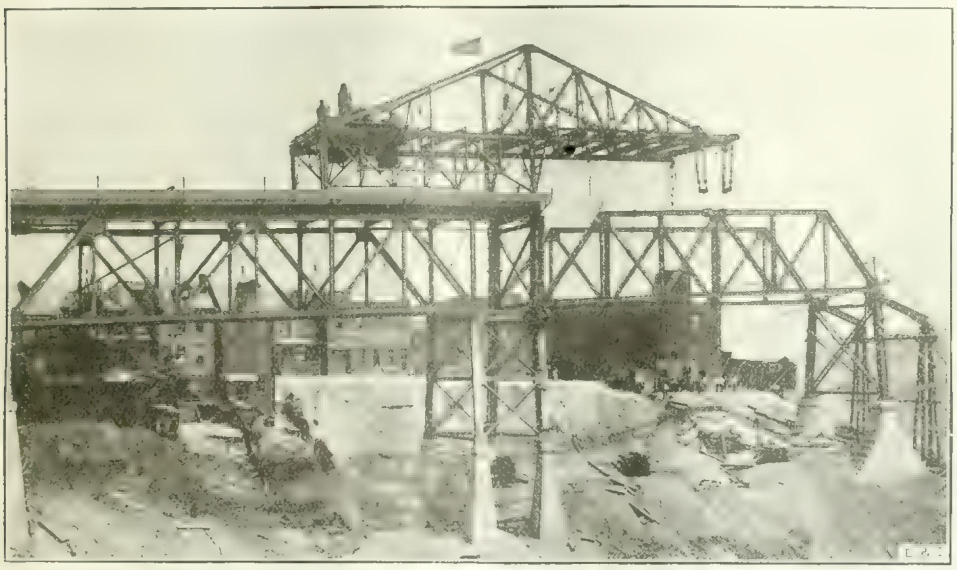


Fig. 4. View Showing Erection of 120-ft. Trusses Between Anchor Pier No. 9 and Pier No. 10 of Bloomfield Bridge— Note Type of Creeper Used.

While the load was being changed 20-ton jack screws were placed under the corners of the platform. Before the jacks were removed the pile of pig iron was balanced as nearly as possible, and side supports were set in place to keep it from tipping over. The full 60-ton load of pig iron made a pile about 16 ft. high.

CONSTRUCTION OF SUBSTRUCTURE.

The south abutment (a detailed drawing of which is given in our Sept. 23, 1914, issue.—Editor) is located over an old stone quarry, which, for a number of years after it was abandoned, was used for dumping purposes. Test pits showed practically a horizontal layer of rock about 12 ft. below the surface of the ground at the front of the abutment, and about 30 ft. at the end. The front wall and 40 ft. of the adjoining sidewalls were built with their bases on fair earth foundations from 9 to 13 ft. above the rock, and with a toe wall 3 ft. wide running down to the rock. The pilaster bridge seat was also founded on rock. This type of construction proved to be very satisfactory. Figure 2 is a view of the site of the south abutment. This view shows the shoring used for carrying the pilaster bridge seats and the toe wall down to rock. It also shows the excavation required for the remainder of this abutment. The other side walls, however, were not provided with the toe wall, but were designed with exceptionally wide bases. For example, the highest wall was 20 ft. high and had a base 15 ft. wide; while the lowest one was 10 ft. high and had an 8-ft. base. Soon after these walls were built, and before much back-fill was placed, they began to show settlement. As soon as this was noticed the copings were omitted, the abutment was filled to subgrade, and the walls were watched for settlement during the winter. This settlement varied from 1 to 3 ins., most of which was in a vertical direction, with very little tilting. By spring the walls seemed to have reached their bearings, and the copings were put on during this summer. The side walls were built in 20-ft. sections, with tar paper expansion joints at the end of each section.

The four main piers, which are located in the bottom of the valley, are founded on solid rock. The excavation for these piers was mostly shale rock and hard blue stone. For the two piers nearest the Pennsylvania R. R. (Nos. 5 and 6) the excavation was trimmed as nearly as possible to the size of the piers, forms being used only for the exposed parts. Figure 3 shows the manner of excavating for main piers Nos. 4 and 5, and of disposing of the excavated material. On the other two piers, which are located near Lorigan St., forms were used on all four sides, from the footings to the top. This was done to get away from any danger of having the hill dug away from them and exposing a rough surface.

The material excavated for the anchor piers (No. 4) was extremely hard. Close under the surface of the ground hard blue stone was encountered, and in order to place the anchor grillage and to get the required weight for the anchorage it was necessary to excavate about 30 ft. into this rock. All the other piers have good foundations, either on hard shale, rock or concrete piling.

During the pouring of all concrete care was taken to have it properly spaded against the forms, and as soon as possible the forms were removed and all exposed surfaces were finished by rubbing with clear water and a wooden float, which gave the desired sand finish. The time of removing the forms varied from 15 to 48 hours, depending upon the weather and the size and position of the parts poured.

In constructing the substructure the contractor used both electrically-driven and steam-driven equipment. For the north abutment and for the piers out as far as bent No. 12, a ½-cu. yd., motor-driven batch mixer was used. This mixer was mounted on wheels and was easily moved along the line of work by the auto truck which delivered the sand and gravel. At this abutment there also was erected a 40-ft. tower for distributing the concrete. The hoist in this tower also was motor driven.

At the anchor piers for bents Nos. 4 and 9 ¾-cu. yd. batch mixers were installed, both of which were driven by steam from portable boilers. The mixer at bent No. 9 served for all piers from bent No. 13 to main piers Nos. 7 and 8. The one at bent No. 4 served the piers for this bent and the main piers Nos. 5 and 6. The concrete was distributed from the two mixers by means of chutes laid along the slopes of the hills.

At the south abutment a stiff-leg derrick equipped with an orange-peel bucket was used for excavating and back-filling. The derrick was also used for moving forms and placing concrete in the walls. There was a motor-driven batch mixer located near the front wall, which served this abutment and the piers in bents Nos. 1 to 3, the concrete being carried to the piers by means of chutes laid along the side of the hill.

A stiff-leg derrick located on Melwood Ave. was used in excavating for anchor pier No. 4. Most of this excavation was a good grade of blue stone, and the contractor sold it for building purposes.

For handling the excavation from main piers Nos. 5 and 6 a 14-in. continuous link belt conveyor, electrically driven, was installed under the four tracks of the Pennsylvania R. R. The material was fed into the conveyor by chutes from the excavation and was discharged into a hopper on the side of the bank, from which it was loaded into wagons and hauled to a near-by dump. The excavation from main piers Nos. 7 and 8 was loaded directly into wagons and hauled to the dump. The remainder of the excavated material was used either as back-fill in the two abutments or was wasted along the line of the work.

The electric power was obtained from one of the power companies in the city, and it was distributed along the line of the work by a branch cable which was run from the company's main feeder on Liberty Ave.

ERECTION OF SUPERSTRUCTURE.

The erection of the steelwork was started from both abutments by means of stiff-leg derricks of eleven tons capacity, mounted on sliding bases. These derricks were used for all of the 60-ft. plate girder spans and their towers, which constituted the work out to bent No. 12 on the north end and out to bent No. 3 on the south end. Here they were used in the assembling of the two "creepers," which were used for the erection of the remainder of the steelwork. The stiff-leg derricks were afterwards used as yard derricks, one being located at bent No. 15 and the other at the south abutment.

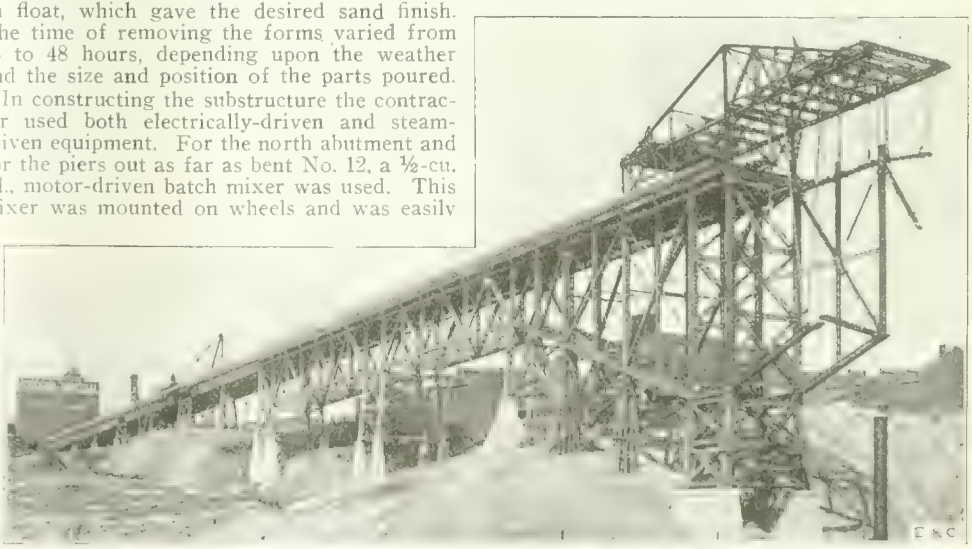


Fig. 5. View of East Portion of Bloomfield Bridge Showing Manner of Erecting Cantilever Arm—Note Supports Under Lower Chord Panel Points of Anchor Arm.

The two creepers were specially designed for this bridge. They were 120 ft. long, 65 ft. of which were in the cantilever arm. The trusses, which were spaced 32 ft. on centers, were designed for a load of 20 tons on any one of the six panel points, together with 10 tons at the end of the cantilever arm, thus giving each truss a capacity of 70 tons, or a total capacity of 140 tons. Each creeper was operated by two engines mounted at the rear end, one having a capacity of 45 HP. with six spools and the other a capacity of 40 HP., with four spools.

The two 120-ft. truss spans from bents Nos. 9 to 12 are on a side hill, which slopes at an angle of about 50° with the horizontal. For a part of the distance this hill consists of a loamy fill, and for the remaining distance it consists of slippery clay. To erect falsework along this slope would have required considerable excavation, on account of the difficulty of providing suitable foundations. To overcome this it was decided to assemble the trusses on the ground; and in order to do this, a set of blocking was laid out along the line of the bridge between the two bents at the proper elevations to allow for the camber in the trusses. The bottom chord was placed on this blocking and the truss then assembled. After all the connections were made by means of bolts and drift pins, the truss (which weighed about 34 tons) was raised to position, the outstanding bent having been erected by means of a gin-pole which was operated from the engines on the creepers. Each set of blocking served for the two trusses of the span. Figure 4 is a view of the creeper engaged in the erection of the 120-ft. span between the anchor bent No. 9 and bent No. 10. This view shows clearly the construction features of the creeper; it also shows the blocking on which the lower chords were assembled and the trusses erected before being raised to position.

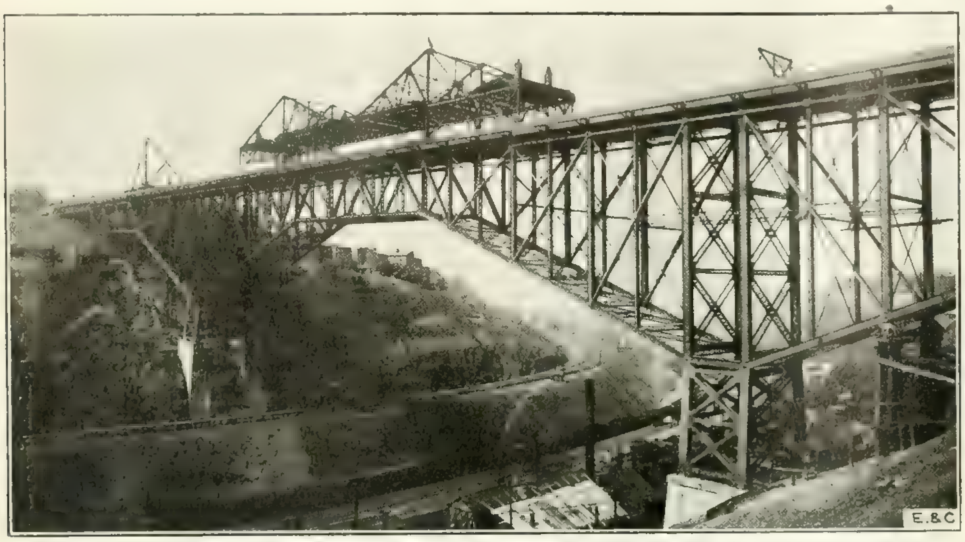


Fig. 6. View of Cantilever System of Bloomfield Bridge—The Two Creepers Are in Position for Erecting Suspended Span.

The 120-ft. truss span from bent No. 3 to bent No. 4 (which spans Melwood Ave.) was erected on falsework in the usual way. This method proved to be considerably longer and more expensive than that used for the other two truss spans, but it permitted Melwood Ave. to be kept open to traffic.

In erecting the cantilever arms the bottom chords of the anchor arms were blocked up as shown in Fig. 5. This view, which shows the east portion of the bridge, also illustrates the procedure used in erecting the cantilever arm. One of the stiff-leg derricks is shown in the background.

In the erection of the suspended span, an interesting method was used. Since the Baltimore & Ohio tracks are directly under this span, it could not be assembled on the ground and then raised to position. To erect it, the two creepers were moved out until their ends practically met (see Fig. 6). The bottom chord, which is in three 40-ft. sections, was then hung from the creepers by means of adjustable slings, and after it was properly connected and placed the rest of the truss was assembled on it. The view of Fig. 6 shows the cantilever span and the west portion of the bridge.

ROADWAY PAVING BASE AND REINFORCED CONCRETE SIDEWALKS.

The paving base, which rests directly on the buckle-plate floor of the bridge, is of 1:2:4 concrete, this part of the work being done by contract. To obtain the proper crown for this base a steel templet was used, which slid along the top of the curbs and was kept at right angles to the curb by means of braces from the templet to the face of the curb.

The wearing surface of the pavement is of asphaltic concrete 2 ins. thick, and it was put down by the city's asphalt plant.

The reinforced concrete sidewalk slabs are 3½ ins. thick. These slabs are 1:2:4 concrete, with ⅜-in. square twisted bars on 5-in. centers for reinforcing. The slabs are supported on the sides by shelf angles (which are riveted to the fascia and curb girders) and in the center by an 8-in. I beam stringer, the distance between supports being 4 ft. The slabs are laid in 20-ft. sections, at the ends of which are provided ½-in expansion joints. The forms for the slabs consist of sheets of No. 20 gage black corrugated iron. They were laid on the shelf angles and I beams, and the concrete then deposited on them. At the expansion joints, instead of lapping the iron sheets, the two sides were turned up and made the end forms of the slab.

QUANTITIES OF MATERIALS AND COST.

The substructure contains 5,012 cu. yds. of plain and reinforced concrete, 8,443 lin. ft. of 16-in. "Simplex" concrete piles, 44 tons of steel reinforcing bars, and 68 tons of structural steel grillage. It was built during the summer of 1913 at a cost of $82,630. The superstructure contains 3,590 tons of steel, and its cost, erected, was $250,535. The roadway paving base and the reinforced concrete sidewalks were constructed at a cost of $19,879. The total contract cost of the bridge, exclusive of pavement wearing surface, was $353,044.

PERSONNEL.

The entire structure was designed and its construction supervised by the Bureau of Engineering, of Pittsburgh, N. S. Sprague, superintendent, T. J. Wilkerson, division engineer, and A. E. Sortore, assistant engineer, Division of Bridges.

The substructure was built by the Dravo Contracting Co., the superstructure was fabricated and erected by the Fort Pitt Bridge Works, and the paving base and reinforced concrete sidewalks were constructed by the M. O'Harron Co., all of Pittsburgh.

Floors for Steel Highway Bridges in Illinois.

The following data on highway bridge floors in general, and on the standard floor designs for steel bridges used by the Illinois Highway Department, will be found of particular value by those interested in highway bridge construction. The data were taken from a paper by Clifford Older, bridge engineer, Illinois Highway Commission, presented at the annual convention of the American Road Builders' Association in Chicago, Dec. 14-18, 1914.

Definite statistics in regard to the number and length of highway bridges for any considerable mileage of highways are difficult to obtain and are not at present available. In some states, however, we are able to ascertain the amount of the total expenditure for bridge work of all kinds. Available information of this kind seems to indicate that approximately one-half of the funds raised for ordinary road and bridge purposes are expended in the renewal and maintenance of bridges.

It is evident, therefore, that if maintenance expenditures are to be reduced to the minimum highway bridges and bridge floors should receive careful consideration.

Judging from conditions in Illinois it is probable that at least 90 per cent of all existing highway bridges are provided with nothing better than plank floors, and that the maintenance of these floors costs approximately 15 per cent of the total expenditure for road and bridge maintenance, or about $10 per mile of road per annum.

FLOORS FOR NEW BRIDGES.

It is a simple matter to provide sufficient strength in the design of a new bridge to accomodate any of the various modern types of floors or wearing surfaces.

It seems desirable to select a type of floor which will permit the use of a wearing surface of the same kind as that on the adjacent highway, so that the same method of maintenance may be used on the bridge floor elsewhere.

The difference in weight of various types of floors has but little effect on the design and cost of concrete bridges. Steel bridges, however, are materially affected, both in design and cost, by a comparatively small variation in the weight of the floor. The saving in the weight and cost of the steel in the trusses and floor system for the lighter floors may out-weigh the advantage of having the same wearing surface on the bridge as elsewhere on the highway.

Floors for steel bridges only will be considered in this discussion.

It is desirable to provide an independent wearing surface so that even though the pavement may be worn practically through, the bridge will still carry traffic with safety.

The bridge floor should then preferably consist of two elements: The sub-floor, which should be as permanent as the bridge superstructure, and should provide the necessary strength to transmit the highway loads to the floor supports; and a wearing surface of such character as to permit of economical maintenance.

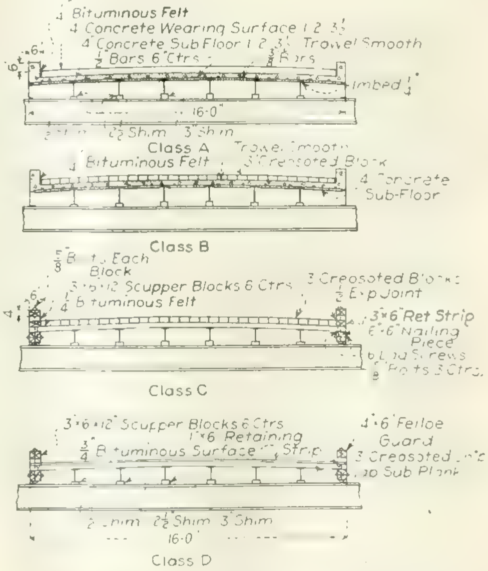


Fig. 1. Standard Types of Bridge Floors Used By Illinois Highway Department.

In considering construction materials for both of these elements the matter of weight increases in importance with the length of span. For sub-floors of the more permanent type buckle-plates with concrete covering, reinforced concrete, and creosoted plank cover the field. For wearing surfaces, brick, concrete, creosoted blocks, macadam gravel, mixtures of bituminous materials with sand, gravel or stone, plank, ordinary soil, and practically all other varieties of surfacing materials have been used.

In comparing costs it is necessary to consider, not only the cost of the floor and its maintenance, but also the effect of the weight of floor selected on the design and cost of the remainder of the bridge.

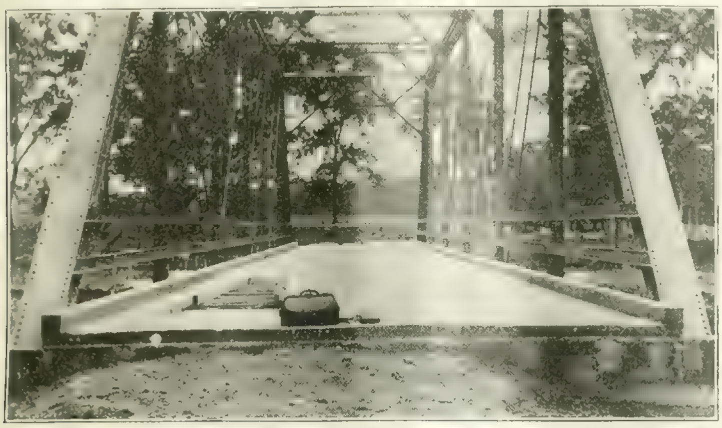


Fig. 2. Through Truss Bridge With Concrete Sub-floor Ready for Wearing Surface.

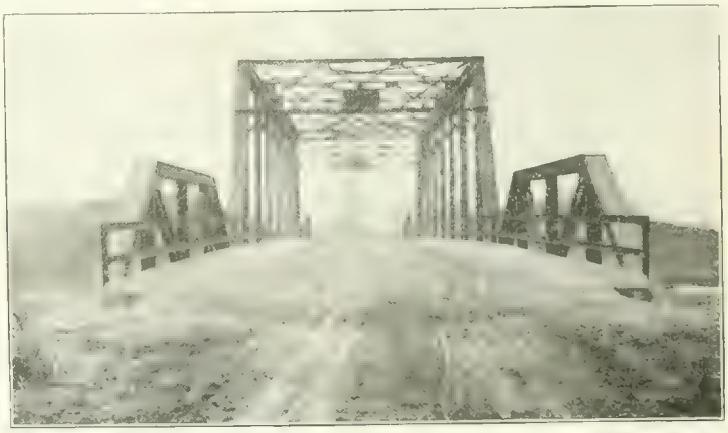


Fig. 3. Bridge With Concrete Sub-floor and Macadam Wearing Surface.

CLASSIFICATION OF FLOORS WITH RESPECT TO WEIGHT.

For the purpose of considering the effect of the weight of the floor on the design of the superstructure the various types of floors are herein grouped in four classes, as follows:

Class A Floors.—Floors which weigh approximately 100 lbs. per square foot of roadway surface are included in Class A. Floors consisting of a reinforced concrete sub-floor, assumed to weigh 50 lbs. per square foot, on which is placed a wearing surface of concrete, brick, macadam or gravel, are of this class. The wearing surface is assumed also to weigh 50 lbs. per square foot of roadway surface.

Class B Floors.—Floors which weigh approximately 65 lbs. per square foot of roadway surface are included in Class B. Floors consisting of a concrete sub-floor, with a creosoted block wearing surface, and floors consisting of creosoted plank sub-floors with a brick wearing surface, are of this class.

Class C Floors.—Floors which weigh approximately 32 lbs. per square foot are included in Class C. Floors consisting of a creosoted plank sub-floor, with a creosoted block wearing surface, are included in this class.

Class D Floors.—Floors which weigh approximately 26 lbs. per square foot are included in Class D. Floors consisting of a creosoted plank sub-floor, with a wearing surface about ¾ in. thick and composed of a mixture of gravel and bituminous material, are of this class.

Buckle-plate floors are not considered, as they weigh as much and cost more than concrete sub-floors.

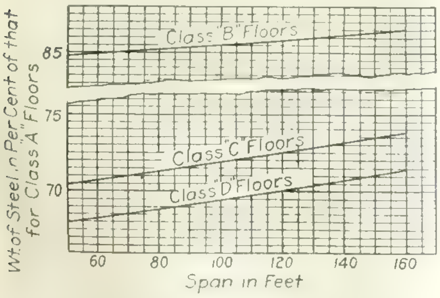


Fig. 4. Relative Weights of Steel in Superstructures of Bridges Having Different Types of Floors—Class A Taken as 100 Per Cent.

STANDARD TYPES OF FLOORS.

Figure 1 shows standard designs used by the Illinois Highway Department for the floors above mentioned.

The creosoted plank sub-floors (Class C and Class D) are crowned by bending the plank over the stringers and anchoring the ends to the nailers by means of lag-screws.

The creosoted blocks (Class B and Class C) are laid on a ¼-in. bituminous felt cushion, which is coated with asphalt immediately before laying the blocks.

Ship-lap sub-plank are used for floors having a bituminous gravel wearing surface. The use of this form of sub-plank has been found to be the cheapest and most effective method of preventing the leakage of the bituminous material.

Figure 2 shows a through truss bridge with a concrete sub-floor ready for the wearing surface, and Fig. 3 shows a bridge with a concrete sub-floor and a macadam wearing surface.

EXPLANATION OF CURVES OF FIGS. 4, 5 AND 6.

The curves shown in Fig. 4 give the weight of the structural steel in bridge superstructures as a percentage of the weight of the steel in superstructures having Class A floors, that is, the weight of superstructure steel in bridges having floors weighing 100 lbs. per square foot is taken as 100 per cent and the weight of steel required for the lighter floors is expressed as a percentage of this weight.

These curves are based on the weight of steel in spans which conform to the standard designs of the Illinois Highway Department. The designs used provide for 16-ft. roadways. The curves were checked at a number of points, however, for 18-ft. roadway designs, and were found to conform very closely. These curves are sufficiently accurate to enable a designer to determine the relative cost of steel superstructures having floors of various types and weights.

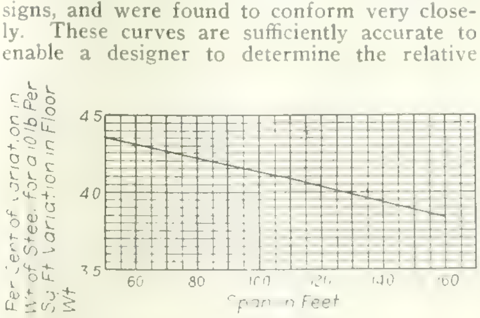


Fig. 5. Variation in Weight of Steel for 10-lb. Variation in Floor Weight.

The curve shown in Fig. 5 is based on the curves of Fig. 4, and it shows the average per cent variation in weight of steel for a variation of 10 lbs. per square foot in the weight of the floor.

Figure 6 shows the average contract prices for the Illinois Highway Department standard 15-ft. roadway steel spans with floors complete. For spans up to 80 ft., inclusive, riveted pony trusses are used, and for spans from 90 to 160 ft., riveted Pratt trusses are used. This range of span length covers at least 90 per cent of the highway bridges in Illinois.

The average contract price of materials is as follows:

Structural steel complete in place, per lb.	$ 0.03½
Concrete sub-floors, including reinforcing steel per cu. yd.	12.00
Concrete wearing surface, 4 ins. thick, per sq. yd.	0.90
Creosoted sub-plank (12-lb. treatment), complete in place, per M ft. B. M.	70.00
Creosoted block wearing surface, per sq. yd.	1.80
Bituminous gravel wearing surface, per sq. yd.	0.60

The average cost of sub-floor and wearing surface per linear foot of 16-ft. wide roadway (1.78 sq. yds. including curbs) is as follows:

	Per lin. ft. of bridge.
Concrete sub-floor with concrete wearing surface (wt. 100 lbs. per sq. ft.)	$4.25
Concrete sub-floor with creosoted block wearing surface (wt. 65 lbs. per sq. ft.)	5.80
Creosoted plank sub-floor with creosoted block wearing surface (wt. 32 lbs. per sq. ft.)	7.30
Creosoted plank sub-floor with bituminous gravel wearing surface (wt. 26 lbs. per sq. ft.)	5.15

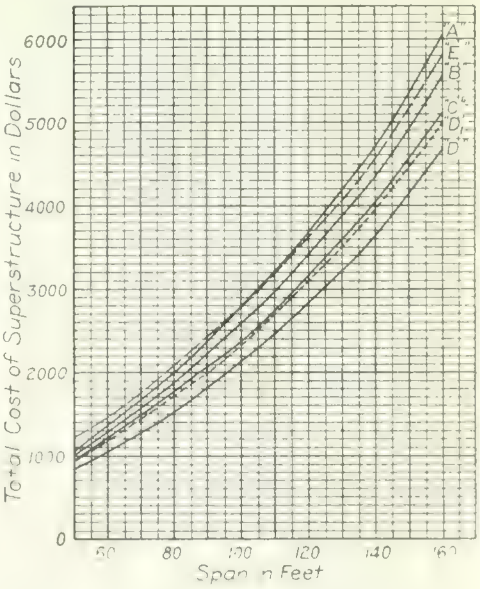


Fig. 6. Average Contract Prices for Illinois Highway Department Standard 16-ft. Roadway Steel Spans Having Various Types of Floors.

"A."—Sub-floor concrete, surface concrete.
"B."—Sub-floor concrete, surface blocks.
"C."—Sub-floor plank, surface blocks.
"D."—Sub-floor plank, surface bituminous.
"D₁."—Sub-floor plank, surface bituminous—includes capitalized maintenance.
"E."—Untreated plank floor—includes capitalized maintenance.

It seems probable that under average conditions the length of life of the floors represented by the upper three full-line curves of Fig. 6 may equal that of the remainder of the superstructure and that the cost of maintenance for this period would be small.

The experience of the Illinois Highway Department seems to indicate that, under average conditions, the bituminous wearing surface requires a light treatment of oil and stone chips or screened gravel at intervals of about four years, at a cost of about 10 cts. per square yard, and a probable complete resurfacing once in about twelve years, at a cost of approximately 60 cts. per square yard. This amounts to 7½ cts. per square yard per annum. Adding to the first cost of the bridge the maintenance charge capitalized at 6 per cent there results the values represented by curve D1, Fig. 6. The position of this curve indicates that it would be preferable to use creosoted block or other floor in building new structures.

Probably 95 per cent of existing steel highway bridges were originally designed for ordinary plank floors. Under average conditions, and at the present price of yellow pine, which is the material now quite generally used, the annual cost of maintaining such floors is about 35 cts. per square yard. The first cost plus the maintenance charge capitalized at 6 per cent gives the results represented by curve E, Fig. 6.

CONCLUSIONS.

It is evident that ordinary plank floors, having an average life of not more than 3½ years, are to be avoided whenever possible.

It is to be noted that, with the exception of the floor with the bituminous surface, the cost of the floor increases as the weight decreases, yet the cost of the entire superstructure decreases as the weight of floor decreases.

The saving in cost for the lighter floors increases with an increase in the unit cost of structural steel in place, and decreases with an increase in the cost of the materials used in such floors.

In re-flooring old steel bridges of satisfactory design, creosoted sub-planks with a bituminous wearing surface have been found to give reasonable service. The weight is somewhat greater than that of a plank floor, but the effect of the added weight is probably offset by the reduction of impact, due to the comparatively smooth and yielding surface.

The cost of maintaining the bituminous surface is only about 20 per cent of that of an ordinary plank floor.

There seems to be no place in the economic design of new highway bridges for floors consisting of a creosoted plank sub-floor with a brick wearing surface, as the life of such a floor could hardly be greater than that of Class C, Fig. 1, while the cost of the complete superstructure would be greater than that represented by curves B and C, Fig. 6.

The floors listed under Class A seem hardly to be justifiable, except for short spans, unless other considerations outweigh first cost.

WATER WORKS

The Use, Design, Construction, Cost and Durability of Wooden Stave Pipe.

III.

The Design of Wooden Stave Pipe.

Contributed by Andrew Swickard, Hydraulic Engineer, Palo Alto, Calif.

(Due to the transposition of two lines of type, in the mechanical process of making up the paper, the reading at one point in Mr. Swickard's second article, as published in our issue of Dec. 2, 1914, lacked the coherence it possessed when it left the hands of the author. The transposition occurred in the third and fourth paragraphs of the third column on page 518. As corrected, at the point mentioned, those paragraphs should read:

"In banding continuous pipe the rods should not be hammered so hard in an endeavor to give them the proper seating that the matter is overdone and the fibre of the wood broken. The same thing applies to the machine banded pipe; if the tension in the wire is too great when being wrapped the wood will be broken. Injuring the wood in any way makes spots where decay will start first and will be particularly active. Staves are often injured, so as to produce this result by striking them with a hammer hard enough to break the fibre.

"It is not probable that natural conditions will often be found under working circumstances that will absolutely prevent decay and rust, but advantage can be taken of favorable conditions to such an extent as largely to inhibit destruction from these sources."—Editors.)

Size of Pipe.—After arriving at the conclusion to use wooden pipe. The first step in the matter of design is the computation of size or sizes to be used.

The available experimental data, that are the results of elaborate and painstaking tests, are meager. The results obtained by the different experimenters do not conform with sufficient closeness to permit of the deduction of a formula with constant co-efficients that expresses, even approximately, the results of the best and most accurate experiments that have been made. It, therefore, remains to use the information that we have in a way that will give safe results.

The elaborate tests referred to are those made by Messrs. Marx, Wing and Hoskins on a 72-in. pipe at Ogden, Utah, recorded in Transactions Am. Soc. C. E., Vol. XL, p. 471, and Vol. XLIV, p. 34; by T. A. Noble on 44 and 54-in. pipe at Seattle, recorded in Transactions Am. Soc. C. E., Vol. XLIX, p. 112; and by Mr. E. A. Moritz on pipe from 4 to 56 ins. in diameter at Sunnyside, Wash., recorded in Transactions Am. Soc. C. E., Vol. LXXIV, p. 411. Other experiments have been made, but none with the forethought and care that these received.

While the results of these three sets of experiments do not conform closely when the comparison is made through the medium of a formula, having constant co-efficients, based on one or other of the experiments, there is no justification in accepting the results of one and rejecting the others. The safest result will proceed from a co-ordination of the results of the three.

A new formula is unnecessary and therefore undesirable. The Chezy formula is extensively used and generally preferred. It will express practical results if the coefficient c is determined as the result of actual measurements. The Kutter formula is generally used, either in the original or same modified form for determining the coefficient c. The writer has endeavored to co-ordinate the results of the experiments referred to by a comparison of the values of n (Kutter's formula) as determined by the experiments. By platting on co-ordinate paper the average values of n for each size of pipe experimented upon, using values of n as abscissas and diameters of pipe as ordinates, there results an apparently promiscuous spread of points, but by representing the center of gravity of different groups by secondary points, they line up in one general direction, and can be well represented by a straight line. This result was obtained by allowing full weight to all primary points, excepting that for the 12-in. pipe of Mr. Moritz's experiments, to which was allowed one-half weight. It is quite apparent that n is not a constant for wooden pipe, but a variable that varies directly with the size of pipe.

The equation representing this resulting straight line is,

$$n = \frac{D}{30{,}000} + 0.0105,$$

where D represents the inside diameter of the pipe in inches. By means of this formula the value of n can be determined for any size of pipe, and used in the Kutter formula for determining the coefficient c in the formula,

$$v = c\sqrt{rs}$$

where v = the velocity in feet per second; r = the mean hydraulic radius in feet, and s = the slope of the hydraulic grade line.

However, by substituting in the above formula $\frac{Q}{\frac{1}{4}\pi D^2}$ for v, Kutter's formula for c, ¼ D for r, and $\frac{M}{1000}$ for s, and letting B represent the expression $\left(41.65 + \frac{.00281}{s}\right)$ found in Kutter's formula, and there results the formula,

$$Q = \frac{.0062}{n} D^3 M^{1/2} \frac{3.622 + 2Bn}{D^{1/2} + 2Bn}$$

where Q = discharge in cubic feet per second; n = the variable to be determined by the formula above; D = the inside diameter in feet; M = the loss in head in feet per 1,000 ft.; $B = \left(41.65 + \frac{2.81}{M}\right)$. The results obtained by this formula will probably be criticized as being unfavorable to the larger sizes of pipe, but it has the virtue of conforming to an average of the best experimental data available, and thus of being on the safe side.

While the formula is quite lengthy its use is by no means laborious. For general purposes a diagram, representing graphically some of the results that can be obtained by the formula, is given in Fig. 1.

Thickness of Staves.—Having settled upon the size of pipe, the next consideration is the thickness of staves. This must be determined before the spacing of the bands can be computed, because the thickness of staves enters directly into that problem.

The wooden staves answer a two-fold purpose: by providing the watertight skin of the pipe, and by imparting to the structure, as a whole, the rigidity necessary to enable the pipe to resist external loads, with a deformation of form that is within the maximum allowable. Under an external load the pipe will flatten, assuming an oval form. This assumption of an oval form is not particularly harmful until it is carried far enough to open some of the seams on the inner surface. The maximum allowable deformation is marked by the beginning of the opening of the seams, or better, just before the beginning.

The size of the external head that a pipe will sustain without opening the seams, depends on the amount of compression between the edges of the staves. In the case of dry staves the amount of stave compression depends on the initial tension in the bands, and might be as high as 500 or 600 lbs. per square inch of stave edge. In the case of water soaked staves, the compression will never be high; not much, if any, above 150 lbs. per square inch, and often not over 125 lbs., depending on whether or not the initial compression in the staves was high or low when water was turned into the pipe. If the initial compression is low for dry staves, say about 70 lbs. per square inch, this will increase gradually as the staves become water soaked until it reaches from 125 to 150 lbs. per square inch and will then remain stationary. On the other hand if the initial compression of dry staves is say about 300 lbs. per square inch, this will decrease rapidly at first and then gradually more slowly, as the staves become water soaked, and will become stationary at about 150 lbs. per square inch. That wood will behave in this manner was ascertained by Mr. D. C. Henney, in a series of experiments, the results of which are recorded in the Transactions Am. Soc. C. E., Vol. XLI, p. 76. Mr. Henney's experiments were with separate pieces of wood, and the results are various, depending on varying conditions. The writer has recently obtained the compressive strains given above, by submerging short sections of wooden pipe, bound with one band, to which was attached a device for measuring the strain in the band. The government experiments on timber indicate that dry timber is 75 per cent stronger than wet timber. The elastic limit of dry redwood and fir, in compression across the grain, is about 600 lbs. per square inch; 25 per cent of this is 150 lbs. per square inch, the elastic limit for wet redwood and fir.

It is safe to assume that the compression between stave edges, for the woods used, will not in ordinary practice ever exceed 150 lbs. per square inch, and that, as most pipe lines stand long enough after being banded to shrink sufficiently to reduce the initial compression very low, before water is turned on, the compressive strain due to the swelling of the wood will seldom if ever exceed 125 lbs. per square inch. This quantity will be used as the maximum compressive strain in the staves in determining band spacing.

An external pressure on a pipe will open or tend to open the seams immediately under the pressure applied; the opening will be on the inner surface of the pipe. That the external load, which will generally be the earth covering, should never be heavy enough to actually open the seams, will without doubt be accepted without question. With no external load the compressive strain will be evenly distributed over a section of the stave, that is 125 lbs. per square inch at both outer and inner surfaces. As the load increases the compression at the inner surface will decrease and at the outer surface will increase, until it becomes naught at the inner surface, when the increase in load should stop.

The center of compression in the seams under the load has been determined by the writer by actual experiment to be 5/6 of the thickness of the staves from the inner surface. Considering that the compression, when under maximum external load, increases uniformly from inside to outside, then there will be 150 lbs. per square inch at the outer surface. Saturated wood will sustain this amount of compression.

The bands act with the staves in resisting the action of the external load; therefore, in the determination of the resisting moment, a length of pipe equal to the band spacing should be considered. The total resistance of the staves, which in effect is acting at the center of compression is

[illegible]

and taking moments about the center of the band there results:

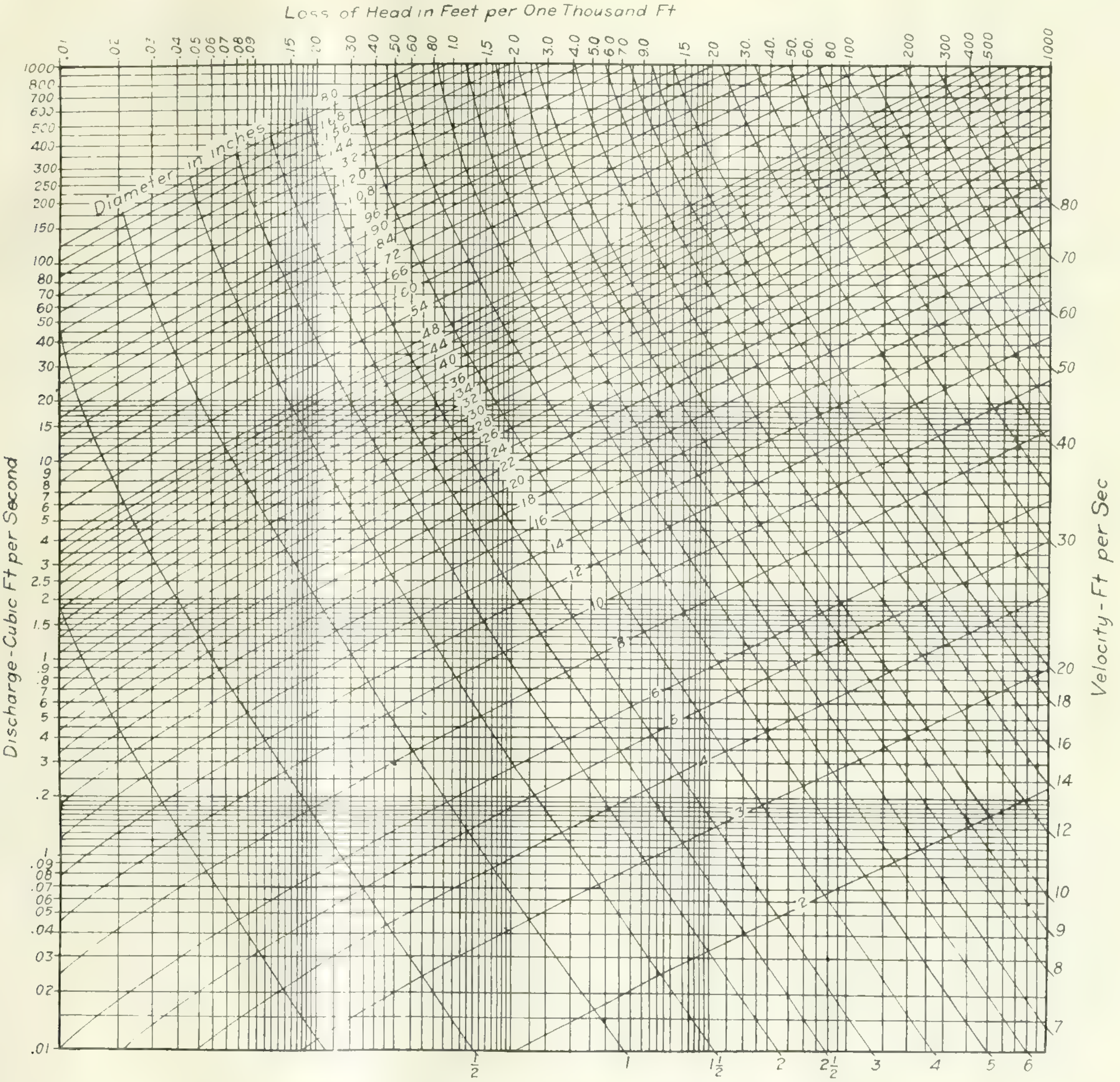


Fig. 1. Diagram for Determining the Flow of Water in Wooden Stave Pipe.

Based on formula, $V = c\sqrt{rs}$. By substitution and reducing there results $Q = \frac{.0062}{n} D M^{\frac{1}{2}} \frac{3.622 + 2Bn}{D^{\frac{1}{2}} + 2Bn}$ in which Q = cu. ft. per second, D = diameter in feet, M = loss of head in feet per 1,000 ft., $B = \left(41.65 + \frac{2.81}{M}\right)$ $n = \frac{\text{dia. in inches}}{30,000} + .0105$.

The value of n is the equation of a line representing a co-ordination of the values of n as determined by the experiments of Marx, Wing and Hoskins at Ogden, T. A. Noble at Seattle and E. A. Moritz at Sunnyside, Wash.

$$\text{Max. resisting moment} = \tfrac{3}{5}\,Ctl\left(\frac{t}{6}+r\right)$$

Where $C = 125$ lbs. per square inch; $t =$ thickness of staves; $l =$ band spacing in inches; and $r =$ radius of rod or wire in inches. For vertical loads the moment is a maximum at the top of the pipe and diametrically opposite.

The maximum bending moments for external loads on pipes and rings are as follows: (See Bulletin No. 22, University of Illinois, Engineering Experiment Station.)

For vertical concentrated loads, $0.159\,WD$.

For vertical distributed loads, $0.0625\,WD$.

For the following ratios of distributed horizontal to distributed vertical loads:

Value of ratio.	Maximum moment.
0	0.06250 WD
0.1	0.05625 WD
0.2	0.05000 WD
0.3	0.04375 WD
0.4	0.03750 WD
0.5	0.03125 WD
0.6	0.02500 WD
0.7	0.01975 WD
0.8	0.01250 WD
0.9	0.00625 WD
1.0	0.000 WD

In the foregoing W equals total load in pounds on the length of pipe considered, and D equals the diameter of pipe in feet.

The bending moment is equal to the resisting moment; therefore,

For vertical concentrated loads, $0.159\,WD = \tfrac{3}{5}\,Ctl\left(\frac{t}{6}+r\right)$

Substituting wl for W and l will disappear, and

$$t = \mp\sqrt{0.0126\,wD + 9r^2} - 3r.$$

A solution of this equation gives two roots but the positive root does not apply, and as we are not concerned with the direction of signs, the formula, for practical purposes, can be written;

$$t = \sqrt{0.0126\,wD + 9r^2} + 3r$$

For vertical distributed loads

$$0.0625\,WD = \tfrac{3}{5}\,Ctl\left(\frac{t}{6}+r\right)$$

and $t = \sqrt{0.005\,wD + 9r^2} + 3r.$

For vertical and horizontal distributed loads, ratio $= 0.5$,

$$t = \sqrt{0.0025\,wD + 9r^2} + 3r,$$

$w =$ the load per lineal inch of pipe in pounds.

As an example, take an 8-in. pipe, banded with No. 6 wire, buried under 6 ft. of soft earth; the distributed load will be about 30 lbs. per lineal inch, which substituted for w in the formula gives

$$t = \sqrt{0.005 \times 30 \times .66 + 9 \times .01} + 3 \times .1 = .73 \text{ in.}$$

which would be the minimum allowable thickness under the assumed conditions, but the staves for an 8-in. pipe would be milled from commercial sizes of lumber, which would be paid for in the rough, and there would be no economical advantage in making a deep cut with the planer when a lighter cut would give say ¼ in. more thickness. In the manufacture of these staves 1¼ x 3 in. or 1½ x 4-in. rough lumber would be used and as a thickness of 1 in. can be obtained from these sizes of rough material, the staves would be made of that thickness. The extra thickness would be desirable because of the probability of heavier external pressures than assumed above. Also the reduction of percolation under high heads would demand the greater thickness. It is doubtful whether it would be wise to consider the horizontal pressures due to a backfilling of earth. There would be much uncertainty concerning it and the safest course would be not to take it into account, except where conditions permit of thoroughly tamping the backfill under and along the sides of the pipe.

As another example, consider a 6-ft. pipe banded with ¾-in. bands, and backfilled with earth to a depth of 4 ft.; the backfilling being tamped under and around the pipe. The distributed earth load would be about 200 lbs. per lineal inch of pipe. Using the ratio of horizontal to vertical pressure of 0.5 we have

$$t = \sqrt{.0025 \times 200 \times 6 + 9 \times (3/8)^2} + 3 \times 3/8 = 3.16 \text{ ins.}$$

If a pipe should be laid on the surface with a supporting bed of only incidental width, the reaction due to the weight of the pipe and water becomes a concentrated load acting upward, and the formula for concentrated vertical loads becomes applicable for determining whether a given thickness of staves will stand the strain produced.

In backfilling under and over a large pipe, it is very essential that the earth be thoroughly compacted under the pipe; the purpose being to distribute thoroughly the reactive load due to the weight of earth, water and pipe material. This applies more particularly to sizes from 3 ft. in diameter up to 6 ft. Above 6 ft. in diameter the earth covering would necessarily decrease in depth, or the staves be made excessively thick.

It is preferable to build large pipe above ground supporting it in yokes or cradles. The spacing of these yokes can be determined by the aid of the formula for thickness of staves for distributed vertical loads.

Spacing of Bands.—The spacing of the bands on a pipe depends primarily on the water pressure. The pressure is transferred, by means of the staves to the bands where it is resolved into a tensile strain, that is resisted by the tensile strength of the material in the bands. In addition to the strain in the band caused by the water pressure, there is that due to the permanent compressive strain in the staves due to the initial tightening of the bands, after having been modified by the saturation of the staves with water. This modification was specifically mentioned when considering the thickness of staves.

The water pressure and the compression in the staves, combined, tend to shove the staves outward. But any material movement is prevented by the bands, provided that the width of the indentation made by the bands in the staves furnishes enough bearing surface to prevent any movement. It, therefore, is evident that there are two distinct considerations entering into the determination of the spacing of bands; the tensile strength of the bands, and bearing strength of the wood under the bands. For all the smaller pipe, up to 26 ins. in diameter, the bearing strength of the wood under the bands controls the spacing; for all sizes larger than 26 ins. the tensile strength of the bands control. However, the diameter of the rod, forming the band, influences the demarkation between the two conditions that control. For bands made from ½-in. rods, the bearing strength of the wood will control the spacing even on a 30-in. pipe, while for a ⅜-in. band it will control for no larger than a 22-in. pipe.

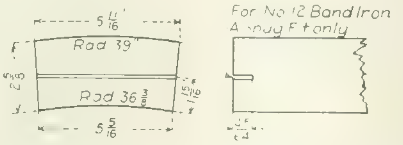


Fig. 2. Detail Sections of Wooden Stave of Minimum Thickness of 2⅝ Ins., Milled From 3x6-in. Stock, for 72-in. Pipe Line.

In deducing a formula to be used in determining band spacing, the following notation will be used:

$S =$ working tensile strain in lbs. per size of band.

$P =$ water pressure in lbs. per square inch.

$R =$ inside radius of pipe in inches.

$t =$ thickness of staves in inches.

$I =$ pressure on indented strip under bands, in pounds per lineal inch of band.

$A =$ a variable representing the permanent compressive strain in staves, in pounds per square inch, for various water pressures.

$l =$ spacing of bands, center to center, in inches, when strength of band material alone controls.

$l' =$ spacing of bands, center to center, in inches, when pressure on indented strip under bands controls.

$PRl =$ band strain in terms of water pressure.

$Atl =$ band strain in terms of stave compression.

Therefore, $S = PRl + Atl = l\,(PR + At)$, and $l = \dfrac{S}{PR + At} =$ band spacing when strength of band material alone controls.

$(R + t)\,I =$ band strain in terms of pressure on the indented strip of wood under bands.

Substituting for S in the expression for l above, and $l' = \dfrac{(R+t)\,I}{PR + At} =$ band spacing when pressure on indented strip under bands controls.

In considering the values for l and l' for any given conditions, the smaller value should be used.

P, R and t are known quantities; having been settled upon, before the determination of band spacing is undertaken.

S, I and A are terms the values of which can be determined by experiment only.

The value of S is determined for any size of rod or wire by an actual measurement, by means of suitable apparatus, of the loads necessary to strain the samples up to the elastic limit, or to rupture them. For Bessemer or Open Hearth steel 58,000 lbs. per square inch will be a close average for ultimate strength and 30,000 lbs. per square inch for the elastic limit. Using a factor of safety of four against rupture and S, or the allowable working strain, for various sizes of rods will be as follows:

Diameter of rods, ins.	Value of S in lbs.
13/64	420
1/4	710
5/16	1,110
3/8	1,500
7/16	2,180
1/2	2,850
5/8	4,450
3/4	6,400
7/8	8,720
1	11,390

The values for I, or the pressure per lineal inch of band, for the area of contact between band and staves, has been experimentally determined by Mr. D. C. Henney. The results of his experiments are recorded in Transactions Am. Soc. C. E., Vol. XLI, p. 74. While his results were obtained with redwood samples, they will apply to fir staves, as wet fir is not materially stronger than wet redwood. The direction of the grain of the wood affects the bearing strength materially; the edge grain bearing much heavier pressures than flat grain. The following are safe bearing loads for wet redwood and wet fir in pounds per lineal inch of band, when the width of the indentation does not exceed the radius of the rod or wire:

Diameter of rods, ins.	Safe bearing loads, lbs. per lin. inch.
5/32	70
13/64	85
1/4	100
5/16	120
3/8	140
7/16	155
1/2	170
5/8	200
3/4	230
7/8	260
1	290

If these pressures per linear inch are reduced to equivalent pounds per square inch, the results will be found to be much larger than the sustaining strength of the wet staves in edge compression, and also pounds per square inch increase as the diameter of the rod decreases. The explanation is that the wood outside the indented strip aids in supporting the band pressure in general, and that the increase, accompanying the decrease in size of rod, is because a short bent (not broken) fiber will sustain more load than a long bent fiber, for the same reason that a short beam supports more load than a long one of the same dimensions.

The values of A or the compressive strain in the staves decreases with an increase of the water pressure when a pipe is being put into operation. With a low initial compression of dry staves there will be an increase in compression, while the staves are becoming saturated under a merely nominal head, until the maximum permanent strain is reached. Then as the pressure is increased there will be a corresponding decrease in stave compression. Practice and experiment indicate that these reductions are permanent. If, on the other hand, the initial compression is high when water is turned on there will be a decrease in compression, due to the saturation of the staves with water, and then as the pressure is increased there will be a corresponding decrease, caused probably by a slight outward movement of the staves due to the water pressure. What actually takes place depends on varying conditions and circumstances, but it is known that if a new pipe is filled with water, under merely a nominal head, and allowed to remain so for 15 or 20 days the stave compression will have changed largely and will be tending toward a permanent compressive strain of 125 to 150 lbs. per square inch. Then as the water pressure is increased this compressive strain will decrease. The experiments of Mr. D. C. Henney, Trans. Am. Soc. C. E., Vol. XLI, p. 69, confirm this conclusion. The writer has deduced values of *A* from these experiments by computing the percentage of decrease in stave compression due to various increases in pressure, and deducing therefrom what appears to be the general law of this decrease.

It is the writer's opinion that it is not necessary to consider a greater degree of stave compression than 125 lbs. per square inch, as affecting the strain in the bands. Starting with 125 lbs. compression at 10 lbs. pressure and applying the percentage of decrease deduced we have the following values for *A*:

Pressure		A
Head in ft.	Lbs. per sq. in.	Lbs. per sq. in
0 to 10	0 to 4.34	125
20	8.68	120
30	13.02	114.5
40	17.36	109
50	21.70	103.5
60	26.04	99
70	30.38	94.5
80	34.72	90
125	54.25	75
185	80.29	60
245	106 33	45
300	130.20	33
400	173.60	15

Values of *A* for water pressures between those given can be computed by a straight line formula, or perhaps more conveniently by platting the figures given on co-ordinate paper and drawing a curve through the points, then taking intermediate values from the diagram.

For the higher heads, say over 125 ft., where the band spacing becomes close, the compressive strain in the staves has a comparatively small effect on the band strain, because of the reduction in the length of stave that is contributing this strain to each band, as well as the reduction in the value of *A*.

As an example, determine the band spacing for a pipe 30 ins. in diameter banded for a 185-ft. head of water with ½-in. rods. Assume for the vertical distributed external load, 4 ft. of earth, which is equivalent to about 80 lbs. per lineal inch of pipe, and a horizontal distributed pressure equal to one-half of the vertical.

Then $t = \sqrt{0.0025 \times 80 \times 21\tfrac{1}{2} + 9} \,/\, (\tfrac{1}{4}) + (3 \times \tfrac{1}{4}) = 1\tfrac{3}{4}$ ins.;

and $l = \dfrac{S}{PR + At} = \dfrac{2850}{80.29 \times 15 + 60 \times 1\tfrac{3}{4}} = 2.177$ ins.;

or $l' = \dfrac{(R + t)\,l}{PR + At} = \dfrac{(15 + 1\tfrac{3}{4})\,170}{1309} = 2.17$[illegible] ins

It happens that in this case the two controlling conditions give practically the same result. If there was any practical difference the smaller result should be used.

Stave Section.—The first requisites in a properly formed stave is that the sides, which will make up the outer and inner surfaces of the pipe, should be arcs of concentric circles, and that the edges should be radial. Unless the staves are milled for a radius a little in excess of the nominal radius of the pipe, the finished diameter will be smaller than required. The amount of reduction will depend on the character of the wood, the spacing of the bands, and the initial tension in the bands due to cinching; but if the staves are milled for a radius 1 per cent greater than the nominal, any practical reduction in size will be taken care of.

As an example, design a stave for a 72-in. pipe, with a minimum thickness of 2⅝ ins.

Nominal inside radius + 1 per cent = 36⅜ ins.

Outside radius = 36⅜ + 2⅝ = 39 ins.

Outside circumference = 245.0448 ins.

Inside circumference = 228.5514 ins.

There must be an integral number of staves, and as rough lumber is not always up to full dimensions, ¼ in. in thickness and width must be allowed; therefore, if milled from 3x6-in. the width of stave cannot exceed 5¾ ins., which means 43 staves to complete the ring; if milled from 3x8-in., there will be required 32 staves. Sectional views of a stave milled from 3x6-in. stock are shown in Fig. 2.

Chord of inner arc = 2 (sin. ½ subtended angle × inside radius).

Chord of outer arc = 2 (sin. ½ subtended angle × outside radius).

Max. thickness = 3 ins.—(¼ in. + mid. ordinate of inner arc).

Middle ordinate = Ver. sin. of ½ subtended angle × radius.

Metal Tongues.—The tongues used in the end joint of the staves can be made of iron or wood, but the general practice is to use iron. There is no trouble from this source due to tongues rusting, even in the oldest pipe lines. The tongue, whether of wood or metal, should be about 3/32 in. wider than twice the depth of the slot and about ⅛ in. longer than the slot; allowing a projection of 1/16 in. at each end into the adjoining staves.

Shoes or Band Couplings.—The band couplings should be made of malleable cast iron. It is no longer necessary to design and have these shoes specially manufactured, because there are iron works, now, that manufacture these shoes as one of their staple products. However, before the length of a band can be determined it must be known how much lap-over of the rod there is in the shoe. This differs in the shoes for different sizes of pipe; increasing with the increase in size of rod. However, this quantity will average about as follows for various sizes of rods:

Diameter of rod, ins.	Lap-over of rod in shoe, ins.
5/16	1/2
3/8	5/8
7/16	3/4
1/2	7/8
9/16	15/16
5/8	1 1/16
3/4	1 1/4
7/8	1 1/2
1	1 5/8

The type of shoe referred to above was illustrated in Article I of this series which was published in the issue of Nov. 4, 1914.

For estimating purposes it is necessary to know approximately the weight of shoes. The weights vary with the size of rod and diameter of pipe, but the following are average weights for various sizes of bands:

Diameter of rod, ins.	Weight of shoe, lbs.
5/16	0.35
3/8	0.40
7/16	0.65
1/2	1.00
5/8	1.75
3/4	2.75
7/8	4.00
1	6.00

Length of Bands.—Up to and including 48 in. pipe it is the general practice to use a band made in one part, necessitating the use of but one shoe, but for larger sizes of pipe the band is composed of two parts, necessitating the use of two shoes. It is a convenience in construction to have one part of the band headed at both ends and the other threaded at both ends. Care must be taken, however, in the manufacture of the part headed at both ends to have corresponding sections of the heads in the same plane. This, of course, applies to square or tee heads.

The determination of the size of the rod to be used is largely an economic matter. It is desirable to have the minimum amount of steel per unit length of pipe, but the life of the bands as affected by their size must be a factor in the solution of the problem. In all cases where the spacing of the bands is controlled by the bearing strength of the wood indented by the rod or wire, a saving of metal is made by using the smaller sizes, in fact the reduction in the size of the wire in the smaller sizes of pipe can be carried to such extremes that an exceedingly cheap article is turned out, that will successfully withstand the pressures for which it is banded, but which has no lasting qualities. In this case economy demands that a surplus of metal be used; wire large enough to withstand the action of rust for a reasonable length of time. In all cases where the stress of the metal controls the spacing, the amount of metal is theoretically and practically the same for all sizes of rods, but the price per pound for rods decreases slightly with the increase in size. The cost of bending, painting, putting on, spacing, and tightening bands is greater per any given length of pipe, in the case of the smaller rod, because of the greater number of bands per unit length. As an example, take a 72-in. pipe banded for a 100 ft. head, and compare the relative costs for ⅝ and ¾ in. bands:

Factory cost—		
⅝-in., 126 lbs. per foot at 2.20 cts.	$2.77	
¾-in., 124 lbs. per foot at 2.10 cts.		$2.50
Bending, painting, etc.—		
⅝-in., 4.69 bands per foot at 18 cts.	0.84	
¾-in., 3.26 bands per foot at 18 cts.		0.59
	$3.61	$3.09

Notwithstanding that economy is with the larger rod for sizes of pipe above about 30 ins., practical considerations demand that this be deviated from. The following sizes are generally representative of the best practice:

Machine Banded Pipe—

Diameter, ins.	Size of wire, No.
2 to 8 inclusive	6
10 to 14 inclusive	3
16 to 20 inclusive	0
22 to 30 inclusive	000

Continuous Stave Pipe—

Diameter, ins.	Size of rod, ins.
Up to 20 inclusive	3/8
22 to 26 inclusive	7/16
28 to 44 inclusive	1/2
46 to 66 inclusive	5/8
68 to 108 inclusive	3/4
108 up	7/8

The rod used in the band for continuous pipe should have a liberal length of thread; not less than 4½ ins. for ⅜ in., 5 ins. for 7/16 in., and 6 ins. for other sizes of rod. There are three types of heads in use; button, square, and tee heads. The writer prefers the tee head, as it permits of keeping both ends of the rod closer to the staves and shortens the space over which the rod is raised from the staves; it permits of a shoe of less length. If stock shoes are used, the shape and dimension of the bolt heads that they are made for should be learned before ordering the rods. The length of rods under the head should be such that after the pipe is finally tightened, at least 1½ ins. of thread will remain ahead of the nut. The length of the rod excluding the head is determined in the following manner, where the rod is in one part, and 6 ins. of thread is being used:

Total length $= (D + 2t + r)\,\pi + k + 4\tfrac{1}{2}$ ins.

Where D = nominal diameter of pipe in inches.

t = thickness of staves in inches.

r = diameter of rod in inches.

k = lap of rod in shoe in inches.

If the rod is in two parts the following would be the method:

Total length $= (D + 2t + r)\,\pi + 2k + 9$ ins.

Where the notation is the same as above.

The total length is distributed to the two parts of the band so as to bring the shoes about diametrically opposite. This would make the part headed at both ends, measured under the heads, a little less than one-half the circumference, at the center of the rod, or as follows:

Length of headed part of band =

$\dfrac{(D + 2t + r)\,\pi}{2}$ [illegible] (length of shoe [illegible] 2k)

The length of the threaded part would, of course, be the remainder of the total length.

A cold rolled thread is preferable; the outside diameter of the thread will be greater than the nominal diameter of the rod, and while the diameter at the base of thread is less, the cold rolling process increases the strength of the threaded part sufficiently to make it stronger than the body of the rod. The nuts should be hexagonal and of liberal dimensions; the thickness should be at least 30 per cent greater than the diameter of the rod. Washers of a liberal thickness should be used under the nuts.

SPECIFICATIONS FOR CONTINUOUS PIPE.

Staves.—The following short specification for staves and bands covers all the essentials:

Staves—Redwood.—The staves shall be manufactured from absolutely clear California Redwood (lumber), that has been well seasoned; containing, by weight, not more than 12 percent of moisture, and with this content of moisture, weighing not less than 30 lbs. per cubic foot. It shall be free from sap-wood, spongy grain, all indications of decay, curly grain, shakes, checks, warp or wind, and any other defects that are not admissible in pipe works.

Shape.—The staves shall have a finished thickness of .... inches. The concave side shall be the arc of a circle, conforming accurately to the nominal radius of the pipe plus 1 per cent. The chord of this arc shall be .... inches. The convex surface shall be concentric to the concave. The edges shall be milled to true radial planes. The ends of the staves shall be trimmed square and shall be slotted to allow the insertion of a metal tongue. The width of the slot shall be such that the tongue will fit snugly, but without danger of splitting the staves. The depth shall be 3/64 in. less than ½ the width of the tongue. The position of the slot shall be uniform in the ends of the staves.

Length.—The staves shall not be less in length than 10 ft., but may vary from 10 ft. to 24 ft., but not more than 10 per cent shall be less than 12 ft., and not more than 40 per cent less than 14 ft.

Fir Staves.—The specifications for best quality of fir staves will differ from the above in the following essentials:

The staves shall be manufactured from clear Douglas Fir, weighing not less than 34 lbs. per cubic foot, with a moisture content of 12 per cent. In addition to the imperfections forbidden in redwood should be added pitch seams longer than 8 ins. and extending more than one-fourth of the distance through the staves. The percentage of short lengths can be reduced.

The specifications for a second quality of fir staves allow tight knots not greater than 1 in. in diameter, and not more than one to any three or four foot length of stave. While these knots are allowed in the outer and inner faces they should not be permitted in the edge faces of the stave. A thin layer of sap on the inside surface of the stave is permissible.

SPECIFICATIONS FOR BANDS.

The bands shall consist of long steel bolts bent to conform to the outside radius of the pipe, joined at the ends with malleable cast iron shoes.

Bolts.—The bolts shall be made from rods made by "Open Hearth" (or Bessemer) process, having an ultimate tensile strength from 56,000 to 62,000 lbs. per square inch, and an elastic limit of not less than 30,000 lbs. per square inch. The percentage of elongation in 8 ins. shall not be less than 25 per cent, and the rod shall be capable of being bent back flat upon itself without showing signs of fracture.

The section of the bolt shall be a circle with a diameter of ... inches. The bolt shall be made in two parts; one part being a ...×... ×... in. head at each end and the other part 6 in. of cold rolled thread at each end. (If the bolt is in one part, then headed at one end and threaded at the other.)

The nuts shall be hexagonal, have a short diameter of ... inches and ... inches thick, and shall fit close but turn easy upon the threads. Under each nut shall be a ...×... ×... washer.

Shoes.—The shoes shall be malleable iron castings, made from gray pig iron, containing low percentages of phosphorus, sulphur, and manganese. They shall test a bolt of the size for which intended, to rupture without showing signs of weakness. They shall fit close upon the outside of the pipe, and shall be smooth, clean, and free from flaws and tags.

Band Spacing.—The bands shall be spaced with reference to the pressures to be sustained as follows:

Heads 0 to 10 ft. ... ins.
Heads 10 to 15 ft. ... ins., etc.

SPECIFICATIONS FOR TONGUES.

The tongues shall be cut from No. 12 (or No. 10) band steel 1½ ins. in width; cut at a right angle and long enough to project 1/16 in. at each end of the slot in the stave. They shall be painted before being put in place.

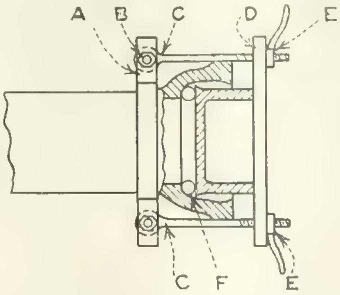
BAND COATING.

The bolts, after being bent to the proper form and before being put on the pipe, shall be thoroughly coated with a good quality of paint that will form an elastic coat that, when hardened, will not crack and fly from the band when struck with a hammer. The shoes and tongues shall be coated with the same quality of paint.

SPECIFICATIONS FOR MACHINE BANDED PIPE.

The specifications for staves relative to quality will not differ from those for continuous pipe, with the exception that in practice only the first quality of fir staves are used. White pine is used by Eastern manufacturers in this type of pipe. It probably finishes smoother than redwood or fir.

Bands.—The pipe shall be banded by cold drawn "open hearth" steel, annealed and galvanized, having a tensile strength of 58,000 to 60,000 lbs. per square inch. The bands shall be wound on spirally under sufficient tension to seat the wire in the wood to a depth of one-eighth of the radius of the wire. The ends of the wire shall be secured by a suitable malleable cast iron clip. The wire for any one section of pipe shall be continuous; splices will not be permitted. The diameter of the wire shall be ... inches. The spacing of the wire shall be as follows:



Detail of Home-Made Plug for Use in Testing Water Mains Under Construction.

For heads 0 to 25 ft. ... inches.
For heads 25 to 50 ft. ... inches.
For heads 50 to 100 ft. ... inches.
Etc.

Pipe Coating.—After banding the pipe shall be covered with alternate layers of hot asphaltum and sawdust until a tough, elastic coating of sufficient thickness is formed to thoroughly protect the bands against injury and act with the galvanizing as another barrier against rust.

Couplings.—The pipe couplings shall be made of staves banded in a manner similar to the pipe, and treated with asphaltum in the same manner.

Tenons.—The tenons at the ends of the pipe sections shall be cut uniform in length, and each shall be one half the length of connection or coupling. The outside of the tenon shall be concentric to the inside of the pipe and shall be of a dimension that will fit snugly in the coupling.

The next article, the fourth in this series, will deal in detail with the estimation of cost of the manufacture and installation of wooden stave pipe.

An Inexpensive Plug for Use in Testing Sections of Water Mains During Construction.

The accompanying diagram illustrates the design of a cheap, home-made test plug for water mains, devised by Mr. W. E. Haseltine, Manager of the Ripon, Wis., Light and Water Co., and described by him in the December number of the Journal of the American Water Works Association.

The test plug consists of a clamp, *A*, surrounding the pipe directly back of the bell. Attached to the bolts which fasten this clamp together are eye bolts, *C*, with long threads. These eye bolts extend through holes in the bar *D* and are supplied with long threads to receive the wing nuts *E*. A ring of ½-in. or ⅝-in. rainbow tubular manhole gasket *F* is put into the bell and against this is placed an ordinary cast iron water main plug. The wing nuts *E* are then turned down, clamping this plug against the gasket by means of the bar *D*.

The entire adjustment can be made in a few minutes and the cost of the outfit is very small. With the exception of the clamp, the same outfit can be employed for various sizes of pipe by having the bar *D* long enough for the largest size and drilling holes at various points in its length. This clamp has proved very satisfactory in service.

Methods Employed at Champaign-Urbana, Ill., in Pushing Service Pipes Under Pavements.

Mr. F. C. Amsbary, Manager of the Champaign and Urbana (Ill.) Water Co., gives the following description of the methods employed by his forces in pushing service pipes under pavements, in the December number of the Journal of the American Water Works Association:

Champaign and Urbana, Ill., the municipalities we serve, with a combined population of 25,000, have a large percentage of their streets paved. It is the practice of our company to lay all water mains in the parking, that is, between the curb and the sidewalk. Before beginning the pushing of the service pipe it is necessary to dig a trench about 18 ft. long, to take a full length galvanized wrought iron pipe, the material we use for service pipe. The pipe pusher is first laid in the trench and fastened down by means of wooden stakes. It consists of an iron frame on which is a steel carriage. The pipe is laid in position on the carriage and fastened securely by a locking device. The carriage and pipe are moved forward by means of a ratchet with a long handle, the carriage traveling about 2 ft. When it has reached the end of the frame the locks are released, leaving the pipe and carriage free and the carriage is moved back and the pipe is again locked. This operation is repeated until the pipe has gone the required distance. In order to keep the pipe from drifting out of the straight line we turn it frequently with an ordinary pipe wrench. We seldom have any trouble in pushing the pipe to the point desired.

The soil in our streets is, in most cases, heavy clay; in sandy soils of course the pushing would be much easier.

When we have a leak in the service pipe under the pavement, instead of tearing up the pavement to repair it, we push a new service through and abandon the old one, finding it much cheaper than digging up the pavement and relaying it, and, what is equally important, we help preserve the pavement; for no matter how well the work is done, a pavement cannot be put back quite as good as it was before.

The advantage of laying water and gas mains in the parking is not well understood by many water works people. The writer has known cases in neighboring cities where paving jobs have been held up, waiting for the water company to lay its mains, when there were wide parkings on either side of the pavements, where the mains should be laid. With the mains in the parkings the pavements will never be disturbed by reason of leaks and in putting in new services.

There are several good pushing devices on the market.

ROADS AND STREETS

Road Location and the Economics of Road Improvement.

Contributed by D. Tucker Brown, Chapel Hill, N. C.

REQUIREMENTS OF AN IDEAL ROAD.

The proper location of a road consists in determining and marking out those points on the ground through which the road should pass, in order to satisfy as nearly as possible the requirements of an ideal road. An ideal road is one which meets the requirements necessary to make it perfect, not only from a physical or engineering standpoint, but also from the standpoint of its usefulness to the community through which it runs. It may be perfect from an engineering standpoint and yet not satisfy at all the demands of the traveling public, and vice versa; therefore the requirements of an ideal road may be classified under the following two groups, neither of which is dependent upon the other:

Group I—Those which made a road perfect from an engineering or physical standpoint.

Group II—Those which make a road perfect in regard to its serviceability to the community through which it runs.

The requirements for an ideal road under Group I are: (1) As to direction—that it should be straight; (2) as to grades—that it should be level; (3) as to cost—that the amount of work on grading, draining, mechanical structures, and surfacing should be the least that will make the road what it ought to be; (4) as to exposure—that it should have the best. Under Group II they are: (1) that it should be of equal benefit to all; (2) that it should shorten the distance from every man's house to the point where he wishes to go; (3) that it should run through every man's land where he thinks it should; (4) that it should shorten the distance between communities and markets.

It is evident, that to satisfy the requirements of Group I it is necessary for the ground between the termini of the road to be a straight level ridge with adequate drainage to either side and sufficient exposure to the sun; and to satisfy the requirements of Group 2, it is necessary that the road be located according to the wishes and desires of every affected citizen in the community along the proposed route.

Conditions under which the requirements of Group I may be satisfied are rarely ever met with in practice, and certainly not on roads of any great length, nor can we ever hope to fulfill the conditions imposed by the requirements of Group II. Therefore, the problem to be solved by the engineer consists in the economical and equitable adjustment of each requirement of Group I to the other requirements of that group; of each requirement of Group II to the other requirements of that group; of all requirements of Group I to all requirements of Group II; and of all requirements of Group II to all requirements of Group I. To do this, the requirements of each group must each be sacrificed to some extent, and to what extent is left for the engineer to decide. There are limits beyond which neither should be sacrificed, and as the costs of construction, maintenance, and transportation depend upon Group I its requirements should not be sacrificed beyond economic limits, for by so doing lasting expense will be incurred. The limits beyond which the requirements of Group II should not be sacrificed, are neither as definite, nor as important as those of Group I, for the effect of not observing them will only be temporary. The citizens inconvenienced by the location of the road will soon adjust themselves to the new conditions, and become reconciled.

PHYSICAL IMPROVEMENTS.

I shall consider first, Group I, and shall endeavor to give a clear idea of the proper methods which should be pursued in order to determine how far, and to what extent, in a properly located road, one or more requirements may be sacrificed in order that the others may be more nearly fulfilled.

The limits which should not be exceeded are: (1) No curve should be of less than 100 ft. radius; (2) no grade should be less than 0.5 per cent (unless proper drainage can be obtained with less grade); (4) the cost of construction should be governed entirely by the saving made possible by the contemplated improvement; (5) locations should not be made on slopes of mountains which are never exposed to the sun's rays.

In a flat, level country the conditions imposed by the requirements of Group I can usually be satisfied. It is, however, in such sections very difficult to keep grades above 0.5 per cent and as this is essential for proper drainage, great care should be exercised in securing grades greater than this minimum limit. Proper drainage is most difficult to obtain in level countries, and without it a road is useless; therefore, all else should be sacrificed for this most important factor, the requirements of Group I as well as those of Group II.

In the piedmont and mountainous sections vastly different conditions exist. The country is so broken by mountains and valleys, hills and vales, as to prevent great difficulties to securing a location, which will even approach the ideal, so far as Group I is concerned, and the engineer is confronted with the proposition of securing the best location that the topography of the country will permit, without sacrificing to too great an extent any of the requirements of an ideal road.

To enable him to accomplish this, it is necessary that he have a general knowledge of those features of the earth's surface which govern the location of roads, and a more thorough knowledge of the topography of the country immediately adjacent to the proposed line of road.

It is an undisputed fact that hills are the natural enemies to the road-maker, and water courses are his guides and assistants. It is essential, therefore, that their relation to one another, the advantages and disadvantages which they each present, be most carefully studied. In this connection, the following facts will be noted: (1) If a principal ridge is met by two secondary ridges at the same point—that point is of maximum height. (2) If a principal ridge is met by two valleys at the same point—that point is of minimum height. (3) If a principal ridge is met by a secondary ridge and a valley at the same point—nothing can be inferred. (4) If two parallel streams with a ridge between suddenly diverge—the ridge between will be found to increase in height. (5) If two parallel streams with a ridge between suddenly converge—the ridge between will be found to decrease in height.

The facts mentioned in the preceding paragraphs will be of great help in making reconnoissance surveys and in reading topographical maps.

Surveys—For the purpose of determining the proper route through any section of country, so far as the requirements of Group I are concerned, it is customary to proceed in the following manner.

A reconnoissance survey should be made, and it is generally made by the eye alone, without instruments. It is intended to be only approximate, and to serve to determine through what points routes should be instrumentally surveyed. No time, or labor should be spared in these first explorations, for they will save much expense in subsequent detailed surveys.

If a topographic map is at hand, it will be of great survice, and it is not infrequent that sufficient information may be obtained from it to enable one to decide what routes are the best to be surveyed with the instruments, and thereby save such reconnoissance work.

After having become familiar with the topographical features adjacent to the proposed route, either by the aid of maps, or an actual reconnoissance survey, it will be found that there are governing points through which the road must pass. There may be a low gap, a narrow point in a stream (suitable for a bridge), or some other point of equal strategic importance to the final location. Between these governing points the straight line joining them is marked out, and the routes adopted for instrumental surveys must continually tend to coincide with it; except when deflected to the right or left by weighty reasons, such as the requirements of Group I demand, and the topography of the country will permit, all routes which are to be instrumentally surveyed will pass through these ruling points.

It may be necessary to instrumentally survey only one route, and again as many as five, depending entirely upon how many routes meet so nearly the requiremnts as to make it impossible to decide upon the proper one without more specific information than can be obtained by a reconnoissance survey.

The instrumental surveys to be complete should consist of a transit line, level line, cross section notes, classification notes, topographical notes, and notes on all conditions which may in any way affect the construction or maintenance cost of the road. Maps, profiles, and estimates of the costs of construction, maintenance and transportation of each route should be made, and from them it can be determined which is the route that will more nearly satisfy the requirements of Group I.

The cost of construction, and the unit cost of transportation can be estimated very closely from the information obtained by the instrumental surveys, but the cost of maintenance and the total cost of transportation while depending to a great extent upon the alignment, grades, drainage, and exposure, will have to be determined largely by the amount of traffic that will pass over the road, and a traffic census is necessary for this.

A traffic census consists of an estimate (if an old road is to be improved) and of approximations (if a new road is to be opened) of the tonnage, number, and class of teams, which do, or may be expected without much doubt, to pass over the road in a specified length of time. It must be remembered that the traffic on a road will be materially increased by any form of improvement that will decrease the cost of transportation.

The cost of construction is determined by the survey; the unit cost of transportation by the survey; the total cost of transportation by the survey and the traffic census; and the total cost of maintenance by the survey and traffic census. Therefore, with the survey and traffic census complete the costs of construction, maintenance, and transportation can be determined.

As the costs of construction, maintenance and transportation are affected by the alteration of any of the requirements of Group I, the total cost may be determined for any adjustment of the requirements of Group I.

The economical adjustment would be the one in which the cost of construction, the unit cost of maintenance, and the unit cost of transportation, were reduced to a minimum.

Criterion for Cost of Improvement.—Any improvement of an old road should be undertaken without delay, if the sum of the interest on the first cost of construction, plus the costs of maintenance, and transportation would be reduced by the improvement, below what it was for the same amount of traffic on the old road.

To demonstrate: suppose it were proposed to make an improved road out of an old earth road 10 miles long, and that the following assumptions were true:

	Earth.	Sand-clay road.
6% int. on original cost one year	$ 180.00	$ 720.00
Cost of maintenance one year	250.00	800.00
Cost of transporting per year 20 tons per day at 10c per ton-mile on sand-clay, 30c per ton-mile on earth	21,900.00	7,300.00
Total	$22,330.00	$8,820.00

It will be readily seen that a community could easily afford to spend the difference between $22,330 and $8,820 or $13,510 in improving the road for a traffic of 20-tons per day. This does not take into account the possible development along the road after its improvement.

A new road should be opened if the saving in transportation costs due to it be greater than the interest on its first cost plus its maintenance.

To demonstrate: suppose it were proposed to open a road 10 miles long and the following assumptions were true:

6% interest on first cost	$ 720.00
Cost of maintenance one year	800.00
Total	$1,520.00

It would be necessary, if the improvement were an economical proposition, for the saving in cost of transportation due to new road to be more than $1,520.

REQUIREMENTS OF IMPROVED SERVICE.

The requirements of Group II can never be satisfied, as there are not only physical impossibilities, but human impossibilities. To carry out the suggestions, and wishes, of the citizens of a section in regard to road location would require the performance of miracles or an entire disregard of all the requirements of Group I. There are people in all communities who have never seen a properly located road, but think they know all the essential details. They can tell you without a moment's thought, the cheapest, shortest, and most level route between any two points. They will in most cases suggest the route which suits them best, and it is peculiar to note that a great majority of the average laymen will oppose road improvement unless their wishes are carried out.

The effect of trying to satisfy the wishes of the individuals of a community frequently necessitates a sacrifice of one or more of the essential requirements of Group I and in consequence the community is burdened with a road, either costly in construction or maintenance.

It will be well to bear in mind, when making locations, that a great deal of trouble with rights of way may be avoided if it is found out just where the people of the locality wish the road. It frequently happens that through property, there are two routes of equal value, one may be the landowners' choice, and the other just what he does not want. Again, if there are two routes one of which is not desired either by the engineer or the property owner, it should be surveyed; the property owner will then be more willing to give right of way on the proper route.

I do not believe there will ever be a proper adjustment of the requirements of Group II to those of Group I until the road is taken out of politics, and the people become willing to leave their road problems to people who have studied them.

I shall try to explain just how far I think the requirements of Group I should be sacrificed for those of Group II. I hope by so doing I will convince some people that good roads are money well invested, provided the requirements of Group I are not ignored.

It is seldom economy to build a road between two important points and sacrifice to a great extent its alignment, its grades, its cost or its exposure, in order that it may be accessible to some outlying community. It is far better to build less expensive spur or branch roads from the main roads into such communities.

No improvement that will increase the cost of construction or maintenance of a road should be made for any person or persons unless it is economy.

For demonstration, suppose it were proposed that a road be built between two thinly settled communities, A and B, Fig. 1, and that there were a question as to whether or not it should go by C.

In Fig. 1 let

D = distance A to B proposed road.
D' = distance A to B old road.
E = distance A to C proposed road.
E' = distance A to C old road.
F = distance C to B proposed road.
F' = distance C to B old road.
T = tonnage hauled between A and B per year.
T' = tonnage hauled between B and C per year.
T'' = tonnage hauled between A and C per year.
N = total cost construction proposed road A to B.
N' = total cost construction proposed road A to B via C.
N'' = total cost construction old road A to B.
N''' = total cost construction old road A to B via C.
M = maintenance cost per mile per year proposed road.
M' = maintenance cost per mile per year old road.
X = cost hauling one ton one mile proposed road.
Y = cost hauling one ton one mile old road.
R = usual rate of interest on money.
Z = net amount saved per ton mile by citizens on account of proposed road. $= Y - X$ when old road is considered.

Then,

If: $RN + DM < ZTD$ the direct line from A to B is an economical proposition and vice versa.

If: $RN' + (E + F)\,M < Z\,(T'F + T''E + T)\,(E + F)$ the line from A to B via C would be an economical proposition and vice versa.

If $RN' + (E + F)\,M < Z\,(T'F + T''E)$ the line from A to B via C would be an economical proposition and vice versa, whether or not there was any through traffic from A to B.

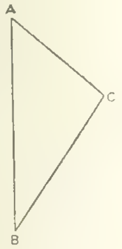


Fig. 1.

Suppose an old road were in existence between A and B, between A and C, and between B and C, and improvements were contemplated. By the use of the following equations it may be determined whether or not the improvement is warranted.

If: $RN + DM + TX < RN'' + D'M' + TY$ the improvement from A to B should be made and vice versa.

If: $RN' + (E + F)\,M + (T' + T'')\,X < RN''' + (E' + F')\,M' + (T' + T'')\,Y$ the improvement from A to C and from B to C should be made and vice versa whether or not there were any through traffic from A to B.

If: $RN' + (E + F)\,M + (T + T'\,T'')\,X < RN''' + (E + F')\,M' + (T' + T'')\,Y$ the improvement from A to B via C should be made and vice versa.

If $TX\,(E + F) - TXD > RN + DM$ and $RN + DM < ZTD$ then the through traffic from A to B should not be made to go via C.

HINTS ON LOCATION.

In conclusion I will make a few suggestions which should be borne in mind by a locating engineer.

(1) When possible cross streams at narrow points and at right angles.

(2) Make openings for all streams amply large.

(3) When following or crossing a stream be sure that your grade line is well above high water.

(4) If necessary to ford a stream, do so at a point where the least length of road will be subject to overflow.

(5) Make your streams crossing as well as gaps governing points in your survey.

(6) Cross streams where you can secure solid foundations.

(7) Generally speaking, when crossing a ridge parallel to a stream ascend down stream and descend up stream. This will shorten your line.

(8) Compensate for curves on maximum grades.

(9) When following streams the least expensive line is usually the one just above high water line.

(10) It is economy practically in all cases to cross a ridge at its lowest point.

(11) The aesthetic features should receive consideration but not at the expense of the serviceability of the road.

(12) Above all things, if called upon to locate a mountainous road, always go to the gap and work down on the proper grade to the stream below.

Conditions Determining Maximum Grades and Methods and Cost of Road Grading in West Virginia.

The conditions limiting the selection of maximum grades in the improvement of rural roads and the methods and cost of earth excavation were discussed in an interesting manner by A. D. Williams, chief road engineer of West Virginia, in a paper before the American Road Congress and his paper is given here in part.

CONDITIONS DETERMINING THE MAXIMUM GRADE.

There are a number of factors that enter into the maximum grade, but before attempting to locate any road or to establish any grade the engineer should make a thorough study of the territory to be developed by the proposed road, giving due consideration to the following points:

(1) What will be the present and future demands of the territory adjacent to the proposed improvement?

(2) What are the possible developments in the territory from an industrial, agricultural, educational and social standpoint?

(3) What part will the proposed road be of a general system of roads reaching to other communities and what will be the effect of the improvement on other sections?

(4) The nature of traffic that the road will be called upon to take care of, making due allowance for development, considering the present and future tonnage;

(5) The general direction in which the greatest amount of tonnage will be transported, the class of tonnage and the time necessary to move it in order to make it the most marketable;

(6) The direction in which the ascending grade will be in comparison with the possible traffic demands;

(7) The maximum load that a horse can pull based upon the length of grade and the time required to make the trip, from the standpoint of the horse and the time necessary to get the best results for the kind of material the country will produce;

(8) Consideration should always be given to climatic conditions and to the season that the roads will be required to take care of the heaviest traffic, as well as a study of the foothold for horse-drawn vehicles. The possible amount of frozen or icy weather should be noted in determining a maximum grade;

(9) The class of material over which the road is to be made and the cost of construction on the longer distance compared with the steeper grade and shorter distance have a certain bearing upon the subject, because the most important subject in connection with the cost of roads on grades is that of maintenance, which increases very rapidly with the increase of grade. Roughly speaking the destructive effect of violent and periodical storms is four times as great on a 5 per cent as on a level ground, and nine times as severe on a 10 per cent as on level grade. Thus, if no other factors were to be considered on earth roads alone, the cost of upkeep in a very few years would justify the elimination of bad grades;

(10) The condition of the right of way and the possible chances for disposition of water and drainage are factors of much importance when considering the maximum grade, because on steeper grades the increasing velocity demands more drainage and greater skill in

handling the water, which, if kept on or near the road will soon destroy it.

(11) The consideration of a grade from the ascension is not the only angle of approach in the location of highway grades because important items enter into the descending grade that should be given as much, if not more, consideration than the ascending direction;

(12) A grade should not be steeper than a horse can descend safely in a trot;

(13) A grade should not be steeper than a team can safely descend with a load that it can handle for 10 hrs. under normal conditions, exerting its normal tractive force.

(14) The amount of time necessary to descend a grade should be considered, making due allowance for the maximum speed that can safely be used on that grade;

(15) The highway engineer of today must remember that as time passes the motor traffic requirements of the public highway will be more and more exacting. Experiments as to gasoline consumption and its efficiency on difficult grades and materials are now being conducted near Uniontown, Pennsylvania, by R. O. Gill, experimental engineer for the Chalmers Motor Co. of Detroit, Mich. In this connection we have but little data. Some recent experiments made by H. Kerr Thomas and D. Ferguson of Buffalo, N. Y., for the Pierce-Arrow Motor Co., show that the class and kind of surface exert more influence upon the motor-driven truck than the percentage of grade and that it requires practically the same tractive force on a 1 per cent grade in sand and loose stone to handle the same load as it does on a 27 per cent grade on concrete, asphalt, new brick and first-class macadam. But observations of the speaker lead to the conclusion that grades of any length exceeding 5 or 6 per cent are not as satisfactory and as economical as lighter grades for motor traffic owing to the increased hazard, increased consumption of gasoline, and loss of power due to the resistance to gravity. The speaker's observation further concludes that in frozen or icy weather motor traffic is extremely hazardous on grades exceeding 10 per cent, and entirely unsafe on grades exceeding 16 per cent.

TRACTIVE POWER OF A HORSE.

By reference to Gillespie, whose work contains about all we have upon tractive power of a horse, which embraces the experiments of Sir John McNeil, Sir Henry Parnell, and Gayffier, some of whose works are quoted by nearly every writer, we find that a horse traveling at the rate of 2½ miles per hour can exert 10 per cent of his weight, and traveling at the rate of 4 miles per hour, can exert 6 per cent of his weight. These observations prior to 1850 and just before the advent of the steam road into our field of engineering, embrace about all the experiments we have excepting the work of E. B. McCormick of Kansas State Agricultural College and the works of J. H. Waters of the University of Missouri, and other work by McCormick is now being done for the Office of Public Roads, at Washington.

The writer's personal observations have shown that a horse for a limited period can exert one-fourth and sometimes even greater percentage of his weight, this depending in a measure upon the kind of shoes on the horse and the foothold on the grade. A horse on a road material that offers safe footing can be safely trotted down a 5 per cent grade, but cannot be trotted down this heavy a grade for any great length of time without injury by "jamming or stoving him up." Therefore, the ruling grade should not exceed 5 per cent, **if for a horse-drawn** vehicle, over which speed must be made on the descending grade because the average horse in walking down a grade will not make over 4 miles per hour, while he will trot 12 miles per hour; thus, from this standpoint, we can double the distance of the road and increase the time 33⅓ per cent. The speed of 12 miles per hour should not be undertaken down a grade of more than 3 per cent with a vehicle bearing any kind of a load. In ascending a 5 per cent grade the capacity of the team is about four-tenths of its capacity on level ground and about one-fourth of its capacity on 10 per cent grade, on a loading for the same tractive exertion, but a point here that should not be forgotten is that for a short duration a horse can exert from 25 to 40 per cent of his weight, thus doubling and quadrupling its normal tractive force and in this connection it is often economy, considering the financial condition of the community, to put in a short piece of 6 and even 7 per cent grade, than to expend a large amount of money in making an exhaustive and expensive cut, especially so if the cut must be made at the expense of development in some other part of the community.

TABLE I.—COST OF MOVING EARTH VARIOUS DISTANCES, USING DIFFERENT METHODS.

	Comparative cost per cubic yard for moving earth with								
Distances hauled, ft.	Wheel-barrow.	Drag scraper.	No. 1 wheel scraper.	No. 2 wheel scraper.	One horse cart.	Wagon.	Tractor and trucks.	Grader.	Casting over bank.
100	$0.057	$0.090	$0.100	$0.100	$0.056	$0.095	$0.080	$0.022	.....
200	0.114	0.135	0.130	0.125	0.068	0.103	0.080	..	
300	0.170	0.180	0.160	0.150	0.080	0.111	0.080		
400	0.230	0.225	0.190	0.175	0.090	0.119	0.080		
500	0.285	0.270	0.220	0.200	0.101	0.127	0.080		
600	0.342	0.315	0.250	0.225	0.112	0.135	0.080		
800	0.457	0.405	0.310	0.275	0.135	0.151	0.080		
1,000	0.570	0.495	0.370	0.325	0.160	0.167	0.090		
1,500	0.875	0,720	0.520	0.450	0.214	0.207	0.090		
2,000	1.143	0.945	0.670	0,575	0.271	0.247	0.100		
3,000	1.713	1.395	0.970	0.825	0.388	0.327	0.100		
4,000	2.280	1.845	1.270	1.075	0.500	0.407	0.100		
Loading by hand—									
.....	0.050	0.010	0.010	0.010	0.130	0.130	.....	.....	$0.100
Loading by steam shovel—									
.....	.....	.....	.....	.....	0.060	0.060	.....	.....	0.060

Picking, 5 cts.; plowing, 2 cts.; steam plowing, 1.5 cts. per cubic yard. Hauling by wagon, approximately 35 cts. per cubic yard. Hauling by trucks and tram, 14 cts. per cubic yard, per mile.

One thing that should be borne in mind is that each year's development of our country makes the chances for changing of grades and their elimination less possible, and that, while the improvement of the surface of a road increases its tractive efficiency about 200 per cent on level ground, it only increases about one-fourth for a horse-drawn vehicle on a 10 per cent grade; thus money expended in decreasing the grade within a reasonable amount of distance is the best possible investment. With these conclusions drawn and a decision as to the kind of surface that will possibly be placed upon the road at some future time, we are in position to determine what should be the maximum grade.

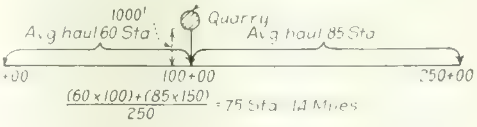


Fig. 1. Method of Determining Average Haul From One Quarry.

THE MINIMUM GRADE.

The principal factor entering into the determination of a minimum grade is the question of sufficient drainage. Except on fills over 2 ft. the minimum grade should not be less than three-tenths of 1 per cent and preferably not less than five-tenths of 1 per cent.

METHODS AND COSTS OF GRADING AND EXCAVATING.

This is a machine age and wherever grading can be done by machinery it is usually more economical. Table I based upon figures taken from different pieces of work is approximately correct to a wage scale of 15 cents per hour and capable supervision. It will be seen that 22 cts. per yard, or at the same cost for any given ratio, the ratio cost distances are for wheelbarrow, 200 ft.; drag scraper, 400 ft.; wheel scrapers, 500 and 600 ft.; one horse cart, 1,500 ft.; wagon, 1,800 ft., while tractor and truck on track do not reach the amount within one mile. The cost of grading depends materially upon the class of material, the location and the management of the operation. In McDowell County, West Virginia, a contractor failed on a contract at 65 cts. per cubic yard, for a material running about 60 per cent soft sandstone rock, and 40 per cent earth. The county purchased a steam shovel and moved the material at a cost of 19 cts., including explosives, drilling and shooting. This was casting work on heavy hillside grade. Thus the contract price to the county was $13,000 for the 20,000 cu. yds. The cost of the labor and explosives, upkeep of the machine was $3,800. The cost of the machine, including drill and compressor, was $5,500, or a total of $9,300, including the cost of the machine, leaving the county a profit of $3,700 in cash and the equipment.

In Marion County, West Virginia, a contractor recently contracted for a piece of work unclassified at 46 cts. and the work cost 52 cts. This was done by steam shovel, being about 70 per cent rock and 30 per cent earth.

In Mercer County, West Virginia, Walton & Co. have contracted for grading of 9 miles of road at 48 cts. per cubic yard unclassified, which work is running about 7,360 cu. yds. per mile.

In Pleasants County, West Virginia, material running about 80 per cent rock, and 20 per cent earth costs 83 cts. per cubic yard to grade by day labor at 20 cts. per hour; teams at $3.50 per day. On the same piece of work with prison labor on the honor system, which costs 75 cents per day and teams $3.50 per day, the grading cost 30 cts. per cubic yard.

In Kanawha County, West Virginia, the Atlantic Bitulithic Co. has a contract for 3 miles of road grading and surfacing. The grading is contracted at $1.25 for stone and 34 cts. for earth classifications running about 70 per cent and 30 per cent earth, or an average of 97.7 cts. per yard. The state has a prison camp working on the honor system under a comptent engineer, and is moving the same class of material at 24 cts. per cubic yard.

On ground free from roots and stone, where a road machine can be used, the material can be moved at a cost of less than 5 cents per yard, and on hillside grading where the work is casting a small steam shovel is an economical machine to use. With this should go a drilling outfit and attachments so it can be operated with the same power. Barbour County, West Virginia, this season purchased a tractor and heavy grader for each district, equipped them with drilling outfit and with less money than they expended in 1913 without showing visible improvement upon their roads, have graded nearly all of the roads of the county in good shape.

Method of Computing Average Haul of Road Material Used by the New York Highway Commission.

The method of computing average haul of road material used in the construction of New York state roads is given in a pamphlet of instructions issued by the commission as follows:

The average haul must be computed by the method of weighted values. Thus, if all stone is estimated to be hauled from one quarry or from one railroad siding, multiply the average haul from the source of supply in stations, for each end of the road, by the length, in stations, of that portion of the road covered by this average haul; add together the two products thus obtained and divide by the total length, in stations, of the road to be built from this source of supply. The result will be the average haul for the entire road, in stations. Figure 1 illustrates a typical example.

If the stone for the road is to be hauled from more than one quarry or siding, the average haul should be computed in the same

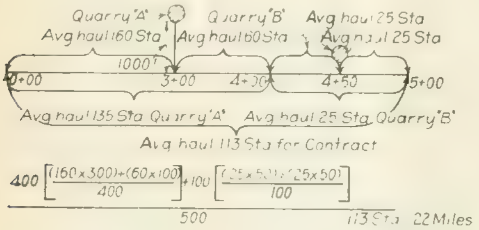

Quarry 'A'
Quarry 'B'
Avg haul 25 Sta
Avg haul 160 Sta
Avg haul 60 Sta
Avg haul 25 Sta
1000'
0+00
3+00
4+00
4+50
5+00
Avg haul 135 Sta Quarry 'A'
Avg haul 25 Sta Quarry 'B'
Avg haul 113 Sta for Contract
400 [(160x300)+(60x100) / 400] +100 [(25x50)+(25x50) / 100]
500
113 Sta 22 Miles

Fig. 2. Method of Determining Average Haul From Several Quarries.

general manner as when a single source of supply is used. The portions of the road estimated to be built from each source of supply must be carefully considered. On a comparatively level road, this length would depend entirely on the relative locations of the sources of supply. On a road with heavy grades the portion to be served from each source of supply will depend largely on the grades, avoiding, if possible, a heavy uphill haul. Having gotten the average haul from each source of supply for the portion to be built from it, in the same manner as when a single source of supply is used, proceed as follows:

Multiply the average haul from each source of supply by the length, in stations, of the portion of the road to be built from this source of supply. Add together the products thus obtained and divide by the total length of the road in stations. The result will be the average haul in stations. Figure 2 illustrates a typical example.

The price of transferring broken stone from cars or boats to wagons should be estimated at from 15 cts. to 20 cts. per cubic yard. If the stone is quarried on the road, and loaded from bins directly into the wagons, no price should be estimated for transfer to wagons.

The cost per cubic yard mile haul should run from 30 cts. to 35 cts. when estimating team haul, on the basis of a day's team travel of 20 miles, and loads of 1½ cu. yds.

The following manipulation costs should be used in estimating the cost of different types of macadam pavement:

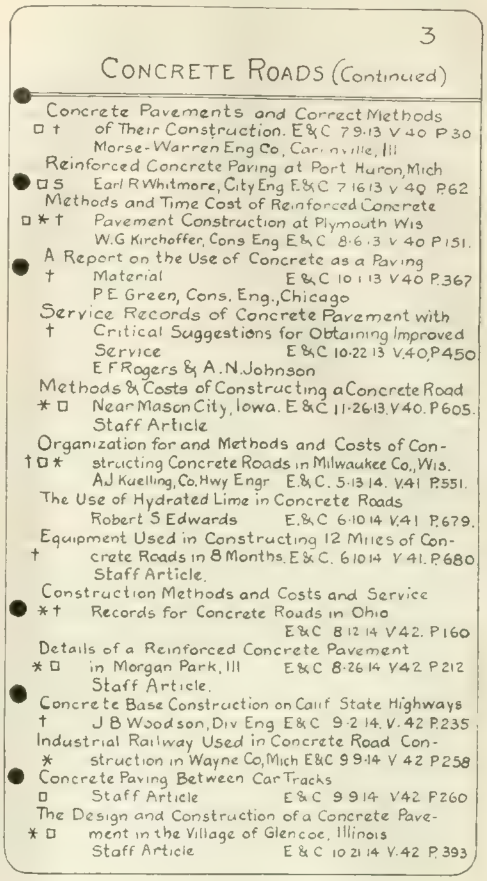
Class. Macadam	Stone, per cu. yd. loose.	Screenings, per cu. yd. loose.	Binder, per gal.
Bottom	.30	.25	....
Top, waterbound	.30	.30	....
Top; penetration method	.25	.20	.015

The following manipulation costs should be used in computing the cost of various other types of pavement:

Item.	Per cu. yd.
Concrete foundation for pavement	$0.65
Concrete pavement	1.00
Brick pavement	.17
Stone block pavement	.17
Wood block pavement	.17

A Pocket Index of Engineering Articles.

To the Editors: A useful loose-leaf pocket index of engineering articles has been devised and used by the writer with gratifying results. It has often saved much valuable time in supplying a wealth of information readily on any given subject. The index is a 4¼x7¾ in. loose-leaf book with the various subjects hand printed on cloth—index tabs pasted to the margin of each sheet, and arranged alphabetically. My list of sixty-five subjects was for convenience selected from the general index of the Proceedings of the American Society of Civil Engineers; but I have confined my index to only those articles appearing in ENGINEERING & CONTRACTING to avoid duplication of subject matter for there seem to be few important engineering projects written up in any journal that are not also covered authoritatively and efficiently in this magazine. The accompanying sheet (Fig. 1) is a sample page taken at random from my index to show the method of making the weekly entries. The symbols indicate which articles contain illustrations (*); plans (□); tables (†); diagrams or charts (△), and specifications (s). Entries are made only on one side of each leaf so that blueprints may be made of any page, for which purpose I use black carbon ink in my fountain pen. The sample page herewith shows only one of three index pages of articles appearing on the subject of "Concrete Roads," of which the writer has successfully supervised the building of 28 miles during the past two years and he attributes his success largely to the valuable fund of information on this subject offered by ENGINEERING & CONTRACTING and made available through this pocket index.



3

CONCRETE ROADS (Continued)

Concrete Pavements and Correct Methods
□ † of Their Construction. E&C 7 9·13 V 40 P 30
Morse-Warren Eng Co, Carlinville, Ill
Reinforced Concrete Paving at Port Huron, Mich
□ S Earl R Whitmore, City Eng E&C 7 16 13 V 40 P 62
Methods and Time Cost of Reinforced Concrete
□ * † Pavement Construction at Plymouth Wis
W.G Kirchoffer, Cons Eng E&C 8·6·13 V 40 P 151.
A Report on the Use of Concrete as a Paving
† Material E&C 10 1 13 V 40 P.367
P E Green, Cons. Eng., Chicago
Service Records of Concrete Pavement with
† Critical Suggestions for Obtaining Improved
Service E&C 10·22 13 V.40, P450
E F Rogers & A.N.Johnson
Methods & Costs of Constructing a Concrete Road
* □ Near Mason City, Iowa. E&C 11·26·13. V 40. P 605.
Staff Article
Organization for and Methods and Costs of Con-
† □ * structing Concrete Roads in Milwaukee Co., Wis.
AJ Kuelling, Co. Hwy Engr E.&C. 5·13 14. V.41 P.551.
The Use of Hydrated Lime in Concrete Roads
Robert S Edwards E.&C 6·10 14 V.41 P.679.
Equipment Used in Constructing 12 Miles of Con-
† crete Roads in 8 Months. E&C. 6 10 14 V 41. P 680
Staff Article.
Construction Methods and Costs and Service
* † Records for Concrete Roads in Ohio
E&C 8 12 14 V42. P 160
Details of a Reinforced Concrete Pavement
* □ in Morgan Park, Ill E&C 8·26 14 V42 P 212
Staff Article.
Concrete Base Construction on Calif State Highways
† J B Woodson, Div Eng E&C 9·2 14. V·42 P.235
Industrial Railway Used in Concrete Road Con-
* struction in Wayne Co, Mich E&C 9 9·14 V 42 P 258
Concrete Paving Between Car Tracks
□ Staff Article E&C 9 9 14 V42 P 260
The Design and Construction of a Concrete Pave-
* □ ment in the Village of Glencoe, Illinois
Staff Article E&C 10 21 14 V.42 P.393

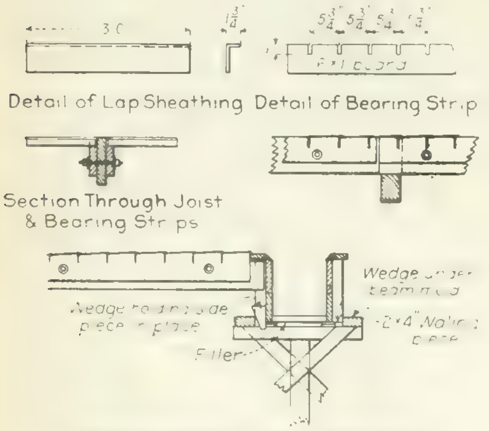
Sample Page from Index.

Sincerely yours,
M. ROY THOMPSON,
County Engineer and President State Association County Engineers.
Tacoma, Wash., Nov. 11, 1914.

CONSTRUCTION PLANT
MACHINES DEVICES MATERIALS

Metal Lap Sheathing for Concrete Forms for Building Construction.

The accompanying illustration shows details of "Blaw Lap Sheathing," and indicates the use of this metal sheathing in the construction



Details of Metal Lap Sheathing.

of flat-slab and beam-and-girder floors for buildings. As noted in the illustration the sheathing unit is in the form of an angle having legs of 6¼ and 1¾ ins. and a length of 3 ft. Special lengths may be obtained, but at higher prices than the standard. In a typical framing plan for flat-slab floors the wood joists are spaced 3 ft. ½ in. on centers. The bearing strips, which are bolted to the joists, are notched as shown in the illustration to receive the short leg of the sheathing, these notches being 5¾ ins. apart. The removal of the bearing strips permits the removal of the sheathing without disturbing the joists. Where beam-and-girder floors are to be constructed, wood forms are used for the beams and girders and metal lap sheathing for the slabs. The metal lap sheathing described above is manufactured and furnished by the Blaw Steel Construction Co., of Pittsburgh, Pa.

A Safety Block for Incline Hoists.

The safety block illustrated was designed primarily for mine work but is applicable wherever cable incline hoists are employed. It is a design suggested by the State Mine Inspector of New York. It consists of two almost upright timbers *a*, fastened to the square shaft *d* by the straps *c*. The shaft is turned in two places to fit the boxes. The bottoms of the timbers *a* are bolted to a transverse piece *b*. The hoisted car hits the timbers *a*, which revolve with the shaft, permitting the car to pass. The weight of *b* then brings them to the upright position and the cross-piece prevents their swinging in the other direction. To release the car, the lever, which

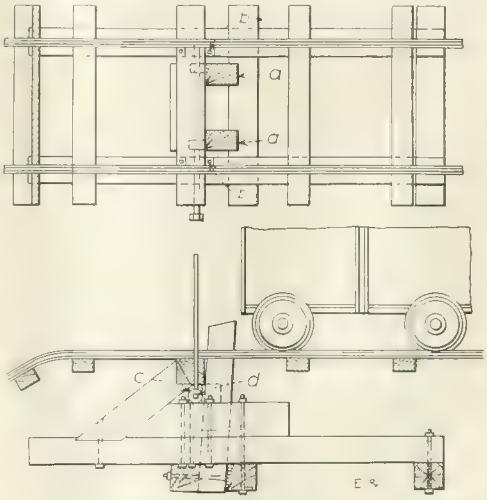
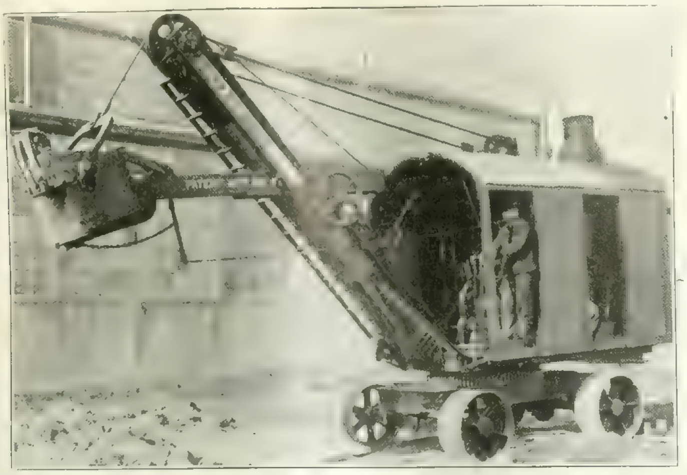


Fig. 1. Safety Block for Cable Incline Hoists.

is attached to a square portion of the shaft, is used to force the timbers down below the level of the axles.

A New "Single Line" Shovel.

The novel feature of the shovel illustrated is the use of a single sheave of large diameter at the point of the boom, the engines being compound geared. Their arrangement dispenses with the padlock sheave entirely and permits of an increased reach and a higher lift to the dipper.



A New "Single Line" Light Steam Shovel.

This machine is claimed to be a true one-man shovel. The few levers necessary for control are banked near the left-hand forward corner of the cab. The operator has a clear platform, an unobstructed view and a wide passageway to the boiler. The crowding engines on the boom are so geared in relation to the speed of the hosting engines that a level grade may be cut. The boom may be readily lowered to any angle permitting easy passage under obstructions and a steel gudgeon inverted from above permits of rapid assembly and dismantlement. No iron castings are used on the shovel except in the engine cylinders. All parts on the shovel are standardized and are machined on the interchangeable principle.

The dipper has a ⅝ cu. yd. capacity and the shipping weight of the shovel complete is about 33,000 lbs. The boom is 16 ft. long and will dump 12½ ft. above the wheel level. The radius of cut at the wheel level is 15 ft. The spread of the traction wheel is 8½ ft.

The shovel is manufactured by the American Steel Dredge Co., Fort Wayne, Ind.

An Electrically Driven Shovel Used on Street Railway Construction.

In building its 79th Street line, the Cleveland Railways Company had to do a considerable amount of excavation for which it employed the electrically driven Thew automatic shovel illustrated herewith.

This shovel is of the horizontal crowding motion type and has several other features of interest. It weighs 13 tons, has a dipper with a capacity of ⅝ cu. yd. and a clearance height over the house of 12 ft. 2 ins. It is mounted on regular car wheels on which it travels on the car tracks and in addition is equipped with a set of auxiliary traction wheels, 33 ins. in diameter, and 15 ins. tread, which permits it to run under its own power over the ground, pavement, or wherever it is desired to take it.

The horizontal dipper crowding motion utilized is said to be particularly adapted to the application of electric drive because of the ease of control and power demands. In excavating material with a shovel, it is necessary first to crowd the dipper forward into the material, then to hoist it upward through the material. In this case, the first motion is made horizontally, being obtained as follows:

The dipper is suspended by an adjustable arm, hinged to a carriage or trolley moving horizontally along a suitable trackway. This enables the shifting of the point of rotation for dipper, so that the hoisting force is at all times exerted in the most effective manner, while the crowding force is applied horizontally. The combination of the horizontal trackway and the boom channels results in a structure braced and reinforced to withstand the severe strains which the boom is called upon to endure.

The trolley motion is controlled by a lever. This lever is further connected to a trip rod which is operated automatically when the trolley reaches the limit of its motion in either direction.

The entire motive power for traction, hoisting, and swinging consists of one 20-hp. Westinghouse compound-wound 550-volt direct-current motor with a starting and reversing control equipment. The motor operates at approximately constant speed, the various motions being controlled through suitable friction and gears.

An Electrically Driven Shovel Used on Street Railway Construction.

The current is usually admitted to the shovel through a flexible insulated cable connected to a switch on the truck frame and transmitted through copper rings to brushes suspended from the swinging turntable. The use of one motor appears to be a particularly desirable feature, for reducing the initial cost, and affording greater flexibility of action in the frequent reversals of the various operating motions; it also means the operation of three levers instead of three separate controllers, and a gain in time over starting and stopping three separate motors. It is distinctly a one-man machine.

The boom is of the Jack Knife type with an adjustable section that can easily be lowered, allowing the shovel to pass under the trolley wire, without interfering in any way with the efficiency of its operation. The shovel swings through a complete circle delivering the excavated material at any desired point.

A buffer is furnished which takes up the shock that occurs when the shovel strikes a hard piece of excavation. This allows the shovel to be released and relieves the whole machine from the strain to which it would otherwise be subjected. The cab is cut away so as to allow plenty of room for passing cars, a feature of particular importance when used on street railway work.

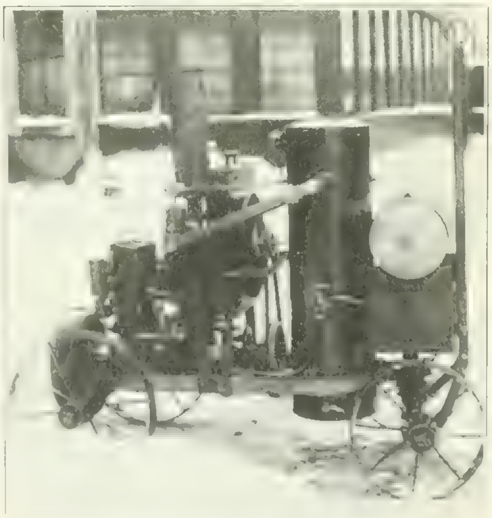
The illustration shown herewith affords an excellent idea of the class of work being done by the Cleveland Railways Company and the manner in which the shovel is operated, while the following data obtained through the courtesy of Mr. J. J. Stanley, president, and C. H. Clark, engineer maintenance of way, show the cost of the entire operation.

Loading	
Shovel man at 40 cts.	$ 4.00
Four laborers at 21 cts.	8.40
Current, oil, repairs, etc.	1.50
Loading cost per day	$13.90
Hauling—	
Four men at 26 cts.	$10.40
Four men at 19 cts.	7.60
Two men at 30 cts.	6.00
Hauling cost per day	$24.00
Dumping—	
1 foreman at 30 cts.	$ 3.00
6 laborers at 20 cts.	12.00
Dumping cost per day	$15.00
Cu. yds. loaded in 10 hours May 8	540
	Cts.
Cost of loading per cu. yd.	2.6
Cost of hauling per cu. yd.	4.4
Cost of dumping per cu. yd.	2.8
Cost of loading, hauling and dumping	9.8
Lineal feet excavated on this work	2,700
Number of 10-hour shifts operated	12
Lineal feet excavated per 10-hour shift	225
Cu. yds. loaded (place measure, per 10-hour shift)	450
Average loading cost, 450 yds. at $13.90—3 cts. per cu. yd.	
Average hauling cost, 450 yds. at $24.00 5½ cts. per cu. yd.	
Average dumping cost, 450 yds. at $25.00—3⅓ cts. per cu. yd.	
Average loading, hauling and dumping cost—11⅔ cts.	
Length of haul—approximately 6 miles.	
Average HP. used in moving shovel	15.0
Maximum HP. used in moving shovel	20.2
Average HP. used in operating shovel	11.7
Maximum HP. used in operating shovel	43.6

The shovel is built by the Thew Automatic Shovel Co., of Loraine, Ohio, and the electrical equipment by the Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa.

A Small Portable Air Compressor.

The small gasoline engine driven portable air compressor illustrated has been developed by the Ingersoll-Rand Co., particularly to meet the needs of the contractor doing work of a temporary character requiring compressed air in small quantities, such as the laying of gas and water mains, where air tools of various types are used for cutting asphalt, tearing up roadways, rock cutting, calking lead joints, drilling and riveting on steel pipes, tamping dirt, etc. The compressor is operated by a simple sin-



A Portable Gasoline Driven Air Compressor.

gle cylinder gasoline engine which is coupled directly to the compressor, both pistons working on the same crank shaft. The engine is of the single acting two cycle type, closely following the well known marine designs. The air compressor, which is one of the company's standard types, known as "Imperial XII," has a capacity of 45 cu. ft. per minute at a pressure of 90 lbs.; it is fitted with an air unloader and the engine with a centrifugal governor. Cooling is provided for by a gear driven pump and an automobile type radiator with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

The frame, axles and wheels are of steel, the front axle is arranged with a swivel connection to the frame, permitting horizontal rotation for turning corners and sufficient vertical movement to accommodate the wheels to inequalities of the road without strain on the frame.

An air receiver tested to 300 pounds water pressure and fitted with safety valve, pressure gage, necessary piping, outlets, etc., is hung at one end of the frame and a gasoline tank of 15 gals. capacity is supported on a large tool box as shown in the illustration.

The outfit complete weighs 1,600 lbs.; it is designed for hand transportation, but can be fitted with tongue and singletree if desired. The makers rate this outfit in term of pneumatic tools of its make as follows: Three medium size "Little David" chippers; two "Crown" pneumatic picks; two "Little David" riveting hammers; one "Little David" wood boring drill or one metal drill; two "Crown" sand rammers; two small plug drills or one jackhamer; one medium size "Imperial" hoist; ten small stone tools or six larger sizes.

Drill Wagons in Quarry Work.

Contributed by Frank Richards.

At the quarry of the Dewey Portland Cement Co., Dewey, Okla., the one thing to be accomplished is the getting out of the material in condition suitable for the crushers and at as low a cost as possible for the operation. The surface of the rock is practically level and the general scheme is to drill holes to a uniform depth and about 10 ft. apart, loading them with 3 in. 40 per cent gelative and firing a large area at once, the object being to raise the rock and break it up, and not to throw it out into the quarry, the subsequent handling of the rock being done by a steam shovel.

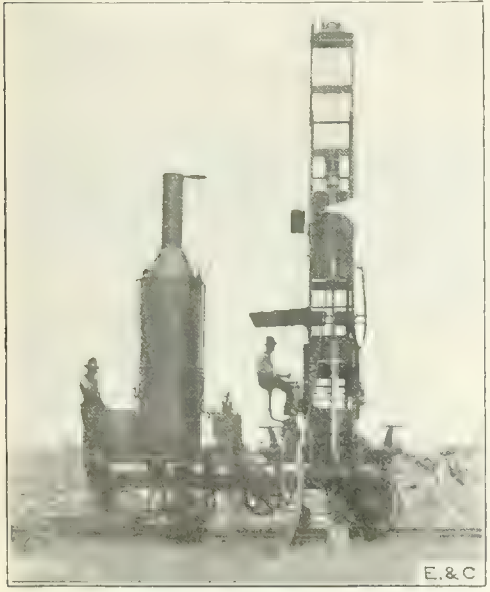


Fig. 1. Drill Wagon for Quarry Work.

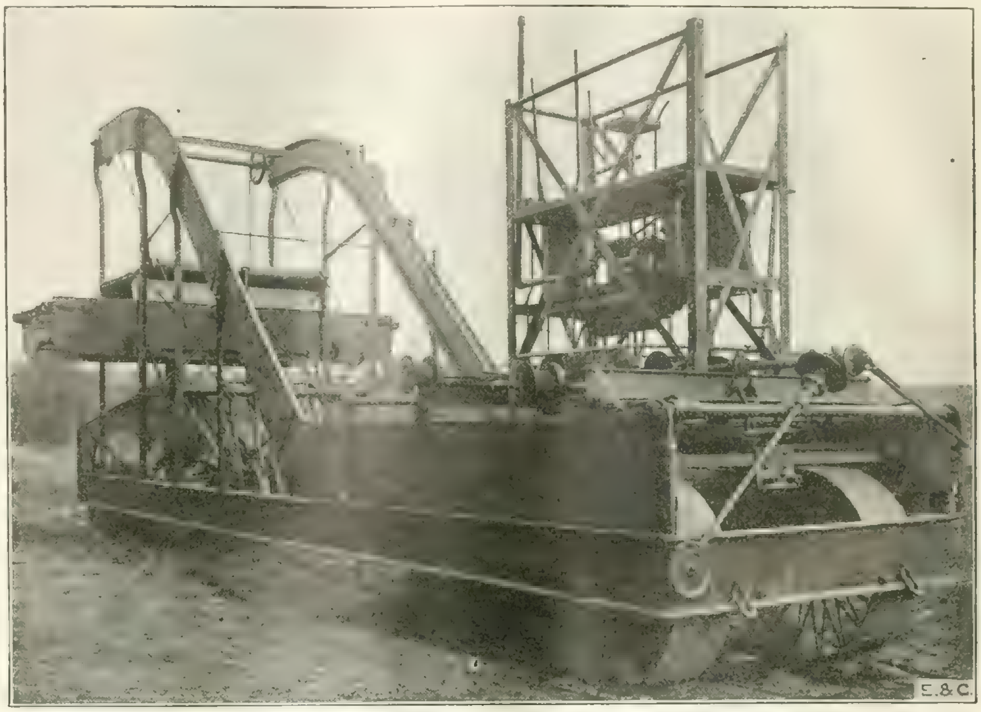
During the present year the drilling has all been done by one drill wagon equipment. This comprised a standard Ingersoll-Rand H-64, 20 ft. feed, turntable drill equipped with a 35 hp. boiler. Ordinarily the machine is operated by one drill runner and one helper, and when necessary to move the track additional help is called up from the steam shovel and switching gang in the quarry. It is considered, however, that there should be three men constantly attached to the drill to run it most efficiently, as even though the boiler is gas fired, it requires considerable attention to keep the steam right, and the one helper can hardly find time to keep things going all right at each end of the wagon.

When demonstrated for acceptance this drill did from 140 ft. to 200 ft. of 3¼ in. hole per 10 hr. day, the holes being from 18 to 20 ft. deep. The drill was sold under a 150 ft. guarantee, which was easily made to the satisfaction of the quarry owners, and no attempt was made by the demonstrator to make or break any records, most of his time being spent in teaching the new operator how to get the best results. Another reason for not attempting any astonishing records in this case was in the fact that there was great objection to the water used in washing the cuttings out of the hole, as the rock mixed with this water becomes more or less muddy and does not go through the crusher as well, so that it was necessary to reduce the supply of water to a minimum and then the drill throttle could not be opened to take full advantage of the power available. Under other conditions the drill would not be under this handicap, and could make a still better showing.

At each setting of the wagon on the track one hole would be drilled on the side, with the drill in the position shown in the photo, Fig. 1 and then the turntable would be given half a turn for drilling a corresponding hole on the other side of the track; after moving the machine along 10 ft. on the track two more holes would be drilled in the same way, and so on.

A New Excavating Machine.

The essential elements of the excavator illustrated herewith, which is manufactured by L. C. Wood & Co. of Alden, Ia., are gang plows and a scoop. The machine plows seven furrows, 6 to 12 ins. deep, and the scoop handles 56 cu. ft. at each trip. The machine is designed for loading dirt onto dump wagons in railway grading, reservoir dam construction, and in ditching for irrigation and road work. It is operated by a 35-HP. double cylinder traction engine, constructed with a winding drum and anchors so that the engine remains stationary while the excavator is in operation. The machine is drawn ahead about 7 ft. for a load then, without stopping the engine, the scraper is unlocked, fills and is drawn up the track and dumped onto the conveyor. The conveyor discharges into dump wagons at either side of the machine.



View of New L. C. Wood Plowing and Scraping Excavator.

The machine is 8 ft. wide and 38 ft. long. It weighs about 12 tons. About 150 ft. of 1⅛-in. steel cable is used so there can be several loads handled without moving the engine. The machine is drawn from place to place behind the traction engine. It is ready to work as soon as the motor on the machine is started, and begins loading as soon as the engine is unhooked, the cables hooked together and the engine run out to the end of the cable. The small motor on the machine furnishes power to operate the conveyor, to control the plows, to steer the machine and to raise and lower the front end of the machine. When the machine is working the front wheels are on top of the ground and the rear ones travel behind the scraper where the plowing has been picked up. The machine, therefore, always works on the level.

In operation one man is required on the machine and two on the engine. The engine is of special design for operating the machine. Both are built almost entirely of steel and steel castings. The machine is constructed to handle very hard material, such that if plowed with teams three or four teams would be required on a single plow. A full load is handled in 20 seconds and, in service, from 80 to 100 loads are handled per hour.

Small Concrete Mixer.

A small, low-priced concrete mixer, recently placed on the market, weighs 2,500 lbs. complete. It takes a batch of 5 cu. ft. of loose sand, stone and cement. It holds 3 cu. ft. of wet concrete without splashing and mixes 40 to 60 cu. yds. of concrete per day. It is known as the "Smith Mixerette," and, it is claimed, is economical and will wear indefinitely, costing little for repairs. When equipped with geared loader two batches can be handled at once. Both men and machine are busy all the time. The feed level is low, the skip is broad and easy to fill. In construction this loader is unique. It is gear-driven—no sheaves, no hoisting ropes. The "Mixerette" is manufactured by the T. L. Smith Co., 1128 32nd St., Milwaukee, Wis. It sells for the price of $315 f. o. b., Milwaukee, with all equipment.

One of the largest underground water systems in the world was recently completed at Prague, Bohemia. The water is supplied by nearly 600 artesian wells 15 miles from the city, and is carried by a gravity pipe line.

Engineering and Contracting

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Vol. XLIII. No. 1. January 6, 1915.

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Gives additional information on plant described in issue of Dec. 2, 1914. Gives local conditions which led to the adoption of this form of treatment. Describes operation conditions. E. & C., Jan. 6, 1915; 1½ cols.

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Construction Features of the Bloomfield Bridge, Pittsburgh, Pa 6

Describes and illustrates the construction features of the Bloomfield Bridge, Pittsburgh, Pa. This structure has a total length of about 1,960 ft. and contains girder and simple truss spans and a cantilever system. The methods used in erecting the superstructure are of special interest. This article is Part III of a series of articles which cover completely the design and construction features of this bridge. Part I and II were published in our Sept. 9 and 23, 1914, issues. E. & C., Jan. 6, 1915; 7 cols.

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Some essential data by Clifford Older, bridge engineer, Illinois Highway Commission, on floors for steel highway bridges in Illinois. Illustrates standard types of floors used by Illinois Highway Department, and gives classification of types and cost data. E. & C., Jan. 6, 1915; 4½ cols.

PIPE, WOODEN STAVE: Use, Design, Construction, Cost and Durability of.

The Design of Wooden Stave Pipe 10

Third in a series of five articles on the use, design, construction, cost and durability of wooden stave pipe. Discusses experimental data on flow of water in this class of pipe, and gives a diagram for use in the computation of pipe sizes. The design of every part of continuous and machine banded pipe is fully analized from both the practical and algebraic standpoints. All limiting factors and conditions are discussed and recorded. Specifications for both types of pipe are given. E. & C., Jan. 6, 1915; 13½ cols.

WATER MAINS: Test Plug for.

An Inexpensive Plug for Use in Testing Sections of Water Mains During Construction 14

Describes and illustrates simple, inexpensive, home-made test plug for use in testing tightness of newly caulked joints during water main construction. E. & C., Jan. 6, 1915; ½ col.

PIPES; WATER SERVICE: Under Street Pavements, Method of Pushing.

Methods Employed at Champaign-Urbana, Ill., in Pushing Service Pipes Under Pavements 14

A brief description of the device and methods employed by the Champaign and Urbana Water Co. in this work. Calls attention to desirability of laying water mains in parking rather than under pavements. E. & C., Jan. 6, 1915; ½ col.

ROADS: Economics, Location.

Road Location and the Economics of Road Improvement 15

States requirements of an ideal road from the standpoint of service and economy. Discusses the principles of road location on new projects and the improvements of old roads. Gives an example of the correct solution of a problem in road economics. E. & C., Jan. 6, 1915; 5½ cols.

ROADS: Economics, Grading, West Virginia.

Conditions Determining Maximum Grades and the Cost of Road Grading in West Virginia 16

Discusses economic conditions affecting maximum grades; hauling with regard to motor trucks and horses and costs of grading on various roads in West Virginia. E. & C., Jan. 6, 1915; 3½ cols.

ROADS: Haul of Material, New York.

Method of Computing Average Haul of Road Material Used by the New York Highway Commission 17

Describes the method of determining average haul by weighted averages. Methods and value assigned in estimating haul. E. & C., Jan. 6, 1915; 1¼ cols.

INDEX, POCKET: For Engineering Articles.

A Pocket Index of Engineering Articles ... 18

Letter explaining a loose leaf pocket index used by the writer to keep account of engineering articles appearing in technical papers. E. & C., Jan. 6, 1915; 1 col.

CONSTRUCTION PLANT: Machines, Devices, Materials:

Metal Lap Sheathing for Concrete Forms for Building Construction 18

A Safety Block for Incline Hoists 18

A New "Single Line" Shovel 19

An Electrically Driven Shovel Used on Street Railway Construction 19

A Small Portable Air Compressor 19

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A New Excavating Machine 20

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Building Material.—Manufacturer's agent would like to be put in touch with manufacturers of, or dealers in, all kinds of building materials, with a view to obtaining exclusive agencies for that territory. No. 15004.

Locomotive Fire Box Plates.—European locomotive manufacturer desires to communicate with American manufacturers of copper plates used in making locomotive fire boxes. It is desired to purchase and import direct from manufacturers in the United States. No. 15005.

Cement and Automobile Tires.—A Portuguese importing firm is in the market for large quantities of yellow and white cement and automobile tires for its branch house in South America. Prices f. o. b. New York or c. i. f. South American port are desired. Correspondence may be in English. No. 15007.

Builders' Hardware, Etc.—Canadian firm wishes to enter into communication with American manufacturers and exporters of builders' hardware, hardware specialties and tools. No. 15025.

Machinery.—Commission firm in Southern Europe desires to buy, for shipment to South America, machinery, etc., for a brewery. It is desired to install a plant of a daily capacity of about 100 gals., costing about $17,000. Correspondence may be in English, but catalogues should be in Spanish, if possible. No. 14969.

Iron and Steel Products.—East Indian firm wishes to be placed in communication with American firms shipping iron and steel products. No. 14974.

Dynamos, Transformers, Etc.—A merchant in a European capital desires to act as agent in this country for an American manufacturer of electric supplies, such as accumulators, electrical appliances for automobiles, dynamos, transformers and wire installation. No. 14977.

Machines and Machine Tools.—European firm of machinery dealers is in the market for a large variety of machines and machine tools. Catalogues and offers from American manufacturers are requested. No. 15030.

INDUSTRIAL NOTES

The three contractors for the 1,800 ft. section of the Mill Creek intercepting sewer, recently let in St. Louis, Mo., have purchased Sullivan air compressors and shields for the work. The contractors are Brocklehurst & Potter of New York, James T. McMahon Construction Co., St. Louis, and Thomas Connor & Sons, St. Louis. The tunnel is to be driven through medium soft lime rock with a section of 19½x19 ft. Brocklehurst & Potter are sinking two shafts, one at Armstrong St. 95 ft. deep, 11 ft. of which is in dirt; one at Ewing St. 84 ft. deep, 23 ft. of which is in dirt. At 12th St. a shaft, which is 8½ ft. deep, 40 ft. being in dirt, is being dug by the McMahon Co., and the second McMahon shaft is at 6th and Rudger Sts., 38 ft. deep. Thomas Connor & Sons are putting in two shafts, one 98 ft. deep at Theresa St., of which 95 ft. is in dirt; and one at Tamm St. 63 ft. deep, 35 feet in dirt. Some quicksand was encountered in the last shaft and sheet steel piling was used down to the rock. All these shafts are concrete throughout. Six belt-driven two-stage compressors are in use, five having a piston displacement of 1,015 cu. ft. per minute and one having a piston displacement of 628 cu. ft. per minute. These are being operated by short belt drive from electric motors. It is interesting to note that the rock drills, of which 46 are now in use, are all of the Sullivan "FF-12" 2⅝ in. Liteweight pattern with water attachment. This is the size and make of drill used so successfully on the Mount Royal Tunnel of the Canadian Northern R. R. at Montreal, and with which a record of 810 ft. of 8x12 ft. heading in hard limestone was made last year, in 31 working days. Sullivan Rotators or self-rotating hammer drills are employed by the contractors at St. Louis for sinking their shafts.

The Cement Gun Co. of New York announces that Thomas A. Edison has installed two cement guns for use in the reconstruction of his plant at West Orange, N. J., recently destroyed by fire.

The A. Milne Co., steel and iron merchants, with main offices at 741 Washington St., New York City, has opened a branch warehouse at 550 Washington Blvd., Chicago, Ill., and will carry there a complete stock of tool steel and hollow and solid drill steel.

The Galion Iron Works, Galion, O., manufacturers of culvert pipe, road makers' machinery, and contractors' and municipal supplies, has presented each one of its employes, from the president down, with an insurance policy. The policy guarantees that in the event of death from any cause whatsoever, the salaries of such employes will be paid to their families each month for an entire year.

NEW CATALOGUES

Road and Farm Machinery.—Paper, 8½x11 ins.; 4 pp. The Utility Road and Farm Machinery Co., 143 N. Wabash Ave., Chicago.

Consists of brief description and photographs of the Clark Traction Grader and Trenching Machines. Shows two types of graders which can be readily transformed into trenching machines, and which are built to handle earth, clay, sand, gravel, broken stone or small boulders.

Concrete Mixers.—Paper, 6x9 ins.; 16 pp. Archer Iron Works, 2402 W. 34th Pl., Chicago.

Catalogue No. 25, devoted to the No. 1 Archer Special Concrete Mixer, a small capacity mixer, with end discharge and engine mounted on top of steel mixing frame. Shows views of mixer equipped with hoist, batch hopper and gate, steel engine, housing, etc., and also shows actual operations. General specifications and testimonial letters are included.

P & H Products.—Paper, 8x10 ins.; 52 pp. Pawling and Harnischfeger Co., Milwaukee, Wis.

An interesting and artistically compiled souvenir booklet entitled "Thirty Years of Progress," giving a history of the inception, progress and organization of the firm of Pawling & Harnischfeger and a brief resume of P & H products. Cranes and hoists form the chief of these, and a number of photographs of the manufacturing departments, of the machines, and of the men at the head of the company are shown.

Steam Shovels.—Paper, 9x16½ ins.; 36 pp. The Thew Automatic Shovel Co., Lorain, O.

Catalogue No. 9 describing Thew full circle swing shovels, and the horizontal dipper crowding motion which is its distinguishing feature. Shows views of the shovels at work and describes and illustrates the various types.

Air Compressors.—Paper, 6x9 ins.; 24 pp. Chicago Pneumatic Tool Co., Chicago.

Bulletin No. 34-K, devoted to Class N-S O and N-S G fuel oil and gas-driven compressors and their application to the unit system of air power plants. Illustrated.

Steel Forms.—Paper, circulars. Concrete Engineering Co., Omaha, Neb.

Meyer system steelform concrete floor construction and Ceco bar chairs are described in these circulars. Show photographs and sections of the steel forms and bar chairs which are wire supports for the reinforcing bars. A table of safe live loads is given.

Piston Rings.—Paper, 4½x6¾ ins.; 68 pp. Burd High Compression Ring Co., Rockford, Ill.

Directory of piston ring sizes, for automobiles, motor cycles, cycle cars, trucks, tractors and engines. Introduction consists of a brief summary of the qualities of Burd High Compression Rings. Illustrated.

Rotary Pumps.—Paper, 3½x6 ins.; 16 pp. Blackmer Rotary Pump, Power & Mfg. Co., Petoskey, Mich.

Describes and illustrates the various types of Blackmer rotary pumps, particularly oil, sanitary creamery, and bilge pumps. Points out the distinctive Blackmer features, such as the lined pump as applied to rotaries and the interchangeability of parts.

Hoists and Derricks.—Paper, 6½x9½ ins.; 112 pp. Minneapolis Steel & Machinery Co., Minneapolis, Minn.

Catalogue B201, giving construction details, specifications, tables of sizes, etc., with halftone illustrations of the various types of Twin City hoists and derricks. Also briefly describes engines, buckets, wire rope and other appurtenances.

Road Binder.—Paper, 3½x6½ ins.; 20 pp. Robeson Process Co., 20 E. 41st St., New York City.

Briefly explains the nature and action of Glutrin and its advantages as a road binder. Shows photographs of various macadam, clay-gravel or shale roads treated with this substance.

Electrical Equipment.—Paper, 8x10½ ins.; 3 bulletins. General Electric Co., Schenectady.

Bulletin No. 45,602, 8 pages, describes horn and aluminum lighting arresters for series lighting circuits. Illustrations and dimension diagrams are given.

Bulletin No. 42,010, 14 pp., an attractive booklet on small turbo-generator sets, 7 KW. to 300 KW. Illustrated.

Bulletin No. 42,300, 12 pp., steam engine-driven generator sets, 2½ KW. to 75 KW. Illustrated. Both engine and generator are described in detail.

Threshing Machinery. — Paper, 9x11¾ ins.; 88 pp. J. I. Case Threshing Machine Co., Racine, Wis.

Complete illustrated and descriptive catalogue and price list of Case threshing machinery. Gives specifications, photographs and description of operation, etc. Also describes Case road graders, scarifiers, drags, rock crushers and stone graders.

Dump Wagons.—Paper, 9x10½ ins.; 20 pp. Studebaker, South Bend, Ind.

Catalogue No. 805, showing Studebaker bottom dump wagons and dump boxes. Gives detailed illustrated description of the construction of these wagons and views and specifications of the various styles.

Wagons, Trucks, Drays, etc.—Paper, 14 bulletins. Studebaker, South Bend, Ind.

Catalogue No. 600, 9x10½ ins., 96 pp. Studebaker farm wagons. Price lists and dimensional tables. Illustrated.

Catalogue No. 1001, 5x8 ins., 172 pp. Studebaker delivery wagons. Illustrations, specifications and price list.

Catalogue No. 1002, 5x8 ins.; 176 pp. Studebaker carriages. Complete data, prices and illustrations of various kinds of buggies.

Serial No. 916, giving data and illustrations of Studebaker wagons for draying and trucking.. 5x8 ins.; 14 pp.

Serial No. 873, 5x8 ins.; 4 pp.; eight-wheel log wagons. Illustrated.

Serial No. A874, 5x8 ins.; 8 pp.. Removable sleeve bar axle wagons. Illustrated.

Serial Nos. 851 and 852, circulars. describing Studebaker street sprinklers and dump wagons.

Serial Nos. A890 to A897, circulars calling attention to various points in favor of Studebaker construction.

CURRENT NEWS

The Doings of the Week.

A continued improvement in general business conditions is indicated by the developments of the past week. Many factories have started up again and others are preparing to resume operations. Railroad shops in various sections of the country have been re-opened, and some 2,000 coke ovens in the Connellsville District which have been banked for months have been relighted. The Chamber of Commerce of the United States, which has been gathering statistics on general crop and business conditions, in its report issued Monday, predicts slowly improving business conditions during the first three months of the year. In the construction field there have been few important developments during the past week. A fair amount of improvements came up for bids, but with a few exceptions most of the undertakings are small. The holiday season and close of the business year undoubtedly held back many advertisements, especially for municipal work. In the highway field there is quite a bit of new activity this week, as indicated by the calls for bids. The same condition also applies to the drainage field. In the Steel and Iron market the main development of the last week of 1914, according to *The Iron Age,* was the action of a number of manufacturers of bars, structural shapes and plates in advancing prices from 1.05 cts. Pittsburgh on early deliveries to 1.10 cts. The U. S. Steel Corporation received many orders during December and it is estimated that the unfilled tonnage at the close of the month will show an increase of over 200,000 tons as compared with the figures for November. More inquiries for cast-iron pipe from private companies were received in December than in any other time since 1906. Railroad demands are also increasing, the Pennsylvania R. R. in particular having asked bids on a large tonnage of structural steel and reinforcing rods.

Railroads.—Little activity as regards construction undertakings has been shown as yet by the railroads. This, of course, is to be expected. It is not likely that many of the improvements and betterments planned by the carriers will be placed under contract before spring. One or two lines have already announced construction programs for the present year. The Erie R. R. is understood to contemplate beginning work on 66 miles of double track work, the longest section covering 36 miles of line between Lomax and Griffith, Ind. Among the construction contracts awarded recently are the following: W. J. Newman Co., Chicago, Ill., 20-mile electric railway from Hamilton to Connersville, Ind.; Essex Construction Co., Omaha, Neb., for drag line work near Carbon, Ind.; Board & Duffield, Charleston, W. Va., 3 miles of line on Peter Cave Fork for Horse Creek Land & Mining Co.

Roads and Streets.—Some very fair construction undertakings in the highway and municipal paving field reached the call for bids stage during the past week. Flint, Mich., is calling for proposals on 110,000 sq. yds. of pavement; the State Roads Commission of Maryland opens bids Jan. 19 for 5 sections of highway aggregating 10.56 miles; the County Auditor at Plymouth, Ind., opens bids Jan. 12 for 12 roads in German Township; James R. Masker, State Highway Commissioner of Ohio, is asking proposals on a brick paved road, estimated to cost $91,279. The County Commissioners at Chehalis, Wash., open bids Feb. 1 on 2 miles of concrete road to cost $32,500. Pueblo, Colo., will call for bids probably some time this month on the construction of $185,000 worth of improvements in the Mineral Palace paving district, the work consisting of gravel macadam paving to cost $57,000, curb and gutter to cost $63,000, excavation $15,000, and sewer $50,000. Houston, Tex., also is planning to ask bids this month on a $300,000 job, the work calling for the construction of the Main St. boulevard to the Rice Institute. Hillsborough County, Florida, awarded a contract for 16 miles of brick road; Louisville, Ky., let a $76,000 paving job; the contract for the Somers Point-Longport Boulevard in Atlantic County, New Jersey, was awarded to the Atlantic Construction & Supply Co., Atlantic City, N. J., at $182,212. Providence, R. I., opened bids on paving work to cost about $150,000.

Bridges.—Two or three good sized bridge contracts have been let in the past few days, and a number of new undertakings are now ready for bids. Hillyer & Sperring Co., Jacksonville, Fla., were awarded the contract at about $120,000 for the reinforced concrete viaduct at Duval St., Jacksonville; Cole Bros., Inc., Baltimore, Md., secured the contract for a reinforced concrete arch bridge at Morgantown, W. Va., at $53,331; J. J. Jobst, Peoria, Ill., was awarded the contract at $80,000 for reinforced concrete bridge at Bridge St., Danville. Bids are being asked for the construction of a 197-ft. steel highway bridge over Rondout Creek at Wawarsing, N. Y.; the County Commissioners at Anthony, Kan., open proposals Jan. 11 on five reinforced concrete structures, 23 ft. to 300 ft. in length. A number of western counties also are taking bids on their bridge construction to be done during 1915.

Drainage and Irrigation.—A considerable amount of work in the drainage field has come up for advertising for bids during the past week. The Commissioners of Drainage District No. 4, Edna, Tex., open bids Jan. 12 on about 100 miles of ditches requiring 400,000 cu. yds. of excavation; the New River Drainage District of Gonzales, La., is asking proposals on drainage canals involving 2,000,000 cu. yds. of excavation; Beltrami County, Minnesota, is calling for bids on three Judicial Ditches, the aggregate estimated cost being about $130,000. The U. S. Reclamation Service is calling for bids on about 158,000 cu. yds. of excavation and 7,000 cu. yds. of concrete near Payson City, Utah.

Water Works and Sewerage.—No particularly large undertakings in either the waterworks or sewerage fields appears to have reached the advertising stage during the past few days. Montreal, Que., is readvertising the construction of the Elgin Basin pumping station; the Board of Water Supply of New York City is calling for bids for about 8,000 sq. ft. of face cutting of stones for the Kensico Dam; Lockport, Ill., is reported to be calling for bids for a sewer system. The New York & New Jersey Construction Co., Essex Bldg., Newark, N. J., at $179,531 was low bidder for Section 17 of the Main intercepting sewer for the Passaic Valley Sewage Commissioners; Harrison & Burton, New York City, were awarded the contract for the collecting sewers, and Frank Puglia, Paterson, N. J., the contract for the collecting system for North Plainfield, N. J.; Guthrie-McDougall Co. at $168,907 was low bidder for the E. 82nd St. and Willow St. sewer for the city of Portland, Ore.

The Outlook for 1915.

The outlook for constructional activities in 1915 is encouraging. Many things make this so: the abundance of idle capital, the opening of the Federal reserve bank system, the favorable decision in the Eastern rate case, and the tremendous crops of last year are all important factors. The new year opens auspiciously. The period of greatest unsettlement has been passed and general business conditions are returning gradually to the normal. Confidence and optimism are widespread, and there is every reason to believe that financial and industrial affairs will continue to show improvement. Nineteen fifteen may not be a record breaker for construction undertakings, but it would seem a safe prediction that the amount of work undertaken will be greater than in 1914, and will be well up to the average of other years. In the railroad field especially prospects are brighter now than they have been for several years. If the carriers are able to handle the necessary financing there is little doubt but they will make a start this season on a considerable part of their long held up improvements and betterments. One or two of the larger lines already have announced substantial construction programs for the year. An encouraging feature of the financial side is that during December over $50,000,000 of new railroad securities were sold. Municipal work will furnish many opportunities. The extent of these improvements, of course, will depend on the ability of the cities and towns to dispose of their securities. There has been a steady improvement in the demand for municipal bonds and last month over $20,000,000 worth were disposed of. The market for securities of this sort is now very active and all conditions point to its continuing in that condition. Construction prospects also are excellent in the highway field. Several states, notably California and New York, have large unexpended balances from bond issues authorized some years ago, that will be available for work during the present season. Other states will carry on their improvements under direct appropriations. There is no reason to think that their legislatures will be less liberal this year; in fact, in three or four states the allowances will be larger than ever before. Many counties and road districts authorized bonds last year for highway improvements. In Illinois alone two counties voted a total of $3,500,000 of bonds for road purposes. Practically all of the work for these various political units will be ready for letting during this season. In the highway field, state, county and district, 1915 should be a banner 12 months. Many notably large construction undertakings probably will be commenced this year. These include the $75,000,000 Hetch Hetchey water supply project of San Francisco; the $65,000,000 union station and terminal at Chicago; the $10,000,000 sewage disposal system for Milwaukee, Wis.; the $17,000,000 flood prevention project for the Miami Valley Ohio, and the $3,000,000 8-ft. waterway for Illinois. A start also may be made late in the year on the construction of the government railway in Alaska. No one can say with any definiteness what this year will bring forth. At the present time, however, every indication points to a busy and prosperous season for engineers and contractors.

Alien Labor Decision.

A decision of importance to contractors operating in states that have labor laws providing that only citizens of the United States should be employed upon public works, was handed down on Dec. 31 by the Appellate Division, First Department, of New York. The court held that the alien labor provisions of the state labor law were unconstitutional. This labor question having arisen in the case of one of the contractors for the new subways of New York City, a taxpayers' action was begun in the Supreme Court for an injunction to restrain the Public Service Commission for the First District, which is in charge of the construction of the new dual system of rapid transit, from declaring forfeited any subway contract because of the employment of aliens by the contractor. The Commission demurred to the complainant, and the demurrer was sustained by a lower court, but on appeal the Appellate Division reversed this decision and held the law unconstitutional. The Commission has taken steps to appeal from this decision in order that a final construction of the statute may be obtained from the highest court in the state.

DREDGING HUDSON RIVER AT NEW YORK.

600,000 Cu. Yds. of Material from Westerly Side of River.

Bids to Be Opened Jan. 22 at New York City.

A fair-sized contract for dredging in the Hudson River is now being advertised for bids by the U. S. Engineer at New York City. The work provides for the improvement of New York Harbor by dredging in the Hudson River channel. The section of the river to be improved under this project extends from the Battery and Ellis Island to the northern limits of New York City, about 2½ miles north of Spuyten Duyvil Creek, a length of about 16 miles. The least width of the river in this section measured between pierhead lines is 2,725 ft. and the greatest width is about 5,400 ft. A depth of more than 40 ft. at mean low water can be carried through the easterly side of the river up to and beyond the northern limits of New York City.

The work to be done under the contract now being advertised lies in the westerly side of the river along the Jersey City waterfront. The object is to make a channel adjacent to the pier head line extending from opposite Newark St., Hoboken, N. J., to deep water opposite Ellis Island, this channel to be 30 ft. deep at mean low water and of such width as available funds will permit. The shoal through which this channel is to be dredged has a least mean low water depth over it off Communipaw, N. J., of about 20 ft., gradually increasing in depth as it approaches deep water off Newark St., Hoboken.

The mean range of tides at the Battery is about 4.2 ft. It probably does not vary from this to an appreciable extent in the area to be deepened. Though navigation is not likely to be closed during the winter months, ice will probably delay operation at intervals during the period Dec. 16 to March 15. The site of the work is not exposed to severe wave action, nor is the work likely to be affected by ordinary storms. The average number of days during the year of dense fog, as reported by the U. S. Weather Bureau, is 25. No work has been done since 1877 by the United States in the area to be deepened. The work to be done under the contract consists in dredging all material, except ledge rock, above a plane 30 ft. below mean low water. The bottom width of the channel is to be 800 ft., but the funds now available are insufficient to make a channel of this adopted width. It is intended, therefore, to first dredge a through channel 30 ft. deep at mean low water and about 150 ft. bottom width from deep water about off the foot of Newark St., Hoboken, to deep water about opposite Ellis Island, a length of about 3 miles, and then to widen this through channel to such an extent as the available funds will permit. On the basis of a channel width of 200 ft. the amount of material to be removed under this contract, exclusive of allowable overdepths, is estimated at 600,000 cu. yds. scow measurement. The average depth of cut to the required depth is estimated at 5½ ft. It is also estimated that 50 cu. yds. of rock and boulders, varying in size from ½ to 3 cu. yds. and 25 cu. yds. over 3 cu. yds. in size will have to be removed. The material is believed to be mainly mud, some sand and gravel, a comparatively small amount of small stones and possibly a few boulders and some clay. In disposing of the excavated material, the contractor may provide his own dumping grounds outside of the waterways, subject to the approval of the contracting officer. He also can transport it and dispose of it at such places as may be designated by the Supervisor of the Harbor of New York.

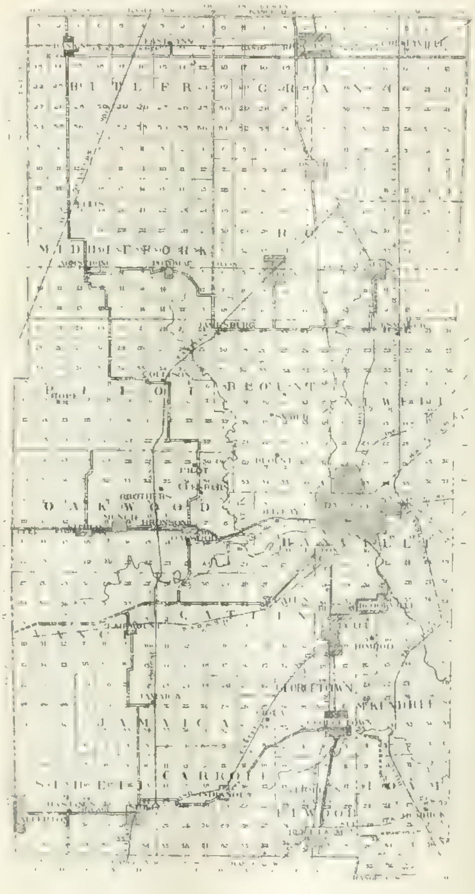
The contractor will be required to start work not later than March 16, 1915, and to complete the contract within 9 months. About $100,000 is available for payment of contractor's estimates. Bids for dredging in Hudson River channel, New York, will be received until noon, Jan. 22, by Col. W. M. Black, U. S. Engineer, 39 Whitehall St., New York.

A $1,500,000 ROAD IMPROVEMENT PLAN.

Bids to Be Asked in Spring for Highway Construction in Vermilion County, Illinois.

Brick and Concrete Roads, with Gravel or Rock Shoulders.

Contracts probably will be let some time before June 1 for the construction of 180 miles of concrete or brick roads in Vermilion County, Illinois. The work will be paid for from a $1,500,000 bond issue authorized at the general election on Nov. 3, 1914. The accompanying map shows the location of the roads in Vermilion County, the highways to be improved under the bond issue being indicated by the heavy dark lines. The bond roads, in general, will extend through all towns of the county and will connect with hard surface roads already built or under way from Danville. The proposed mileage of the roads in the various townships is as follows:


Location of Roads to Be Improved.

Township.	Miles.
Blount	10⅛
Butler	15¾
Carroll	7
Catlin	10½
Danville	1¼
Elwood	4½
Georgetown	7¼
Grant	18⅝
Jamaica	5½
Love	5½
McKendree	2
Middlefork	16½
Newell	8½
Oakwood	17¾
Pilot	11
Ross	11½
Sidell	10½
Vance	10½

The plan of improvement provides for a road 16 ft. wide, with brick or concrete centers 10 ft. wide, and gravel or rock shoulders 3 ft. wide on each side. The cost of such concrete roads is estimated at $8,100 per mile; the cost of brick roads is estimated at $12,500 per mile. The work will be done according to plans and specifications approved by the Illinois Highway Commission. Very little bridge work probably will be required, as it is proposed to use the present structures.

It is planned to divide the system into sections and to commence work on the different sections at approximately the same time, so that construction will be going on in all parts of the county.

The work will be in charge of Wm. S. Dillon, County Superintendent of Highways, Danville, Ill.

RAILROAD CONSTRUCTION IN SOUTHERN STATES.

Work Contemplated by Various Companies During Present Year.

Railroad construction in 1914 in the Southern states showed a great falling off as compared with the mileage constructed in the previous year. According to statistics collected by the Manufacturers' Record only 911 miles of line were completed last year in the South. This is a decrease of 842 miles over the figures for 1913. The largest amount of new line was laid in Florida, the total for the state being 203 miles. Texas, which for a number of years has been first, is now second, its record amounting to only 138 miles. Of the mileage in Florida the Atlantic Coast Line is responsible for 51 miles, the Florida East Coast Ry. for 49 miles, and the Tampa & Gulf Coast R. R. for 47 miles. The statistics show that at this time only 576 miles of new line is proposed for construction in 1915. The following table, which has been abstracted from the data in the Manufacturers' Record shows some of the principal new undertakings proposed for this year:

Name of railway and state.	Miles.
Asherton & Gulf, Texas	50
Atlantic, Waycross & Northern, Georgia	22
Beaumont & Saratoga Transportation Co., Texas	49
Birmingham & Chattanooga, Alabama	12
Birmingham-Tuscaloosa Ry. and Utilities Co., Alabama	45
Buffalo Creek & Gauley, West Virginia	88
Cache Valley, Arkansas	12
Chattahoochee Valley, Alabama	15
Cherry River & Southern, West Virginia	38
Clarksburg Northern, West Virginia	..
Cumberland, Kentucky	24
Cushing Traction Co., Oklahoma	13
Eastern Texas Traction Co., Texas	52
Elkin Alleghany, North Carolina	8
Ensign Yellow Pine Co., Alabama	5
Fayette Traction Co., West Virginia	5
Fellsmere, Florida	4
Florida East Coast, Florida	17
Fort Smith, Subiaco & Eastern, Arkansas	23
Gainesville & Northwestern, Georgia	..
Georgia Southwestern & Gulf, Georgia-Florida	155
Glen Rose & Walnut Springs, Texas	14
Gulf, Florida & Alabama, Alabama	50
Gulf, Freeport & Northern, Texas	20
Hagerstown & Frederick, Maryland	7
Hiawassee, North Carolina	50
Horse Creek Land & Mining Co., West Virginia	3
Houston & Brazos Valley, Texas	2
Kansas City, Mexico & Orient, Texas	100
Lulu & Homer, Georgia	15
Memphis, Dallas & Gulf, Arkansas	164
Meridian & Memphis, Mississippi	15
Middle Tennessee Traction Co., Tennessee	72
Monongahela Valley Traction Co., West Virginia	15
Monroe & Texas, Louisiana	10
Morgantown & Wheeling, West Virginia	29
Morgantown Interurban, West Virginia	9
Norfolk & Western, West Virginia	8
Oil Belt Terminal, Oklahoma	20
Oklahoma, New Mexico & Pacific, Oklahoma	32
Oklahoma, Oklahoma	15
Old River & Kissatchie, Louisiana	12
Orleans-Kenner Interurban, Louisiana	2
Owingsville & Olympic, Kentucky	3
Pecos Valley Southern, Texas	75
Peoples, Alabama	13
Piedmont Northern, North Carolina	5
Pine Bluff & Northern, Arkansas	35
Richmond & Rappahannock River, Virginia	16
Rio Grande, Texas	28
St. Andrew's Bay, Florida	4
South Florida & Gulf, Florida	28
Southern Traction Co., Texas	15
Tampa & Gulf Coast, Florida	3
Tennessee, Kentucky & Northern, Tennessee	20
Tennessee, Tennessee	11
Uvalde & Northern, Texas	44
Vicksburg, Alexandria & Southern, Louisiana	8
Virginia-Blue Ridge, Virginia	10
Virginia-Carolina, North Carolina	22
Watauga & Yadkin River, North Carolina	26
Wilmington & Carolina Beach, North Carolina	13

LOCK AND DAM NO. 33, OHIO RIVER.

Bids Asked on Contract Amounting to $1,140,000.

Concrete—Piling—Sheeting—Structural Steel—Castings.

A contract requiring the expenditure of over $1,000,000 is now being advertised for bids by the U. S. Engineer at Cincinnati, O. This work calls for the construction of Lock and Dam No. 33 in the Ohio River. For this improvement an allotment of $1,140,000 has been made. This sum is expected to be sufficient to cover the entire cost of the work connected with the first general contract. The amount now on hand available for payment to the contractor is about $1,000,000.

The work is located in the Ohio River, about 3½ miles above the public landing at Maysville, Ky. The Chesapeake & Ohio R. R. passes the site on the Kentucky (lock) side of the river. The Maysville street car line reaches to within about ⅔ mile of the site.

The work on which bids are now asked calls for the construction of the fixed parts of the lock, including lighting towers and gate anchorages, the guide walls, the river wall turbine pit, the dam (including the fixed parts of the navigable pass, both fixed and movable parts of the bear traps, and the fixed parts of the Chanoine weir), the abutment and grading and paving the esplanade and the banks back of the abutment and esplanade. The following items are not included in this contract: Trestles, wickets, horses, props, lock gates, operating machinery for lock valves and gates, corner plates for gate machinery pits and tile gages.

The order of the work will be prescribed by the contracting officer, but unless otherwise directed at least 350 ft. of navigable pass will be included in the lock cofferdam and will be completed and the cofferdam about it removed before the bear trap foundations are begun. The bear trap leaves will not be erected until after the lock, except guide walls, and the foundations and piers for both bear traps have been constructed. To comply with these requirements it is expected that the work ordinarily will have to be carried on in two cofferdams.

The cofferdams will be of the box type, except that for guide walls and elsewhere as directed a modified type may be used, such as a bank of earth or box cofferdam of reduced height or a combination of both. The standard box cofferdams will be built to an elevation of at least 16 ft. and the width between sheeting will be at least equal to the full weight of the cofferdam at that point. This width, however, will not be less than 10 ft. nor more than 20 ft. The modified cofferdam will be of such height as to permit work to be carried on at all stages of the river of 10 ft. or less.

The stone for riprap unless shown otherwise on the drawings will be one and two-man stones. All riprap back of the line of land wall and the abutment will include a 6-in. bed of quarry spalls or gravel. The stone paving will consist of one and two-man stone, roughly squared, and carefully hand placed on a 6-in. bed of quarry spalls or gravel. Concrete paving 6 ins. and 8 ins. thick may be substituted for the stone paving. The round piles for the foundations will be of oak, ash, hickory, beech, maple, gum or other acceptable hardwood. They will be not less than 14 ins. diameter 2 ft. from the butt and 9 ins. in diameter at the small end. It is believed that 30 ft. piles will be sufficient. The sheet piles will be made of oak, ash, hickory, beech, maple, gum, yellow pine or other acceptable timber. They will be 10 ins. by 12 ins. full length with hardwood strips spiked on to form tongues and grooves.

The deck timber for the cribs will be oak, ash, hickory, beech, maple, gum or other acceptable hard wood. The common timber for the cribs, 4-in. sheeting, etc., will be hemlock, pine or other wood of equal quality. White oak timber will be used for the upper leaves of bear trap weirs.

All concrete work, except where otherwise directed or approved will be built in alternate monoliths not exceeding 40 ft. in length. The concrete will be composed of 1 bbl. cement, 11 cu. ft. of sand and 24 cu. ft. of gravel or broken stone. All mortar used separately for facing or other purposes will be composed of 1 part cement to 2 parts sand. Only the pump-pit floor, wheel-pit floor of the river wall, pintle blocks, turbine pit and pipe support at center of lock will be classed as reinforced concrete. The contractor will be required to provide two mixing plants having a combined capacity to make and place at least 300 cu. yds. of concrete in 8 hours.

The approximate quantities are as follows:

Cofferdam, standard, lin. ft.	4,700
Cofferdam, modified, lin. ft.	1,500
Common excavation, cu. yds.	40,021
Fill, cu. yds.	61,235
Riprap, cu. yds.	26,522
Stone paving, cu. yds.	600
Round piles, lin. ft.	147,270
Sheet piles, ft. B. M.	1,463,150
Common timber, ft. B. M.	708,018
Deck timber, ft. B. M.	250,180
Oak timber, ft. B. M.	72,426
Reinforced concrete, cu. yds.	254
Concrete, cu. yds.	43,143
Concrete paving, cu. yds.	6,842
Structural steel, lbs.	869,618
Reinforcing rods, lbs.	121,030
Forgings (including wrought iron), lbs.	51,150
Bolts, etc., lbs.	131,804
Iron castings, lbs.	296,082
Steel castings, lbs.	194,129
Bronze, lbs.	1,319
Pipe, 6-in., lin. ft.	2,338
Pipe, 4-in., lin. ft.	2,164
Pipe, 3-in., lin. ft.	2,702
Pipe, 2-in., lin. ft.	555
Pipe, 1½-in., lin. ft.	590
Pipe, 1¼-in., lin. ft.	696
Tile drain, lin. ft.	754

Bids for construction of Lock and Dam No. 33 will be received until 2 p. m., Jan. 26, by Lt. Col. H. Jervey, U. S. Engineer, Cincinnati, O.

First Building Contract Let for Cotton Warehouses, New Orleans.

The contract for the first set of buildings for the cotton warehouses and terminal for the Port of New Orleans, La., has been awarded to the Jefferson Construction Co., New Orleans, at $994,647. The original bid of this concern was $1,323,444. As this was in excess of the sum the Port Commission wished to expend, modifications were made in the plans. The contract covers Compress No 1, sorting sheds 1 and 2, the power house, garage, office and warehouses G, H, J and K. These buildings in general will be of heavy reinforced concrete construction on creosoted pile foundations. Their combined ground area will be about 727,000 sq. ft. and with the exception of the office and garage they will be 1-story (36 ft.) in height.

The total expenditure for the warehouses and terminal is estimated at $3,500,000. The Board of Port Commissioners already has sold a $3,000,000 bond issue and has the money on deposit. The plant will be erected on an 80-acre site on the Mississippi River and will include yards for the Public Belt R. R., a wharf, six warehouses, four of which are included in the contract just let, and several other buildings also included in this contract.

Of the six warehouses, four will be for consigned and f. o. b. cotton and two for through cotton. These latter will each be 102 by 672 ft. in size. Two of the consigned warehouses will each be 203 by 512 ft. in size and the other two will each occupy a space 203 by 672 ft. The wharf will be double decked, 120 ft. wide on the first floor and 100 ft. wide on the second. It will be 2,000 ft. in length and will have a creosoted pile apron wharf 44 ft. wide extending its entire length, which will carry two railroad tracks. The wharf will be of reinforced concrete construction resting on untreated piles. The equipment for mechanically handling the cotton will consist of electrically operated overhead traveling cranes and electric storage battery trucks and trailers.

Ford, Bacon & Davis, New Orleans and New York, are the engineers in charge of the design and construction of the warehouses and terminal.

Grade Separation Work at Milwaukee, Wis.

The grade separation project of the Chicago, Milwaukee & St. Paul Ry. for the northwestern part of Milwaukee, Wis., has been brought one step nearer the construction stage. On Dec. 24 the State Railroad Commission issued a tentative order for track depression and directed that the work must be started before July 1, 1916, and must be finished by Dec. 13, 1918. The order calls for the separation of street grades between 38th St. and Fond du Lac Ave. With one exception the streets crossing the track will either be closed or be above the tracks. The exception to this plan will be at Clark St., where a subway for pedestrians will be built.

The following are the crossing changes to be carried out: 35th St., bridge above the railroad tracks; no approach on McKinley Blvd.; Vliet St., bridge crossing, 7 ft. above present grade; 34th St., side approach 4½ ft. above present grade; 33rd St., bridge over tracks 7 ft. above present grade; Galena St. bridge 1 ft. above present grade; Lisbon Ave., Brown St. and North Ave. overheard crossings at present grade; Clark St., cut 10 ft. for subway; Center St., crossing at a cut of 9½ ft.

The cost of the improvement is estimated at about $3,000,000, apportioned as follows: 70 per cent to the Chicago, Milwaukee & St. Paul Ry.; 25 per cent city of Milwaukee, and 5 per cent Milwaukee Electric Ry. & Light Co.

Surveys Completed for Lake Erie & Ohio River Ship Canal.

Surveys of the proposed route for the Lake Erie and Ohio River Ship Canal have been completed and the engineers are now engaged on their report and estimates of cost. Legislation providing for elections in the counties in Ohio, Pennsylvania and West Virginia, the states that will be affected directly by the construction of the waterway, has been passed, and it is believed that if these counties vote next fall to guarantee the bonds, the canal can be opened in 1920.

The estimated cost of the improvement will be between $40,000,000 and $50,000,000. As proposed the canal will have a depth of 12 ft., a width of 178 ft. and a capacity for 4,000-ton self-propelled barges. The northern terminus probably will be at the mouth of Indian Creek, about 5 miles west of Ashtabula on Lake Erie, and the southern end is proposed for the junction of the Ohio and Beaver Rivers, 26 miles below Pittsburgh. Of the total length of 103 miles, 53 miles would involve the canalization of the Beaver and Mahoning River, and the remaining distance would be new construction.

Water Works Improvements for Dayton, O.

Comprehensive plans have been prepared for water works improvements for Dayton, O., which when completed will give a supply adequate for a population of over 200,000. Improvements will be made in the source of supply, in the pumping equipment and in the distributing mains. The total cost will be about $2,000,000, but this expense will be spread over a period of about 16 years, as needed. In the next two years, however, it is proposed $1,000,000. Of this sum $500,000 will be used for the distribution system and $500,000 on the reservoir and pumping station. The distribution facilities will be improved by uniting the present disconnected system of mains and feeders and by laying mains sufficiently large to carry the amount of water demanded. It is proposed to expend during the year about $250,000 for laying large size main extensions. These will consist of 10-in., 12-in., 16-in., 20-in., 24-in., 30-in. and 36-in. pipe. It is expected that all of this work will be done directly by the city and a contract already has been awarded for 5,000 tons of pipe. J. E. Barlow is Director of Public Service at Dayton.

A $500,000 Bridge at Kansas City, Kan.

Bids probably will be asked early this spring on a good sized bridge undertaking at Kansas City, Kan. The work calls for the erection of a bridge over the Kansas River at Central Ave. The improvement provides for a 3-span steel structure 744 ft. long with approaches at each end 750 ft. long. The piers will be of concrete, and will extend to bed rock, the pneumatic process being used in their construction. Concrete piles will be used in the shore piers. The highway floor of the bridge will be paved with creosoted blocks on reinforced concrete 27 ft. wide. The bridge also will carry a double track street railway.

The present structure, consisting of three double deck spans 198 ft. each, will be removed, the old approaches cut down and the river bed dredged clear of large obstructions. It is expected that the total cost of the work will be about $500,000. Plans are now being prepared by R. L. McAlpine, County Surveyor, Kansas City, Kan., and the work will be ready for advertisement about April 1.

The Eleventh Annual Convention of the American Road Builders' Association.

The notable features of the eleventh annual meeting of the American Road Builders' Association at Chicago, Dec. 14-18, 1914, was the excellent display of road machinery and materials and the excellent attendance upon the sessions of the association, at which papers upon various phases of road building and maintenance were read. Extreme cold weather interfered somewhat with the success of the show but in spite of this the attendance exceeded 3,500. The attendance for the most part included only engineers and contractors engaged in active road construction. At the final business meeting it was decided to leave the election of officers for a letter ballot, to be taken in the near future. The place of holding the next annual meeting was not decided at that time, and this will be left to a committee.

Short Course in Highway Engineering at the University of Michigan, Feb. 15-20, 1915.—The Department of Engineering of the University of Michigan announces a short course in Highway Engineering for the benefit of highway engineers, highway commissioners and others intersted in the construction and maintenance of roads and pavements. This course will be given during the week in February, beginning Monday, the 15th, 1915.

The work will consist of a thorough discussion, particularly of Michigan road conditions and materials. The course as given will be entirely free from the influence of commercialism. The faculty of instruction will be composed of members of the faculty of engineering of the University of Michigan, with the addition of several outside lecturers, among whom may be mentioned Thomas H. McDonald, Iowa state engineer; Prof. Charles M. Strahan, dean of engineering of the University of Georgia; Mr. Frank Rogers, Michigan state highway commissioner; Mr. Prevost Hubbard, chief of division of roads and pavements of the Institute of Industrial Research, Washington, D. C.; Ira O. Baker, professor of civil engineering of the University of Illinois; Mr. O. L. Grover, chief bridge engineer of the U. S. Office of Public Roads, and W. W. Crosby, consulting highway engineer, Baltimore, Md. These lecturers were selected from highway engineers of the United States, who are in no way connected with the sale of machinery or road building materials. It is hoped this fact will result in the saving of time to those in attendance, and also will secure for this short course the same favorable opportunity for an open discussion that is enjoyed in the ordinary courses of study at the University of Michigan. There will be no laboratory fees or charges of any kind in connection with this course.

Any information desired can be had by addressing Mr. H. E. Riggs, professor of civil engineering, University of Michigan, Ann Arbor.

Philadelphia Association of American Society of Civil Engineers.—The next meeting of the Philadelphia Association of Members of American Society of Civil Engineers will be held at the Engineers' Club of Philadelphia, 1317 Spruce St., at 8 p. m. on Jan. 18. Prof. Chas. D. Marx, president-elect, Am. Soc. C. E., will deliver an illustrated address on the Panama-Pacific Exposition and the Engineering Congress of 1915. As this is a subject of interest to all engineers, a cordial invitation has been extended to members of the other engineering societies of Philadelphia to attend the meeting.

Lyttle Creek Flood Control and Conservation Project.—In our issue of Dec. 9 we described the proposed plan for controlling the flood waters of Lyttle Creek in San Bernardino County, California. The consulting engineer for this improvement is Mr. F. C. Finkle, I. W. Hellman Bldg., Los Angeles, Cal. In the issue referred to the name of the engineer was erroneously printed F. C. Hinkle.

The fourth annual meeting of the Arkansas Engineering Society will be held at Little Rock, Ark., Jan. 18 and 19.

PERSONALS

Messrs. H. M. Haven and W. W. Crosby have formed a partnership under the firm name of Haven & Crosby, engineers and architects, with offices at 40 Central St., Boston. Both were formerly members of the firm of F. W. Dean, Inc., of Boston.

Mr. O. H. Lang has been chosen as county surveyor and engineer for Colquitt County, Georgia, and is engineer in charge of $50,000 worth of paving and sidewalks in Quitman, Ga. Mr. Lang was formerly instructor in the Department of Experimental Engineering of the Georgia School of Technology at Atlanta, Ga. Since 1911 he has conducted a general civil engineering practice at Moultrie, Ga.

Mr. H. C. Westover has opened an office at 988 Pearl St., Beaumont, Texas, to practice municipal engineering. He is prepared to undertake the preparing of plans and specifications, the supervision and construction of municipal water, sewer and electric light plants, and the compiling of commercial reports, appraisals and prospectus work. Mr. Westover was formerly a member of the firm of Rollins & Westover of Kansas City, Mo., where he was engaged in similar work.

Mr. C. P. Howard, formerly a member of the firm of Berry, Howard & Roberts, dissolved, as announced elsewhere in this column, announces the opening of an office as consulting engineer, specializing in railway surveys, location, re-location, plans, estimates and studies of economics, of operation as affected by grade and line improvement. Offices are at 1603-4 Transportation building, Chicago. Mr. Howard is a member of the American Society of Civil Engineers, the American Railway Engineering Association and the Western Society of Engineers.

Mr. Thad McKay entered upon the duties of County Surveyor for Lassen County, California, Jan. 1, 1915, for the third consecutive term. Mr. McKay received his technical training at the Van der Naillen School of Engineering at San Francisco, graduating with the class of 1900, and taking advanced work in 1901. After a varied practice as land and mine surveyor he was in 1906 elected to the office of county surveyor of Lassen County, California, and again in 1910. During his past eight years of office he has been an important factor in Lassen County progress for good roads and bridges.

Mr. J. B. Berry and Mr. S. S. Roberts announce the dissolution of the firm of Berry, Howard & Roberts and the continuance of business in the general practice of civil engineering under the firm name of Berry & Roberts, with offices at 1640 Transportation Building, Chicago. Both Mr. Berry and Mr. Roberts are members of the American Society of Civil Engineers and of the American Railway Engineering Association. The firm is prepared to make investigations, estimates and reports of existing and proposed lines, railway location, yard and terminal plans, valuations for private, state and federal use, and studies and reports of the economics of railway operation due to changes of line or gradients.

Mr. R. L. Fitzgerald has been appointed to the office of municipal business manager for the village of Winnetka, Ill. This office has just been created, and its duties are largely a matter of experiment, but the manager will have charge of the business affairs of the community. The position also involves the supervision of the water works and electric plant that are owned by the village. Mr. Fitzgerald, who assumed office on Jan. 1, is a graduate in mechanical engineering of Purdue University. He was employed by the Houston, Texas, Gas Co. from 1904 to 1906, and by the Gary Heat, Light & Water Co., Gary, Ind., from 1907 to 1911. In 1912 and part of 1913 he was on the engineering staff of the Wisconsin Railroad and Tax Commissions. Since August, 1913, he has been employed by Sloan, Huddle, Feustel & Freeman, consulting engineers of Madison, Wis., and has been chiefly engaged in engineering investigation of public service properties in many parts of the United States.

OBITUARIES

F. X. Dion, president of the Lauzon Engineering Co., Ltd., engineers and contractors, 127 Commercial St., Levis, Quebec, died December 17 at his home in Lauzon, Quebec. Mr. Dion was a well-known figure in business circles of Quebec. The firm of which he was the head is engaged largely in railway and municipal work, and has made a specialty of wharves, piers, dams and of reinforced concrete construction.

Richard J. Evans, a civil engineer of New Orleans, died in that city Dec. 21, aged 74. Mr. Evans was for a number of years engaged in railroad construction in the South and West. He was at one time connected with the U. S. Geodetic Survey. He was a member of a commission of three civil engineers appointed to pass upon plans for the drainage of New Orleans and its protection from the overflow waters of the Mississippi.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces examinations as follows:

Physical Laboratorian; $3.04 per diem. New York Navy Yard or U. S. Naval Department at Washington. Technical education and some experience involving a knowledge of the strength of structural materials, elementary physics and mechanics, etc. Feb. 3.

Electrical Draftsman; U. S. Navy Yards or Department at Washington; $3.52 to $5.52 per diem. Feb. 3-4.

Marine Engine and Boiler Draftsman. U. S. Navy Yards or Department at Washington; $5.04 per diem. Feb. 3-4.

Copyist Marine Engine and Boiler Draftsman; $2.80 per diem. Feb. 3.

Sanitary Engineer; Public Health Service; $2,500 per annum. Graduation from college or university, including full course in sanitary engineering and four years' laboratory and field practice required. Feb. 2.

Copyist Electrical Draftsman; Navy Yards; $3.28 per diem; Feb. 3.

Copyist Ordnance Draftsman; Navy Yards; $2.80 per diem; Feb. 3.

Civil Engineer Student; U. S. Office of Public Roads; $720 per annum; Feb. 3.

Topographic Aid; temporary; Geological Survey; $40 to $75 per month; Feb. 3.

Junior Topographer; Geological Survey; $720 to $1,200 per annum; Feb. 4-5.

Structural Steel Draftsman; U. S. Naval Station; $3.52 to $5.52 per diem; Feb. 3-4.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

Vol. XLIII. CHICAGO, ILL., JANUARY 13, 1915. Number 2.

Alignment and Grades on Country Roads Requiring a Pavement Not Readily Replaceable.

It is contended by those advocating the construction of relatively permanent surfaces for country roads that such pavements will have a considerable value as foundations for other pavements after the expiration of their life as a wearing surface. This is undoubtably true if the alignment and grades on the highway are satisfactory at that time. Otherwise the old pavement will constitute a liabilty rather than an asset. May not, then, the added cost of right-of-way and grading necessary to make the location the best obtainable be offset to some degree by the value of the old pavement at the expiration of its life?

The following comparison between the cost of a light western railroad, several hundred miles long, as given by Wellington and 20 miles of gravel road in Mississipoi described in Engineering and Contracting, p. 302, Vol. XLII, is interesting:

Item.	Railroad, per cent.	Highway, per cent.
Engineering	2.8	3.1
Grading	34.0	36.8
Culverts and bridges	16.2	7.3†
Right of way, fencing, crossings, etc.	2.3	2.6
Ballast, cross-ties, rails and track-laying or gravel road	27.0	44.6
Office and incidental expense up to opening of line	2.4	.6
Interest and discount on bonds to opening	15.3	5.0*
	100.0	100.0

†No bridges. *Estimated.

It will be noted that while the cost of grading is approximately one-third of the total cost for both, the cost of ballast, track-laying, etc., is approximately one-fourth in the case of the railroad and almost one-half for the corresponding feature—the gravel pavement—in the case of the highway.

The following statistics from a recent publication of the U. S. Office of Public Roads are derived from a study of 224 sections of road:

Type.	Drainage and grading, per cent of total cost.	Paving, per cent of total cost
Gravel, 20 ft. wide	41.15	58.85
Waterbound macadam, 15 ft. wide	36.89	63.11
Bituminous macadam, 15 ft. wide	26.85	73.15

While these figures are of themselves of no very great value, they are sufficiently accurate to illustrate the economy of securing the best possible alignment and grades before the highway is paved. In fact it can be stated that the improvement of the alignment of railroads may be accomplished at a lower comparative first cost than similar work on highways after the paving is down. Also tracks and ties may be taken up and used over again but an abandoned gravel or other pavement is of no value if relocation or regrading is necessary.

A comparison from the standpoint of economy and safety of operation would perhaps not illustrate the point so clearly. It is believed, however, that there is a material advantage to be gained from a straight alignment and low grades on country roads. The old maximum grade fetish inherited from railroad engineers is still worshiped by many road builders. This, combined with the beauties—perhaps—of a curving road, have led many to follow prehistoric windings in the reconstruction of old roads and tortuous developments in the location of new roads. As long as a road remains unpaved such shortcomings of alignment and grade are permissible, but ultimate economy is sacrificed if these faults are not corrected when the pavement is laid. The ideal location may perhaps never be obtained, but it must be held clearly in mind and striven for mightily.

Is the Philadelphia Water Works System Profitable?

In the recent elections in Philadelphia a proposed million dollar loan for water works extensions led to discussion as to whether the water works plant is profitable. In round numbers the investment in the plant is said to be $102,000,000. The gross revenue in 1913 was $5,010,000, and the operating expense was $2,013,000, leaving net $3,000,000. This shows apparent net earnings of 3 per cent. We say "apparent," for it is evident that but a small part of the depreciation was provided for in the operating expenses.

The apparent net earnings during the six years ending 1913 averaged less than 2.4 per cent per annum on an investment of a hundred million dollars. It is likely that a complete audit would disclose a true investment exceeding that shown on the books, for it rarely happens that municipal accounts have been so kept as to show all the construction costs.

Those who have claimed that the Philadelphia water works are profitable have not only ignored the question of depreciation but have considered merely the interest and sinking fund charges on $30,000,000 bonds. This is a point of view as to profitableness that will hardly appeal to the ordinary business man.

Whether a municipal water works need show a profit at all is subject for debate; but, once it is claimed that a water works is profitable, the ordinary business standards should be applied. A plant that has shown only 3 per cent net earnings on the investment that has not had to pay taxes (almost 2 per cent on actual values in Philadelphia), and for which no depreciation fund is provided out of earnings, can certainly not be called a profitable plant.

It is to be hoped that every state public service commission will ultimately have the same jurisdiction over municipally owned utilities as over utilities owned by companies. Then there will be uniform accounting, which will not only disclose the true net earnings but will enable comparisons to be made between operating costs in different cities. The Wisconsin Railroad Commission has done remarkable pioneer work in this respect.

Grouting as a Method of Engineering Construction.

Grout is a liquid mixture of cement and water or of cement, sand and water. The treatises on masonry construction tell only of the use of grout as a substitute for mortar in rubble masonry or for making solid cracked or shaken stonework. It is used for cementing joints in paving, masonry or concrete work; as a paint for finishing, making watertight or protecting from corrosion concrete, masonry or metal surfaces; as a void filler, as in tunnel lining, where concrete or masonry cannot be readily placed to fill corners or irregularities in the surfaces built against; as a means for solidifying seamed and fissured rock, porous soils, cracked and shaken masonry, loose rubble or rip-rap in walls, filling or foundations; as a means of closing water carrying seams in tunneling, shaft sinking, dam foundations, etc.; as a means of stopping leaks in walls, tunnel linings, cofferdams, etc. The reason that these uses of grout are not recorded in the treatises is that they are for the most part newer. Grouting as a widely used method of engineering construction has developed since 1905.

It is too early to assert that grouting practice has matured, but a study of the records of its use permits conclusions on many important features. Considering first grout materials, any cement employed for concrete or mortar may be employed for making grout. Portland cement is most commonly employed. The only property of cement which is called for in grout different from the properties called for in concrete and mortar is its activity. Grouting frequently demands that the cement shall set and harden rapidly. Grout is deposited by flowing it into place; this fact determines the sand requirements. A sand is required which will remain in suspension in the mixture while it is flowing and which will not segregate when flow ceases. This necessitates regulation of density and dimension of grains in selecting sand for grout. Size of grains has also to be regulated to prevent clogging in grout injecting apparatus.

Practice is about the only available criterion of proper granulometric composition for grout sand. Some tests are recorded by the engineers of the Metropolitan Railway of Paris which showed that best results were given by a sand having a density of 1.14, leaving a residue of 5½ per cent on a 900-mesh (centimeter) screen and of 75 per cent on a 4,900-mesh (centimeter) screen. This is an exceedingly fine sand and practice in the United States records its equal for fineness only in instances where sand-cement has been used for grout. In sand-cement the sand is ground with the cement to approximately equal fineness. In grouting the lining of the Pennsylvania tunnel at New York City it was found, with the apparatus used, that sand must be screened of all grains exceeding 0.1 in. in size to prevent clogging at valves. On the Catskill aqueduct, where grouting was employed to an unprecedented degree, all grout sand passed a 100-mesh screen and 50 per cent passed a 1,600-mesh screen. At Waban Hill tunnel of the Metropolitan Water District of Massachusetts the sand for grout was all required to pass a 64-mesh screen and 40 per cent was required to pass a 1,600-mesh screen.

Roughly, practice has determined that sand having all grains less than 1/10 in. in diameter and from 40 to 50 per cent of its grains less than 1/40 in. in diameter is a suitable sand for grout. Finer sands can be considered to have had only isolated use. Sand-cement grout comes under a different classification than does a grout of cement and sand. It classes more nearly as a neat cement grout, since physically and, according to some authorities at least, chemically, sand-cement is a distinctive kind of hydraulic cement and not an admixture of a hydraulic cement and a coarser, inert material. In cement and sand grout, sand is used solely to give body and is used only where such thickening is possible without diminishing the required flowing and penetrating ability of the grout. In sand-cement grout, sand is an equally fine constituent part of the cement, is not added to thicken the mixture and has very slight, if any, effect on the flowing and penetrating qualities of the grout. These thoughts bring us to the next consideration in the practice of grouting which is the consistency and proportions of grout.

In grout making, consistency and proportions are differently interrelated than they are in concrete making. In concrete, the term proportions indicates the relative volumes of cement, sand and coarse aggregate; the term consistency indicates the degree of liquidity to which the solid ingredients are mixed with water. In grout, the term proportions means the relative volumes of solids (cement or cement and sand) and of water, and it means in addition, when cement and sand grout is considered, the relative volumes of cement and sand. Consistency and proportions are not separable properties in grout. Every grout must have sufficient liquidity to flow into place, and this degree of liquidity is determined by the openness of the voids to be filled and by the distance of penetration demanded. Thus, for filling loose stone-packed cavities directly behind a tunnel lining a very thick grout can be used because the voids are of size and the distance of penetration is small, but to solidify a finely fissured rock over considerable areas a very thin or highly liquid grout is required because the voids are minute and the distance of penetration is great. Whence it comes that practice shows grout mixtures ranging from 1 part cement and 15 parts water to 1 part cement, 5 parts sand and just enough water to produce smooth flow.

The surplus water used in grout as a vehicle to convey the solid materials into place disappears and the volume of hardened grout in place is less than the volume of liquid grout placed. Tests made when grouting the Catskill aqueduct gave the following values: For a 1 cement 1 sand grout (0.895 cu. ft. cement, 0.822 cu. ft. sand and 1.21 cu. ft. water), 2.93 cu. ft. added volume of materials gave 2.2 cu. ft. of grout mixture. For a 1 cement 0 sand grout (0.895 cu. ft. cement and 0.8 cu. ft. water) 1.695 cu. ft. added volume of materials gave 1.04 cu. ft. of grout mixture. For a ½ cement 0 sand mixture (0.447 cu. ft. cement and 0.8 cu. ft. water) 1.247 cu. ft. added volume of materials gave 0.7 cu. ft. of grout mixture. The 1—1 mixture above, gave 1 cu. ft. of saturated hardened grout per 1.21 cu. ft. of liquid grout mixture. A 1—1 grout is a thick grout; for thin grouts the shrinkage is of course correspondingly greater. Since the ratio of grout mixture pumped to hardened grout in place is large economy dictates in all grouting work the use of the thickest mixture which will meet the penetration requirements.

In grouting, water is the vehicle which carries the cement to the place where it is wanted to harden and fill voids; power is required to produce flow of the water. In grouting a rubble wall gravity will provide the requisite flow, but in grouting water-bearing rock to close leaks positive pressure of several hundred pounds per square inch may be required. Counter pressure due to head of water, friction due to fine or tortuous passages, distance of penetration required, determine the grouting pressure necessary and they must be ascertained by estimate and trial in each case. Though pumps are used to force grout into place, the standard method of grouting as of present development is compressed air injection and the special and remarkably perfect compressed air grouting machines available furnish one of the positive proofs of the assured place that grouting has come to occupy as a method of engineering construction. Air pressure of 350 lbs. per square inch, secured by means of booster compressors on the main 100-lb. air line, were employed on the Catskill aqueduct in grouting tunnel lining. Air consumption for grouting is a matter about which records of grouting operations give almost no information; this is a deficiency which should be supplied.

From what has been stated and from examination of the list of purposes for which grouting has been employed, it is a logical inference that the constructional efficiency of grouting is determined by, or must be measured by, (1) the degree of penetration which may be obtained in grouting, and (2) the precision with which penetration may be controlled. To illustrate by example: In consolidating foundations, a gravel bed under a bridge pier or a ledge of fissured rock under a dam, it is obvious that success of the grouting process predicates a very high degree of penetration by grout of the seams and voids; the circle of thorough grout impregnation from one point of application must be considerable or else the multiplicity of points (drill holes or well points) required to be provided for grout application will be economically prohibitive. Also in grouting to clog or stopper water-bearing rock seams or leaks in a tunnel lining or cofferdam, unless the penetration of the grout can be controlled so that the filling accumulates and hardens close to and within the mouth of the opening to be closed waste of grout going far afield will economically prohibit use of the method. Records of practice offer only very general answers to (1) what is the degree of penetration possible in grouting? and (2) to what degree can grout impregnation or filling be confined or localized?

The distance which grout will penetrate depends finally upon the size, continuity and diameters of the passages taking the grout. Liquidity of mixture is under absolute control and grouting pressure can be made what one will within reason to overcome hydrostatic counter pressure. A sand full of fine, tortuous passages allows small penetration of grout; the grains of cement wedge, friction makes the speed of flow very slow and sedimentation follows, and finally setting of the cement begins and clogs flow. Practice indicates practical failure in all attempts to grout fine sand; gravel and broken stone take grout satisfactorily if moderately free from sand or other fine material. Fissured rock takes grout directly in proportion to the size, continuity and directness of its fissures. Practice records all degrees of success in grouting rock and about the only definite conclusion possible is that each rock deposit is a separate problem to be solved.

The localization of grout deposition in plugging leaks, stoppering water-bearing fissures and filling local voids is not completely possible. Practice records the following means: Employ a thick grout using as much sand as possible to increase its clogging qualities, and a quick-setting cement to secure rapid setting; place the grout with pressures which are regulated so as not to drive or scatter the grout away from the place where it is wanted. Addition to the grout of some fibrous material like horse manure often assists the preliminary clogging action, and surface caulking, damming and plugging as conditions allow are other aids in confining grout.

Cost records of grouting are few and are valuable largely only for showing wherein better cost recording is essential. The terms in which grouting costs are stated are different for grouting tunnels, for grouting fissured rock and for grouting other works, and indeed it is not altogether clear that a common term for all grouting costs is possible. Grouting tunnel involves placing of grout and vent pipes, surface handling of materials and hauling in tunnel, besides the grout injecting operations proper. Grouting a rock foundation involves besides grout injection drilling operations often of considerable magnitude. Other works of grouting show similar differences of tasks to be performed. Under such conditions itemized cost recording is essential if very useful records are to be had. Also it is clear that separate itemized records are required for grouting operations proper and for operations preparatory to or providing for grouting operations. In grouting rock foundations, for example, separate itemized costs of drilling operations and of grouting operations are required. The prime requisite of grouting cost records is completely itemized costs.

A term or terms in which grouting costs can be stated is a secondary but important requisite of grouting cost records. Practice shows costs of grouting tunnel lining stated per lineal foot of tunnel, per cubic yard of grout mixture injected and per barrel "set volume" of grout injected. Costs of grouting rock foundations are stated per lineal foot of hole drilled. It is not sufficient to state grouting costs in any one of these units. To have costs of grouting a rock foundation so that they can be widely utilized, they should include cost per cubic yard of specified grout mixture injected and per lineal foot of hole drilled with a statement of the number of holes and their average length, of the superficial area of rock surface grouted and of the cube of probably grout impregnated rock. To have similarly usable costs of grouting tunnel one needs data on volume of specified grout mixture injected, length of lining grouted, number of grouting connections required, volume and character of voids filled, etc. All of these units obviously cannot always be precisely ascertained, but the desirability of knowing what they are urges that no reasonable effort to ascertain them is spared.

As indicated cost records of grouting are few and generally incomplete, but it is not excusable to neglect such records as there are. We believe that the most complete published record of cost of grouting tunnel lining is that which appeared in our issue of July 22, 1914, referring to the Waban Hill tunnel. These costs submit to brief quotation and are therefore repeated here as follows:

Item.	Cost per cu. yd.	Cost per lin. ft.	Per cent of total cost.
Superintendence and general labor	$0.60	$0.09	4.5
Labor	3.34	0.48	25.2
Teaming	0.01	0.002	0.1
Sand	0.76	0.11	5.7
Cement	4.58	0.65	34.6
Small tools, etc.	0.50	0.07	3.8
Incidental expenses and insurance	0.30	0.04	2.3
Rental, transportation and repairs of grout machine.	0.09	0.013	0.7
Plant—			
Transportation, erection, repairs, operation and dismantling	2.83	0.40	21.4
Interest and depreciation.	0.22	0.03	1.7
Total cost	$13.23	$1.884	100.0

There are no other exactly comparable records. For grouting the Pennsylvania R. R. East River tunnels, however, the following records are given:

	Normal Air.	Comp. Air.
Barrels set volume per lin. ft.	14.93	14.93
Top charges, per barrel	$ 1.63	$ 2.77
Labor, per barrel	0.68	0.93
Total per barrel	$ 2.31	$ 3.70

These figures include all charges except costs of materials. Assuming one barrel "set volume" as 4 cu. ft., the cubic yard costs were in round figures $16 and $25. These much higher costs than those at Waban Hill are probably attributable to "top charges," which here included cost of contractor's staff and roving laborers such as pipemen, electricians, yardmen, etc., and the cost of the whole tunnel plant and its operation prorated, and which were $1.63 per barrel and $2.77 per barrel.

On the Catskill Aqueduct records show from 300 to 400 one-bag (cement) batches of grout placed in three 8-hour shifts. About four-fifths of this grout appears to have been the 1-1 mix noted previously and one-fifth the 1-0 mix. Then the volume of grout mixture placed per three-shifts must have run from about 22 to about 30 cu. yds. Excluding superintendence a grouting gang on top and in tunnel consisted of about 17 men which at the average wage of $2.25 per shift recorded for tunnel workers gives a labor charge per shift of $38.25 or for three shifts, say about $115. The labor cost of mixing and placing a cubic yard of grout was then from $3.85 to $5.25. These are naturally very rough estimates only, but they are indicative of tunnel grouting costs.

Costs of grouting foundation rock given in any detail are available only for dam work at Lahontan, Nev., and at Estacada, Oregon. At Lahontan 83 holes of an average depth of 32 ft. were drilled and 295 bbls. of cement were injected mixed with from 1 to 8 parts water. At Estacada 555 holes of an average depth of about 61 ft. were drilled and 1,526 bbls. of cement were injected mixed with from 1½ parts to 5 parts water. The costs of grouting at these two dams as given by different records were:

Labor and materials.	Estacada Dam. Fisher.	Estacada Dam. Rands.	Lahontan Dam. Cole.
Labor, drilling	$0.58	[illegible]	$0.93
Labor, grouting	0.18	0.18	0.29
Cement	0.12	0.12	0.31
Repairs and supplies	0.17	0.17	0.23
Plant	0.30	...	....
Plant depreciation	....	0.15	0.35
Power	0.05	....	0.03
Other items	....	....	0.94
	$1.40	$1.21	$....
Salvage on plant, credit	0.17	....	....
Direct cost	1.23	1.21	
Total field cost	....	....	3.08
General plant, etc	0.32	0.45	0.12
Coffers and pumping	....	0.15	....
Engineering and superintendence	....	0.19	0.27
Clerical and office	....	....	0.10
Total cost per foot	$1.55	$2.00	$3.57

Not much better is possible than a guess of the volume of grout mixture injected. Assuming the average mixture at both dams to have been 1 cement, 4 water, then somewhere about 900 to 1,000 cu. yds. of grout mixture were injected at Estacada and from 175 to 200 cu. yds. at Lahontan. Taking the greater volumes the cost per cubic yard of grout mixture at Estacada was about $7 and at Lahontan about $5. Again it should be noted that these costs are not much better than guesses.

Attempt to give from the record published precise figures of the efficiency of grouting is a more uncertain task even than attempting precise figures of cost. At the Catskill Aqueduct such measurements as were made indicated that by grouting leakage was reduced from 50 to 70 per cent. Grouting at Lahontan was estimated by the engineer to have saved some $3,300 as compared with a cut-off wall. At Estacada the efficiency of the grouting done is a matter of dispute. These figures compel us to fall back onto general records, which are numerous, that in many cases grouting has provided means for doing work which no other resort could equal.

From the preceding it is clear that grouting is not a process which can be defined by set rules. The engineer must adapt his procedure by trial and elimination to the local conditions and in the light of the objects sought. While definite procedure cannot be stated, records of practice permit conclusions to be drawn that are of assistance in conducting trials to ascertain the best procedure in any particular case. Some of these conclusions which have not been previously stated, or which amplify those already stated, are enumerated.

Grouting behind tunnel lining on the Catskill aqueduct led to the following conclusions: Where imperviousness is a controlling factor grouting should be carried on at reasonably low temperatures; where joints are to be plugged they will be at their maximum opening under these conditions. A quick-setting cement is required. A 1 cement 1 sand grout with sufficient water to lift it into place should be used whenever possible; the amount of water is in part controlled by the character of the grouting machine used; the sand is the important factor in clogging large leaks. Where fine seams carrying water are met the sand should be omitted. Grout pipes should be free from bends; vent pipes should be placed well up in the roof. Grout the lining in sections 80 to 100 ft. long by building cut-off walls outside of the lining to rock; begin grouting at center of section, increasing pressure as the filling proceeds; maintain pressure several minutes to give the grout time to penetrate fine cracks and irregularities. After section has been filled two or three hours reopen highest point to release air and water, and then regrout.

In grouting fissured and rather heterogeneous rock at Estacada Dam in Oregon the knowledge gained is summarized as follows: Do all drilling, grouting and testing through casings; test by means of elevated tanks instead of by pumps; test and grout each hole as soon as drilled and for a few days thereafter keep the drills away from the probable zone of diffusion. In grouting, especially at high pressure, it is best to close the valve before the tank is entirely empty, as the air following the grout into the hole is apt to make trouble. Begin grouting with a comparatively thin mixture and, if taken poorly, thicken until each succeeding batch requires either an increased time for discharging or an increased pressure. In grouting for a dam foundation at Hales Bar on the Tennessee River, fissured and chambered rock under water, it was found that the more thoroughly the seams and cavities were cleaned, the more certain was the effect of the grout. Cleaning may be accomplished by pumping water down one drill hole and letting it escape at an adjacent hole, thus scouring the seam between holes. A small excess head of water in the cofferdam enclosing the area being grouted is required; it should not exceed by more than 1 or 2 ins. the head outside; the grouting pressure should not exceed 5 lbs. per square inch. The grout should be as thick as will pump.

All records of attempts to grout fine sand indicate failures. Coarser materials can be grouted with increasing success with increasing coarseness of material. Tests made of grouting natural gravel bar and sand and gravel mixtures in tank by the Louisville-Nashville R. R. furnish the most complete conclusions available. The coarser and cleaner the material is the more thorough will be the grout penetration; with very fine material the success of grouting is small. The greatest difficulty is to get rid of the excess water in the grout without also carrying away much of the cement. In open gravel bar the grout spreads out in wide, thin ledges along planes of least resistance and therefore gravel in bar to be grouted should be enclosed by piling or other means to restrict lateral spread of the grout. Excessive air pressure should be avoided, as it stirs up the gravel and disturbs the depositing of the cement. The grouting machine requires attention to see that choking does not occur in any of the pipes and valves. Well points should be perforated with holes which will not admit fine particles from the surrounding gravel. A heavy pipe is required to stand driving; to clean a clogged pipe the best method is to lower a hose into it and jet out the material. Clogging can be avoided in sinking pipe by keeping a strong pressure of air passing through it.

In thus reviewing the available records of grouting practice one sees first that these records have many gaps. They do, however, assure one that grouting is a practical development of very wide usefulness in engineering construction. Adoption of grouting calls for judgment. It is not universally applicable; it will not replace older structural means entirely in any case and in most cases is merely their aid. To substitute grouting of foundation rock for cut-off walls in dam constructions is, for example, unwarranted by any success that can be claimed for the process of grouting fissured rock. On the other hand the engineer who has a wet rock shaft to sink, a tunnel lining to make tight, a subterranean leak to close, a mass of loose material to make solid, is not considering all the means available unless he considers grouting.

WATER WORKS

Design and Construction of the New Supply Conduit (Nepaug) of the Hartford, Conn., Water Works.

Hartford, the capital of Connecticut, is located on the river of the same name a little north of the geographical center of the state. The population of the city in September, 1914, was 130,914.

The first public water supply was obtained from the Connecticut River by pumping in 1855. One pump with an estimated daily capacity of 3,000,000 gals. was installed, which forced water to a reservoir holding about 8,000,000 gals. located on a hill about 125 ft. above the river. Hartford at this time had a population of about 23,000, and it is possible that a large proportion of these did not use the city water. In 1869 the consumption of water was at the rate of 1,900,000 gals. per day; in 1876, 4,955,000 gals., and for the year 1913 the amount drawn was at a rate of 9,040,000 gals. per day. In 1867, probably due to the inadequacy of the pump and the desire of the inhabitants to obtain a more sanitary water than it was possible then to obtain from the Connecticut River, a gravity supply was developed on the east slope of Talcott Mountain in West Hartford, about six miles distant from City Hall. The river supply was abandoned then except for emergency service. During the succeeding years five more reservoirs have been built, the 12 square miles of tributary drainage area has been fully developed and there is no possibilty of further extension in this locality. Based on the Sudbury run off data, it is estimated that the safe daily capacity of the West Hartford sources is 7,300,000 gals. per day, which mark was passed about five years ago.

The last constructed reservoir of the West Hartford group was finished in 1895 and, like many other cities, Hartford deluded herself with the thought that she now had an adequate supply for many years to come. In only a few years, however, it was again realized that a larger and more abundant source must be secured. Reports on additional supplies were submitted in 1901 by Rudolph Hering and in 1902 and 1908 by Allen Hazen. Several sources were investigated and reported upon at some length, and a supply from the Nepaug River in New Hartford was finally decided upon. Because the Nepaug River was one of the principal feeders of the Farmington River and because this stream is very fully developed by mills and factories using water power, considerable opposition was encountered when the cty endeavored to get legislative permission to take this Nepaug water. The controversy was waged through two legislative sessions, and the opposition of the principal power users was finally withdrawn on an agreement of the Water Board to construct an additional reservoir solely to store water for use in dry periods and so compensate for the water diverted from the Farmington River.

After the legislative fight was finished, the first real steps toward the development of the additional supply were taken in the first part of 1912 when an engineering department was organized and survey and designing work was begun.

The location of the proposed storage reservoir (Nepaug Reservoir) is about 1.25 miles west of the town of Collinsville, about 8 miles west of the West Hartford system and about 14 miles in a direct line west of the City Hall in Hartford.

The plan contemplates a collecting and storage reservoir on the Nepaug River with a capacity of about 9,000,000,000 gals.; a compensating reservoir on the East Branch of the Farmington River at New Hartford with a capacity of about 3,000,000,000 gals.; a pipe line connecting the proposed storage reservoir with the present reservoir system in West Hartford; a filtration plant capable of treating all of the city supply; and a large-size main supply line reinforcing the present mains from the West Hartford reservoirs to the city. The total drainage area which will be developed by this plan for city supply is about 32 square miles and, based on the run-off records of the Wachusett watershed in Massachusetts, the safe yield to be depended upon is estimated at about 30,000,000 gals. per day or about four times the supply at present available.

The Nepaug Reservoir, when completed, will have a surface elevation of 485 ft. above sea level. It is expected to use Reservoir No. 5 of the West Hartford system as a receiving basin and its elevation is 320.

To bring the water from Nepaug Reservoir to Reservoir No. 5, a conduit, tunnel and pipe line have been constructed in part, there yet remaining to be built a connecting link of conduit about a mile long at the easterly end of the line. An article published in ENGINEERING AND CONTRACTING of Dec. 17, 1913, shows the sections and gives the elements of the new aqueduct. The work now completed comprises 3,667 ft. of conduit on the east and west approaches to Talcott Mountain, 2,333 lin. ft. of tunnel through the mountain and 39,660 lin. ft. of pipe line extending across the Farmington River valley and over the spurs of several intervening ridges.

The conduit is of concrete masonry, horse shoe section, of the cut-and-cover type, 5 ft. by 4.75 ft., vertical and horizontal dimensions, respectively. The tunnel is concrete-lined throughout, horse-shoe section, 6.00 ft. high and 5.33 ft. wide to neat lines. The pipe line is of cast iron and 42 ins. in diameter. The present article describes the new Nepaug supply conduit and is taken from a paper before Section D of the American Association for the Advancement of Science at the Philadelphia meeting, Dec. 30-31, 1914, by Mr. Caleb Mills Saville, Chief Engineer, Board of Water Commissioners, Hartford, Conn.

Previous to 1912 several surveys of a reconnaissance character had been made, and in the early part of that year surveys with a definite purpose in mind were started and investigations with diamond and wash drills undertaken along the line of the proposed tunnel. At the same time the Designing Division was working on problems relating to economical and efficient construction so that, when the surveys were completed, it would be possible quickly to prepare the plans for construction.

Diamond Drilling.—The contract for this work was let to the Sprague & Henwood Co., of Scranton, Pa., at the following prices:

1. Sinking casing and core drilling for cores of less than 2 ins. in diameter, $4 per linear foot.
2. Sinking casing and core drilling for cores of 2 ins. and larger diameter, $5.50 per linear foot.

It was specified that, when rock was encountered, a diamond drill should be used which would furnish a core of rock not less than 1⅛ ins. in diameter. In soft, friable or seamy rock, when 1⅛-in. cores could not be obtained, it was provided that cores up to 3½ ins. in diameter could be ordered by the Engineer. As large a percentage of recovery as possible of the core was desired, and to this end it was provided that the speed of the drill and the frequent removal of core should be regulated by order of the engineer.

Seven diamond drill holes were put down, three on either side of the crest of the mountain to develop the depth and character of the material underlying the rock and to determine the nature of the rock itself, and one hole was drilled near the crest in order to locate the line of contact between the two radically different rock formations shown by the other drill exploration.

Geological Structure.—Talcott Mountain is a low-lying ridge with an elevation of 460 ft. (m.s.l.) directly over the tunnel. It was formed by laval (basalt) flow, and underlying the basalt sheet is a red shaly sandstone. Both lava and sandstone are of the Trassic Age, laid down on a practically flat floor and then tilted to the southeast at an angle of about 15°. The sandstone varied from a very fine-grained shale to a coarse sandstone. This formation was thin bedded, of a reddish color and composed principally of fragments of quartz and feldspar held together chiefly with ferruginous clay. The boring indicated that, except in the coarse sandstone, all this formation was liable to flake and sluff off when freely exposed to water. Decomposed rock was noted at various depths, and the indications were that the cavities, joints and bedding planes were so located as to allow surface water to flow down into the tunnel. It did not appear, however, that water would be encountered in sufficient quantities to hamper construction and subsequent experience justified this view. It was feared that the bedding planes might be at such an angle that, when lubricated by the running water, they would slide into the tunnel and so necessitate considerable timbering. Fortunately this condition did not obtain. It was found that the bedding was practically horizontal and only a very little timbering was required.

The basalt sheet on the easterly side of the ridge was commonly found to be full of cavities, pipes, seam cracks and joints, either open or filled with some mineral. In some instances the rock was dense and firm; when freshly quarried it was dark blue in color, but where weathered or exposed to the air it assumed a purple brown or yellow hue. The portion of the lava flow penetrated at this location was evidently very near the top of the original sheet, the cavities and tubes encountered representing the action of escaping steam while the basalt was molten. Numerous cracks, either open or filled with soluble material, were encountered and then were readily connected with water channels.

As in the case of the standstone, the indications were that there was ample passage for sub-surface waters, either in chambers actually existing or in others that might develop after the tunnel was completed. In the course of excavating the tunnel through the portion of the mountain composed of basalt, several considerable streams were encountered which gushed out from seams in the sides of the tunnel. When the concrete lining was put in, these streams were led into the tunnel by small pipes ("weepers") left in the side walls.

On account of the above conditions, it was decided to line the tunnel throughout in the sandstone to prevent damage and possible filling of the bore, due to caving, sluffing or solution; in the basalt to prevent local falls of rock from the roof of the tunnel and guard against any loss of water through cracks or seams. The lining of the tunnel also not only provided a smooth channel for the flow of water through it and thus added very greatly to the discharging capacity, but also will greatly facilitate future cleaning operations.

Construction.—Bids were called for Nov. 21, 1912, and 10 were received. The contract was awarded to the Stobaugh Contracting Co. of New York. The contractor began at once to get material and plant onto the ground and work was fairly started about three weeks later. The principal plant was located near the easterly end of the work, and comprised a building containing air compressors, engines for running rock crusher and blacksmith shop. Near by was located a rock crusher with storage bins and a cement shed.

The easterly slope of Talcott Mountain is in the watershed supplying the city of Hartford with water and, in order to protect the health of the city, a small hypochlorite sterilizing plant was established on the brook, receiving the drainage at a point about 1,500 ft. below the contract work. This plant consisted of an embankment about 4 ft. high built across the brook valley with a 4-ft. overflow weir in the center. Over this weir was built a small shelter to contain the dosing apparatus. This consisted of two storage tanks about 3 ft. in diameter made from two lengths of reinforced concrete pipe with watertight bottoms; a mixing tank of wood and a small constant-level tank lined with lead and controlled by a glass ball valve. The rate of flow was regulated by a special brass valve, and the setting for the amount to be discharged taken from the height of the water on the weir. The discharge from the constant-level tank led down into the channel below the weir and here were placed four baffle plates set at an angle with the flow. The function of these plates was to mix thoroughly the chlorine with the passing water. The scheme was entirely successful. No illness of any kind is suspected to have resulted from the work and the bacterial counts of raw and treated water showed percentages of removal above 98 per cent.

In order to take other precautions, the laborers' camp was located on the westerly side of the mountain, entirely removed from the city water supply.

Excavation for the cut-and-cover conduit was started on each side of the ridge, and the cut reached a maximum of about 30 ft. before suitable material for the tunnel headings was uncovered. The material was for the most part excavated by a Thew ¼-cu. yd. steam shovel and loaded into 2-horse bottom-dumping carts for removal to the spoil banks. The average removal of material being about 3,000 cu. yds. per month. The tunnel excavation was undertaken at both the east and west portals and from a shaft sunk about 600 ft. east of the west portal. Very good progress was made, the work being begun May 23 and completed Oct. 7, 1913. The work proceeded continuously throughout the 24 hours and without any intermission Sundays. A total of 2,333 lin. ft. were excavated or an average progress of about 17 ft. of completed tunnel excavation per day.

The materials encountered were generally as indicated by the diamond drill explorations, the sandstone formation being found from St. 13 + 33 to Sta. 21 and trap (basalt) from Sta. 21 to Sta. 36 + 66. After careful consideration before writing the specifications, it was decided to pay for the tunnel excavation by the linear foot rather than by the cubic yard. In order that the contractor should be careful in his excavation and not remove an excessive amount of rock and leave holes that would later have to be filled with concrete, certain limits were given and carefully defined in the specifications, designated as the "A" line and the "B" line. These were clearly shown on the contract drawings as well as referred to in the specifications. These lines are shown in the tunnel section, p. 679, ENGINEERING AND CONTRACTING, Dec. 17, 1913. The "A" line was the line within which no unexcavated material of any kind, no timbering, bracing or other support for the sides, roof or other part of the excavation shall be permitted to remain. The "A" line, therefore, was the line defining the minimum thickness of the masonry lining. The "B" line in certain specified cases was the payment line for masonry and dry packing. The "B" line was fixed arbitrarily.

Considerable water was encountered in the excavation, mostly from seepage and continuous dropping, but in several places quite considerable inflows came in through crevices in the rock. The greatest single leak was at the rate of a gallon per second. During construction the total inflow from the whole tunnel was estimated to be at the rate of about 650,000 gals. per day.

On account of the fact that the inflow generally came from the entire length of the tunnel, it was found possible to put in the invert without an underdrain, which was a decided advantage owing to the flat grade and long distance to carry the water. The bottom was kept rather low and filled to subgrade with broken stone. Rather soft concrete was placed on this and worked into it. On top was placed to the required depth the invert masonry of rather stiff mixture and kept about ½ in. below finished grade. After this had had a chance to stiffen up a bit, it was floated with a finished coating well compacted with wooden screeds and worked to a smooth finish. After setting for 24 hours water was allowed to run over the finished work. To keep water from the invert during construction permanent sand bag dams were placed upstream from the work and the inflowing water backed up and was forced out through the conduit above. The concrete work was started from the shaft so that, by backing the water above out through the conduit, the concrete work on the invert proceeded downstream, forcing all water ahead.

Arch construction first was started on narrow lagging laid against ribs placed as near together as necessary to prevent bulging. The face of the concrete, however, was found to be quite rough, due to the spaces between the lagging and also to the mortar running out and leaving voids. The finishing of the work was unsatisfactory and the expense to the contractor considerable. To obviate this, sections of lagging of different widths to be handled easily were covered with thin sheet iron and the results were very satisfactory. Concrete of the proportion of 1:8 was used in the tunnel lining except in the key where a 1:6 mixture was used.

Between Sta. 33 + 57 and 33 + 89 a very interesting and in some respects annoying condition was encountered. Up to this point the material passed through had been the ordinary red shaly sandstone, and a diamond drill boring put down at Sta. 33 + 50 had indicated this formation. When the tunnel excavation had reached this point the rock in the northerly side suddenly ended and instead there was found a mass of loose, coarse and well washed gravel. This condition extended only half way across the tunnel, but its length was about 32 ft. Exploration of this deposit showed that it was undoubtedly a pot hole in the shale formed by a preglacial stream and subsequently filled with glacial detritus. On account of this condition it was necessary to heavily timber this section and the side walls of the tunnel were made thicker.

In the cut-and-cover conduit the proportions of the concrete were 1:6. The thickness of the invert and of the arch at its crown was 6 ins. Expansion joints were placed every 30 ft. and water stops of ingot iron 6 ins. wide and 5/16 in. thick were embedded at the end of each section. The arch of the conduit was built on Blaw collapsible forms and the outside formed with ribs and wooden lagging.

The concrete was mixed in a gasoline power mixer which was moved as occasion required. The concrete was dumped from the mixer into wheelbarrows and conveyed in them to the point needed.

Lehigh cement was used on all parts of this work. The sand was obtained from a local pit and hauled in carts, the coarse aggregate was obtained by crushing trap rock from the tunnel excavation and from boulders found in old stone walls. In computing the capacity of the concrete conduit and tunnel, values of coefficient "C" in the Chezy formula were taken from a curve which had its origin in the design work of the New York Board of Water Supply. The elevation of the top of the conduit at its upper end is 434.6. There are 3,667 lin. ft. of conduit with a grade of 0.0006 and 2,333 lin. ft. of lined tunnel with a grade of 0.0005. With the water at the top of the conduit at entrance, the capacity of the conduit is estimated to be 50,000,000 gals. per day, and with 1.6 ft. head at entrance the amount of water would be increased by 10 m.g.d. This latter amount is about double the estimated safe yield of the Nepaug and Phelps Brook development. Taking into account many considerations of efficiency, permanency and general upkeep, it is estimated that the construction of the conduit effected a saving of about $15,000 over what similar capacity would have cost if a pipe line had been substituted in its stead.

The Pipe Line.—From the end of the concrete conduit to the intake at the Phelps Brook Dam the distance is about 7.5 miles. Various studies were made in an endeavor to construct the most economical and efficient conduit. High water in the Nepaug Reservoir will be at El. 485. Reservoir No. 5 of the present system is planned for a receiving and sedimentation basin. Its elevation is 321 and the top of the conduit at its junction with the pipe line is El. 334.6. With these governing conditions and after a close study of the topography and questions connected with the use and operation of the line, the choice finally rested on

(a) A 44-in. riveted steel pipe,

(b) A 42-in. lock bar or welded steel pipe, and

(c) A 42-in. cast iron pipe.

The other materials considered were wood stave pipe and sections of concrete conduit connected by pipe siphons across the valley.

Both steel and cast iron pipe are used on work similar to the proposed, and the choice between the two materials rests largely on the following considerations: Carrying capacity, durability, leakage, strength and reliabilty, first cost and cost of maintenance.

As a result of closely analyzing and summarizing the various factors entering into the question, it seemed reasonable in this particular case, in order that a uniform basis might be used which would take into account the ultimate value of the pipe line to the city, to add 15 per cent to the prices received for all kinds of steel pipe for comparison with the bids for cast iron pipe. Bids were called for on the above basis on June 16, 1913, and 11 bids were received, five for furnishing and laying rivited steel pipe, two for furnishing and laying lock bar steel pipe, and four for laying cast iron pipe. At the same time bids were received for furnishing cast iron pipe and three bids were submitted. The lowest bid of all was that of the Beaver Engineering & Construction Co. for furnishing and laying 44 in. riveted steel pipe for $376,344. With 15 per cent added this amount became $428,952.60 for comparison with cast iron pipe. The lowest bid for furnishing cast iron pipe was that of the United States Cast Iron Pipe and Foundry Co. for $251,390, and for laying the pipe the lowest bid was that of the Hanover Contracting Co. of New York, for $176,148. The sum of these last two bids was $427,538, an amount $1,425 less than the weighted bid for steel pipe, but $51,194 above the actual first cost of a steel line. In accord with the advertisement the contract was let to the lowest bidders for furnishing and for laying cast iron pipe. The cast iron pipe were cast at the foundries of the United States Co. in both Burlington, N. J., and Scottdale, Pa. The pipe was inspected for the board in both places before acceptance with the following results:

	Straight pipe.	Specials.
	Tons of 2,000 lbs.	
Total weight inspected	12,019.27	109.996
Total weight paid for	10,855.88	98.195
Total weight rejected	1,163.39	11.801
Rejections of total cast	9.7%	10.7%
Tons cast for each ton accepted	1.11	1.12
Total number of pipe inspected	3,646	
Total number of pipe rejected	352	
Total number of pipe accepted	3,294	
Rejections of total cast	9.6%	
Pipe made for each pipe accepted	1.11	

Following is a summary of the principal causes of rejection of 42 in. pipe from both Scottdale and Burlington foundries for Contract 4-A:

Cause of Rejection.	Pipe rejected for this cause.
Mold scabs	8
Leaked	26
Core crushed	36
Socket cut	7
Light	60
Uneven	21
Scabbed	34
Bad bell	24
Core buckled	7
Sand hole	19
Uneven light	5
thin	5
Bad bell face	10
Shrunk hole	8
Shrunk gate	23
Bad Bead	17
Thin	5
Heavy	1
Miscellaneous	36
Total	352

The following tabulation gives additional information regarding the pipes furnished under this contract:

	Class of Pipe—N. E. W. W. Spec.				
	B.	C.	D.	E.	F.
Average weight per length, lbs.	5,556	6,377	7,076	7,820	8,506
Standard weight, lbs.	5,560	6,270	6,970	7,720	8,360
Per cent variation	0.05	+1.7	+1.52	+1.29	+1.75
Number of pipe cut at foundry,	34	87	17	5	1
and average length, ft. and ins.	11—6	11—6½	11—6½	11—7½	11—7¾
Per cent of cut pipe	6.7	6.0	1.4	10.0	1.0

Pipe laying began Aug. 9, 1913, and the line was practically completed Nov. 1, 1914. The location of this pipe line was a straight-away cross country course, crossing twice under the Farmington River and through valley and over hill, mostly in rough wood and pasture land, but for some distance alongside country roads. The following are the principal items of construction with the bid prices:

	Quantity.	Unit Price.
Laying cast iron pipe furnished by the Board	39,644 lin. ft.	$ 3.68
Rock excavation	4,987 cu. yds.	3.00
Upper Farmington River crossing (lump sum)		5,000.00
Lower Farmington River crossing (lump sum)		7,500.00

In order to make partial payments to the contractor on the basis of value of work done, the following schedule was established:

	Per linear Foot.	Per cent of Contract Price.
Laying cast iron pipe, completed work	$3.68	100
Pipe laid, backfilled and tested, surface not cleaned	3.55	96.5
Pipe laid and backfilled, not tested or cleaned	3.40	92.5
Pipe laid, partially backfilled	3.20	87.0
Pipe laid, not backfilled	3.00	81.5
Pipe laid, not leaded, calked or backfilled	1.80	49.0
Trench to grade	1.00	27.2
Trench partially to grade	.50	13.6
Pipe hauled to trench	.50	13.6

Pipe laying was in progress from Aug. 9, 1913, to Jan. 15, 1914, and from April 1, 1914 After July 1 the work of the pipe laying gangs was scattering. During the periods mentioned above the average daily rates of progress respectively were 168 and 148 lin. ft., equivalent to about 14 and 12.5 lengths per day. On 20 days during the construction period 20 or more pipes were laid, the maximum number in any one day being 38. The pipe were delivered to the contractor on board cars at the railway station nearest to the work. They were unloaded with a stiff-legged derrick and hand-operated winch. In transferring the pipes both auto trucks and 4-horse wagons were used. The former proved quite effective, readily taking most of the roughest country without trouble and easily outdistancing the teams in amount of pipe delivered. The country passed through was for the most part of very rough character and the digging was comparatively easy for the greater part of the way. At the upper end of the line a large amount of ledge rock was encountered and for short distances elsewhere many large boulders were found embedded in the glacial deposit.

The contractor experienced the most difficulty at the river crossings. In October, 1913, the coffer dams at both crossings were destroyed by a freshet. The materials encountered at both crossings were rather loose gravels and fine sands and at the upper crossing many boulders were found. These latter interferred with the driving of the sheeting and made the progress rather slow. Several methods of handling these crossings were tried by the contractor and the most satisfactory was that employed in the last section of the upper crossing. Here the coffer dam was constructed at a considerable distance up and downstream from the pipe laying trench, a portion of the river bed laid bare and pipe laying proceeded without any difficulty and as well as if on dry land. On account of the materials encountered, the method of construction and the advantage that would obtain if at some future time it were necessary to get at the pipe line, all sheeting used in the coffer dams was left in place after being cut off below the river bed. The pipe rests on a reinforced concrete floor about 8 ins. thick and extending entirely across the river.

After completion the pipe line was tested under hydrostatic pressure corresponding to about 100 ft. above the hydraulic gradient which it is proposed to operate. The total cost of testing amounted to about 4 cts. per linear foot of pipe tested.

Increasing Precision in Pitometer Survey Work at Washington, D. C.—Meter Reading.

The result of the pitometer survey in the District of Columbia for the fiscal year 1913-14 was the detection and prevention of 2,552,800 gals. of underground leakage per day. This is the eighth year these pitometer waste-water surveys have been carried on at Washington. This leakage was due to the usual sources, and was found scattered throughout the first high service, two districts of the gravity service and about one-half of the second high service. A total of 452 individual leaks was found, giving an average of 5,600 gals. per day. This average leakage is much smaller than that found upon the first surveys in 1907, 20,700 gals. per day, the difference being due to several natural causes. These causes, in the order of importance, are the elimination of large leaks which had probably been running for years before the inauguration of the pitometer service, the repeated surveys checking leaks practically at the time of their starting, and the reduction in the number of special investigations in the federal buildings, etc., where large leaks and waste were previously found.

Throughout the year the increasing scarcity of leaks and waste was very noticeable, and the extremely low rates of flow detected in the various sections of mains introduced entirely new conditions to be overcome in the successful prosecution of the work. Heretofore the flows have nearly always been of sufficiently large size to permit effective use of the aquaphone in the daytime, and the neglect of slightly imperfect isolations; but now, because of the traffic noises and the smallness of the flows under investigation, most of the aquaphone inspection has to be done at night, and as old valves and stopcocks seldom give perfect shut-offs, misleading indications are frequent, causing delay and sometimes failure properly to account for suspicious flows. Also, in addition to these troubles, there is that of the continuous fluctuation in the rate of flow in the mains due to pressure changes. The effect of this can readily be appreciated when it is known that the change in the rate of flow due to this cause is frequently several times as great as the effect produced by the flows under investigation. The result of this state of affairs is that the ability of the operators is being taxed to a greater extent each year, and several whose services were previously satisfactory have been dismissed because of their inability to produce results under the new conditions. The personal element enters into the work of this division to a very great extent; but, due to the use of recording instruments and complete records, it has been reduced considerably during the last few years. Experiments are now being made to increase the sensitiveness of the pitometers, so that they may be used for reading small flows direct instead of by differences, and with pressure-regulating valves on fire hydrants to control the flow and reduce fluctuation during tests. Any success along these lines will be of great assistance in making pitometer surveys an exact science.

The inspection of fixtures in all unmetered houses was continued throughout the year and resulted in turning over to the water registrar's office about 1,600 cases where leaks were found. This represents 9.4 per cent of the total number of houses inspected and indicates that very satisfactory results are coming from this work, as the lowest percentage during any previous year was 14.1 per cent. Of course it is only a question of a few years before the complete metering of all houses will eliminate this branch of the work, but in the meantime the saving of water is undoubtedly being felt.

As a source of under ground waste, iron services have each year been the leaders, and last year was no exception. A total of 166 iron service pipes were found discharging through porous soil 924,000 gals. of water each day. Joints on mains follow as a close second, with 93 cases wasting 596,700 gals. per day. The split lead and pewter services and broken wiped joints on lead services and on lead connection to iron services are also blamable for a very heavy waste of water.

The largest individual leak found was a break on a 4-in. main, discharging 57,000 gals. per day. Considerable difficulty was experienced in locating this leak, because of the fact that it was in a section of main that was not recorded on the plats. This case, therefore, not only shows the direct results of the work in saving water, but the indirect results in the weeding out of errors in the maps of the department. Hundreds of feet of old unrecorded mains have been located since this division started work in 1906, and during the past year approximately 200 ft. of unrecorded 4-in. main was added to the total previously found.

While in the majority of cases where the pitometer tests indicate trouble flows can be heard or some other indication found to help locate the leak, during the past year a number of cases were handled where none of the usual methods were applicable, because of the absence of these customary indications. The leak of 57,000 gals. per day mentioned above was an example of such a case. This being on an unrecorded main, it was obviously impracticable to sink test holes at random, and the leak was found only by the application of the process of elimination carried to a point of actual elimination of all known connections.

METER READING IN CONNECTION WITH WASTE CURTAILMENT.

Meters are grouped as follows: Private meters where the consumption exceeds 100,000 cu. ft. per quarter; private meters where the consumption does not exceed 100,000 cu. ft. per quarter; fire service, and district meters.

Private meters in business establishments that exceed 100,000 cu. ft. per quarter are read weekly and a card is provided which is posted in some convenient place on the premises, and it is the duty of the meter reader to record the consumption on this card. This plan has proved satisfactory both to the consumer and the office, inasmuch as it has reduced the number of complaints in regard to large bills to a minimum, and also keeps the owner of the place in touch with his account from week to week, which has resulted in prompt action on his part in cutting down all waste of water.

Private meters where the consumption does not exceed 100,000 cu. ft. per quarter are read eight times a year. When it is found that there has been an extraordinary consumption of water an examination is made for leaks, and if any are discovered the responsible party is notified.

Fire-service meters are read monthly, and if any show registration an investigation is immediately made as to the cause and an explanation demanded.

District meters in municipal institutions are read monthly, and the responsible department notified if leaks or wastes are found.

District meters installed on service pipes supplying private residences are read at frequent intervals, averaging about eight times a year. Special reading cards are made out and the premises kept under constant observation where the rate of consumption is much in excess of the proportion based upon the minimum payment in advance. Where leaks are found in metered premises the occupants and the agents (if they have a request filed for such information) are notified, and in case no attention is paid to such warnings and the leaks are large enough to justify such action the supply is discontinued until the proper repairs are made. For convenience in handling such accounts houses are divided into three classes: First, large houses, where considerable water is required. In such places if abnormal use of water is indicated by the meter the occupant is notified by card to that effect and the case is dropped. Second, medium-sized houses. If the consumption is found to be excessive a notice is sent to that effect, and if after a reasonable time no change is observed, an examination is made, and if any leaks are found the occupant is again notified that if this condition is allowed to continue large bills will naturally result. Third, small houses, which are occupied in many instances by irresponsible parties. In such cases where an extraordinary wastage of water is found the supply is discontinued after one notice has been served.

In the first two classes the notices are generally met with prompt action on the part of the occupant or agent, but in the third class considerable trouble is experienced, as the principal waste can be traced to these small houses.

In every examination for leaks or wastes a reading of the meter is taken and the per diem rate of consumption computed, and by this means the office is enabled to determine the size and character of the leak or waste.

ACKNOWLEDGMENT.

The information given herewith is from the latest annual report of the Engineer Department of the District of Columbia. Mr. W. A. McFarland is superintendent of the Water Department, Paul Lanham is pitometer operator and G. W. Wallace is water registrar.

Field and Office Methods in Connection With the Laying and Repair of Large Water Mains at San Diego, Calif.

Monthly meetings are held by the officials and foremen of the Department of Water of San Diego, Calif. These meetings are for the benefit of the department as a whole and were instituted two years ago by the superintendent, Herbert R. Fay. The meetings are held during the winter season. The matter here given is from a paper presented at the meeting of Dec. 9, 1914. It is by the foreman of construction, Mr. W. W. Albin, who has charge of the laying of all water mains 4 ins. in diameter and over. The procedure described is as follows:

An enabling ordinance is issued by the council to the superintendent of the Department of Water. Requests calling for the work orders to proceed with the actual construction of this work are issued by the engineering division and submitted, together with the necessary blue prints, to the department auditor, who inserts the book charges in red pencil; then it passes to the secretary of the department, who officially O. K.'s it with the blue pencil, passing then to the hydraulic engineer for final approval, after which it is given to the chief clerk, who gets out the necessary work orders to the foreman of construction to proceed with the actual construction in accordance with the blue prints attached. These work orders are copied verbatim from the original request. Other work orders pass through the same channels, with the exception of the enabling ordinance, issued by the city council, which is only used in connection with bond work.

If at any time work devolves upon any of the foremen, and especially the foreman of construction, and it is found necessary for him to proceed with the work without the work orders, he makes out requests to cover, which pass through the channels mentioned. This method is only used in case of an emergency, and is executed under verbal instruction of either the superintendent or the hydraulic engineer and is covered later by work orders, upon which the cost data are inserted for the benefit of the bureau of accountability and department records. A work order is also issued to the foreman of operation to haul pipe, valves, fittings and hydrants, in accordance with the blue prints submitted, and he, in turn, instructs the yard foreman to deliver so many pieces of a certain class pipe to the job designated.

Everything has been standardized in the department, depth and width of ditches, location of pipe, hydrants, hydrant ells, gates, gate covers and all fittings. All mains are laid 10 ft. east and south of the center of the street and have not less than 2 ft. of covering. It is on account of the lengths of the stems on the gates that some mains are laid deeper than others. The bottom of the ditch for 4-in. mains is 2 ft. 6 ins. and for a 12-in. main it is 4 ft. 2 ins., when there is only a little over 8 ins. difference in the pipe. It is advisable to have some standard to go by, so it will not be necessary to make a dip in the pipe whenever a gate is to be set. That is the reason we have so much trouble in this city, with the gates on the old mains that were laid a few years ago; all the sediment in the pipe collects under the gate disc and the gates cannot be closed.

When using a ⅛ bend, or, in other words, a 45° bend, and it is wanted to make an off-set in the pipe on account of a jog in the street, or for other reasons, it is well to know what to do. If, for instance, it is desired to off-set, say 12 ft., add 5 ins. to every foot off-set and you will have 17 ft. to the next 45°, then cut the pipe and it will fit exactly. Then form a square with the ditch already dug, measure off 12 ft., then square ahead 12 ft. and that is where the other 45° will come, and the 17 ft. of pipe will come right. It is better to use as few fittings as possible, though, in making a turn, but the turn should be made by breaking with short pieces of pipe. All fittings cut down the flow of the water.

In laying cast iron mains, the bottom of the trench should be on an even grade, so that when the pipe is lowered in place it will rest with even weight the whole length. The pipe should be laid so the spigot end is tight against the back of the bell. All pipe should be laid up hill; that is, begin at the bottom of any incline and lay toward the top and connect with the pipe that is already laid, either by buckling in or with a sleeve. What is known as buckling is to raise both ends of the pipe high enough so they will clear and then lower into the ditch; in that way the pipe can be cut so the ends will come together tight. Whenever it is necessary to sleeve the pipe there is always a space between the ends of the pipe and oftentimes it is advisable to place a wedge between the ends before the sleeve is put in place so the pipe can not move endways and cause a leak by loosening the lead joint. After the pipe is laid properly the joints should be yarned, poured and caulked.

The most important part of laying pipe is the yarning. In yarning enough space should be left so the lead will run just back of the lead lock in the bell of the pipe, about 1¾ ins. for 16-in. pipe. If the yarn is placed and tamped properly it is very easy for any one with a little experience to make a tight joint. It is often said anyone can pound lead, but it takes a good yarner to make a good joint.

The joints should all be left exposed until the water is turned in and the mains are tested with a force pump to a pressure at least one-third over the normal pressure at the locality and then if there is no leak, either from a cracked pipe or a joint, it is safe to fill in the ditch with a very little chance of any leak in the future. In backfilling a ditch it is advisable to place only about a foot of earth over the pipe, then wet it thoroughly and use bars to work the earth well around the pipe and then add about 6 ins. more each time and tamp thoroughly. If a main is laid in a street that has been surfaced with decomposed granite, we always lay that to one side and when the ditch is thoroughly tamped to a level of the grade, this surfacing is added and tamped again, which leaves a slight crown so that this will take care of any settlement which may occur.

Three lengths of hydrant ells are made so that no matter what size of main is laid, the hydrant lead is on an even grade with the main, and the top of the hydrant ell is even with the top of the curb. In laying 8-in. and 16-in. pipe use a hydrant ell 2 ft. 5 ins. long; for 10-in., 20-in., 24-in. and 30-in. use a hydrant ell 3 ft. 1 in. long; for 12-in. pipe use a hydrant ell 3 ft 8 ins. long.

All gate covers for 16-in. and over are all the same size. Each one has lettering on the cover denoting the size of the gate and the year it was installed. For gates up to 12 ins., 6 ins. or 8 ins. gate caps are placed on either cast iron or kalamein pipe cut to the desired length so the top of the cap is even with the finished grade of the street.

To show to what state of efficiency the Water Department has been brought in the last few years in the construction division alone I will use as an illustration the installing of the 30-in. pipe that has just been finished through East San Diego under the direct supervision of Foreman Chas. O'Neill. The engineers set hubs and stakes every 50 ft., showing the cut to the bottom of the ditch. After the ditch was dug to the required depth the foreman took a straight edge and placed it across the ditch, measured down the required depth in the center of the trench, set stakes about every 20 ft. and stretched a chalk line, which was a guide for the men grading the bottom of the trench. In this way the bottom of the trench was on an even grade and when the pipe was laid it never had to be moved again and so good results in laying the pipe was made possible. One day in 6½ hours the pipe gang laid 46 lengths of 30-in. pipe, or 552 ft. Another day in 7½ hours they laid 41 lengths, cut one pipe and set a 30-in. gate. This record could have been kept up every day, but we could not get the pipe fast enough. In the last shipment of 30-in. pipe the pipe ran in such uneven lengths that Mr. O'Neill made regular trips to the pipe yard and measured every length of pipe and requested the yard foreman to haul them in such a rotation so that he did not have to dig a bell hole over or cut a length of pipe except where a fitting or a gate was placed. Nor was there a leak in a single joint in about two miles of pipe.

On all new work on streets running east and west the gates are placed on the east side of the street intersection, and the hydrants on the southeast corner. On streets running north and south the gates are placed on the south side of the street intersection, and the hydrants on the southeast corner.

When repairing a break in a large main we always endeavor to notify the consumers who will be out of water and if the break is not too serious, get down to it and get all material on the job before shutting off the water. On all the new work we have placed gates at stated intervals and cut in other gates on the old mains, so we have been able to cut down the districts between gates to a minimum so that in but a very few districts in town only a few consumers will be out of water when a break occurs.

When the 30-in. main broke at Park Blvd. and University Ave., it being the main feeder for the west part of town, Pt. Loma and La Jolla, we stationed a man at the gate and kept just enough water going through to feed all consumers but not enough water to cause a pressure and hamper the men finding the break. We waited to cut the pipe until about 8 p. m., when the consumption was light, then we shut the 30-in. gate and opened the 12-in. from the standpipe, started the pump and kept it going till the break was repaired and no one was inconvenienced for the lack of water. The main was split, so it was necessary to make one cut in the ditch and break a bell, and then we sleeved in a bell piece a few inches shorter than the one we had taken out. To show how readily the men of the department respond to any call, in less than half an hour enough men were working on the job so they could work in relays, some men digging the ditch, some men were in the yard cutting another piece of pipe, while others were eating lunch; in this way the work was moving all the time. Some of the men worked 24 hours straight without a complaint.

The watchwords of the department are Loyalty, Efficiency and Harmony. You can see these in the everyday workings of the department and if it continues in the next few years as it has in the last four it will be known as one of the best, if not the best, water system in the country.

BRIDGES

A New and Simplified Derivation of the Most General Form of the Theorem of Three Moments.

Contributed by G. A. Maney, University of Minnesota, Minneapolis, Minn.

A property of the *M/EI* curve for beams is here made use of to simplify the difficulties involved in the derivation of the most general form of the theorem of three moments for continuous beams.

The general case considered is that where the three supports are not in the same straight line (see Fig. 2), and where the following conditions hold for the adjacent spans:

(a) The spans have different lengths.

(b) There is a different uniform load on each span.

(c) Each span has a different concentrated load at any point.

(d) The beam section has a different moment of inertia for each span, and the material in each span has a different modulus of elasticity.

M, *E* and *I* are symbols for the bending moment, the modulus of elasticity of the material, and the moment of inertia of the sectional area of the beam.

The property of the *M/EI* curve, which is made use of, may be stated as follows:

The statical moment of the area under the *M/EI* curve between any two points on the elastic curve, about one of these points, gives the deflection of this last-mentioned point about which the moment is taken, this deflection being measured from the tangent to the elastic curve at the other point.

As this property is not generally recognized in this particular form a short proof of it will be given. It is assumed in this proof, as is also done in the derivation of the differential equation of the elastic curve, $EI \frac{d^2y}{dx^2} = M$, that the length of the projection of the neutral axis after bending, upon the neutral axis before bending, is the same as the length before bending.

Let *c* (Fig. 1) be the distance from the extreme fiber to the neutral axis.

Let $d\theta$ be the change of angle between two plane sections of the beam perpendicular to the neutral axis and distant *ds* apart. This change of angle is due to bending and equals the change of slope between two points on the neutral axis at a distance *ds* apart.

The unit stress on the extreme fiber equals *Mc/I*, the unit deformation on the extreme fiber equals *Mc/EI*, and the deformation of the extreme fiber for a distance *ds* along it equals *(Mc/EI) ds*.

Then (see Fig. 1) $d\theta$ equals *(Mc/EI) ds* divided by *c*, or *(M/EI) ds*, which equals the area under the *M/EI* curve for a distance *ds* along it.

Figure 1 shows that the effect of the change of slope $d\theta$, in a distance *ds* along the neutral axis, on the deflection *N-N*, from the tangent *M N*, is measured by the product $sd\theta$, where *s* equals the distance from *N* (where the deflection is to be found) to the center of the distance *ds*, which is considered.

The sum of all these products of $sd\theta$ for the consecutive distances *ds* along the beam gives the total deflection.

Since *(M/EI) ds*, or $d\theta$, equals an increment of area under the *M/EI* curve the product of all these increments multiplied by the corresponding values of *s* equals the statical moment of the area under the *M/EI* curve about *N*. Thus we see that the moment of the *M/EI* curve between any two points on the elastic curve, about one of them, gives the deflection of this point from a tangent at the other point.

The application of this property to the solution of the problem depends for its validity upon the continuity of the beam at the support, as do all other solutions of this problem. We may assume a slope or direction of tangent at any support which is common to both adjacent spans, and then may express a relation between the deflections from this common tangent at the two adjoining supports.

The conditions existing before and after bending, respectively, with all the different quantities affecting the solution are given in Figs. 2 and 3. In this general case the beam will not be resting on all the three adjoining supports.

Let H_1, H_2 and H_3 be the vertical distances from the supports to some assumed straight line above them (see Fig. 2).

By proportion from similar triangles we get the relation:

$$\frac{H_1 + y_1 - H_2}{L_1} = \frac{H_2 - H_3}{L_2}, \text{ from which,}$$

$$y_1 = \frac{(H_2 - H_3)L_1}{L_2} - (H_1 - H_2) \qquad (1)$$

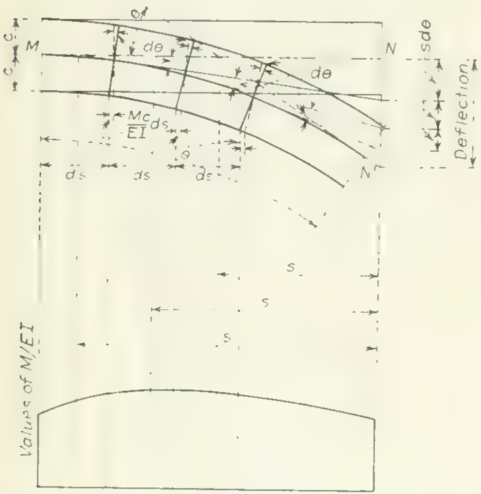


Fig. 1. Diagram Showing Nomenclature and M/EI Curve.

In Fig. 3, where *QNP* is the direction of the common tangent at the support after bending, we have the relation,

$$\frac{OQ}{QN} = \frac{MP}{PN}, \text{ or } \frac{D_1 + y_1}{L_1} = -\frac{D_2}{L_2}, \text{ from which}$$

$$y_1 = -\left[\frac{L_1}{L_2}D_2 + D_1\right] - (H_2 - H_3)\frac{L_1}{L_2}$$

$$-(H_1 - H_2) \qquad (2)$$

Therefore, $L_2D_1 + L_1D_2 = (H_3 - H_2)L_1 + (H_1 - H_2)L_2$ (3)

D_1 and D_2 are the deflections, due to bending, from this common tangent to the two adjacent supports.

It is in the application of the differential equation of the elastic curve to determine these values of deflection that the difficulty of the ordinary derivation arises. Cumbersome algebraic expressions for bending moments must be twice integrated, and values of the constant of integration for slope and for deflection must be obtained. In the general case for which this simplified solution is offered the operations above indicated involve much tedious algebraical transformation in which a liability to error arises.

By the method here proposed this problem is reduced to the writing of one linear equation, which gives, without any further transformation, the value of the deflection, *D*, from the tangent at the support in terms of the *M/EI* values involving the unknown bending moments at the supports.

Both of these equations for the values of *D* may be written by an inspection of the *M/EI* curve given in Fig. 8, which simply expresses the result obtained by dividing the values of *M*, shown graphically in Fig. 7, by the corresponding values of the *EI* product. This resultant bending moment curve is found by combining the moment diagrams shown in Figs. 4 and 5 for simply supported spans loaded with uniform and concentrated loads so as to produce the combined moment diagram for simply supported spans shown in Fig. 6. Then, as indicated in Fig. 7, the moment curve for the continuous span considered will have the same variation between supports as if it were simply supported, and the values of the moments at the supports will be the unknown values of the bending moment at the support, between which we desire to find the relation which is usually designated as the "theorem of three moments." In Fig. 7 the moments represented by the ordinates to the curves *RST* and *TUV* from the base lines *RT* and *TV* have the same values as the corresponding ordinates of the curves *MNO* and *OPQ*, shown in Fig. 6, measured from the base lines *MO* and *OQ*. That this must be true is evident, since the variation in shear throughout the span (which is the same in both cases since it is due to the same applied loads) measures the variation in the bending moment between the supports, regardless of the moment values at the support.

Referring to Fig. 8, we know from the before-mentioned properties of the elastic curve that the moment of the *M/EI* area in span L_1, about point 2, equals the deflection D_1, and that the moment of the *M/EI* area in span L_2, about point 12, equals the deflection D_2. Therefore, D_1 equals the moment of the areas 1-2-3 and 5-6-7 minus the moment of the area 3-4-5 about point 2. This is the same as the moment of the area 1-7-6-2 minus the moment of the area 1-7-4, or as the moment of the areas 1-7-2 and 7-2-6 minus the moment of the areas *ADC* in Fig. 4 and *HIJ* in Fig. 5, when these two latter areas are reduced from *M* to *M/EI* areas.

The values of the moments of the *M/EI* areas measuring D_1, about point 2, are as follows:

$$\text{Area 1-7-2} = \frac{M_1}{E_1I_1}\left(\frac{L_1}{2}\right)\left(\frac{L_1}{3}\right) = \frac{M_1L_1^2}{6E_1I_1};$$

$$\text{area, 7-2-6} = \frac{M_2}{E_1I_1}\left(\frac{L_1}{2}\right)\left(\frac{2L_1}{3}\right) = \frac{M_2L_1^2}{3E_1I_1};$$

$$\text{area } ADC, = BCD + ABD = \frac{P_1k_1(1-k_1)L_1}{2E_1I_1}\left[(1-k_1)L_1\left(k_1 + \frac{1-k}{3}\right)L_1 + k_1L_1\left(\frac{2k_1L_1}{3}\right)\right] = \frac{P_1L_1^3}{6E_1I_1}(k_1 - k_1^3)$$

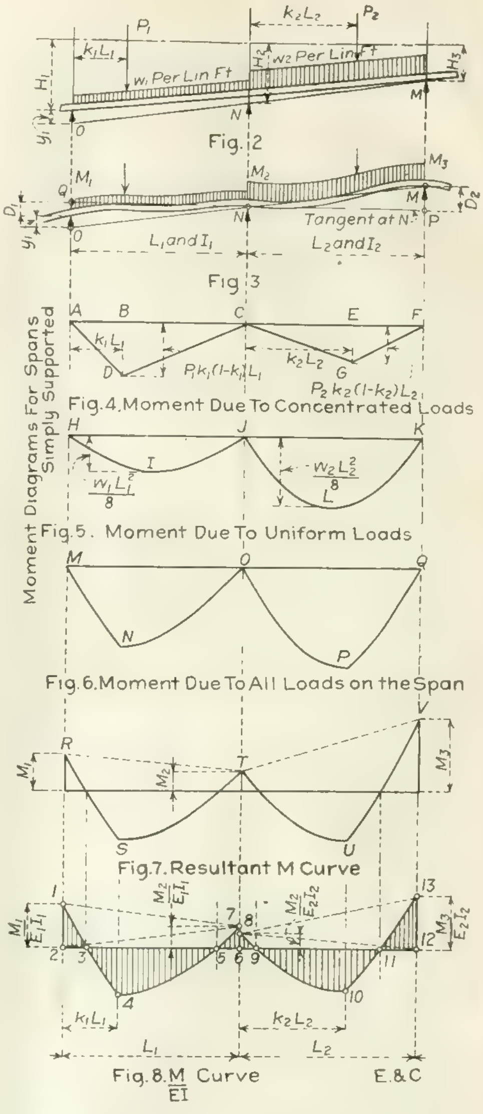
$$\text{area } HIJ = \frac{w_1L_1^2}{8E_1I_1}\left(\frac{2L_1}{3}\right)\left(\frac{L_1}{2}\right) = \frac{w_1L_1^4}{24E_1I_1}.$$

Therefore

$$D_1 = \frac{L_1^2}{6E_1I_1}\left[M_1 + 2M_2 - P_1L_1(k_1 - k_1^3) - \frac{w_1L_1^2}{4}\right].$$

Likewise, the values of the moments of the *M/EI* areas measuring D_2 about point 12 are as follows:

$$\text{Area 13-8-12} = \frac{M_3L_2^2}{6E_2I_2};$$



Figs. 2-8. Diagrams Used in Deriving the Theorem of Three Moments.

$$\text{area 8-12-6,} = \frac{M_2L_2^2}{3E_2I_2};$$

$$\text{area } FGC, = ECG + FEG = \frac{P_2k_2(1-k_2)L_2}{2E_2I_2}$$

$$\left[k_2L_2\left(1 - k_2 + \frac{k_2}{3}\right)L_2 + (1-k_2)L_2\left(\frac{2(1-k_2)}{3}\right)L_2\right];$$

$$= \frac{P_2L_2^3}{6E_2I_2}(2k_2 - 3k_2^2 + k_2^3);$$

$$\text{area } KLJ = \frac{w_2L_2^2}{8E_2I_2}\left(\frac{2L_2}{3}\right)\left(\frac{L_2}{2}\right) = \frac{w_2L_2^4}{24E_2I_2}.$$

$$\text{Therefore } D_2 = \frac{L_2^2}{6E_2I_2}$$

$$\left[M_3 + 2M_2 - P_2L_2(2k_2 - 3k_2^2 + k_2^3) - \frac{w_2L_2^2}{4}\right].$$

Substituting these values of D_1 and D_2 in equation (3), and assuming that the sign of the moments M_1, M_2 and M_3 are minus at the support, we get the following equation, which expresses directly the relation between these three moments for the most general case assumed:

$$\frac{L_1L_2^2}{6E_2I_2}\left[M_3+2M_2-P_2L_2(2k_2-3k_2^2+k_2^3)-\frac{w_2L_2^2}{4}\right]$$
$$+\frac{L_2L_1^2}{6E_1I_1}\left[M_1+2M_2-P_1L_1(k_1-k_1^3)-\frac{w_1L_1^2}{4}\right]$$
$$=(H_3-H_2)L_1+(H_1-H_2)L_2.$$

Then, assuming that $E_1 = E_2$ and that M_1, M_2 and M_3 are negative, and multiplying by $\frac{GE}{L_1L_2}$ and transposing, we get:

$$-M_1\frac{L_1}{I_1}-2M_2\left(\frac{L_1}{I_1}+\frac{L_2}{I_2}\right)-M_3\frac{L_2}{I_2}=\frac{w_1L_1^3}{4I_1}$$
$$+\frac{w_2L_2^3}{4I_2}+\frac{P_1L_1^2}{I_1}(k_1-k_1^3)+\frac{P_2L_2^2}{I_2}(2k_2-3k_2^2+k_2^3)$$
$$+6E\left[\frac{H_3-H_2}{L_2}+\frac{H_1-H_2}{L_1}\right]\ldots\ldots\ldots\ldots\ldots(4)$$

Equation (4), which is the most general form of the useful theorem of three moments, or "Clapyrons" theorem, shows in a very interesting manner the effect of varying moments of inertia.

SPECIAL CASES.

The effect of varying moments of inertia on the moments for continuous beams is usually neglected in building construction, although this formula indicates that it may become an important factor.

To show the effect of different values of I for the adjacent spans, let us assume the case where $\frac{H_3-H_2}{L_2}+\frac{H_1-H_2}{L_1}=0$, (which indicates that the beam touches all the supports in its unstressed condition) and where there are no concentrated loads, the uniform load being the same throughout and all spans being of the same length. Then equation (4) takes the form

$$\frac{-M_1}{I_1}-2M_2\left(\frac{I_1+I_2}{I_1I_2}\right)-\frac{M_3}{I_2}=\frac{wL^2}{4}\left(\frac{I_1+I_2}{I_1I_2}\right).$$

Equations for all the special cases of this theorem which are encountered in theory or practice may be written by inspection from the general equation (4).

For the case where I_1 equals I_2 and the supports are not on the same straight line, and where there are different spans and concentrated loads at any point with no uniform loads, equation (4) becomes

$$-M_1L_1-2M_2(L_1+L_2)-M_3L_2=P_1L_1^2(k_1-k_1^3)+$$
$$P_2L_2^2(2k_2-3k_2^2+k_2^3)+6EI\left[\frac{H_3-H_2}{L_2}+\frac{H_1-H_2}{L_1}\right].$$

For the above case where there are no loads at all on the beam equation (4) becomes

$$-M_1L_1-2M_2(L_1+L_2)-M_3L_2$$
$$=6EI\left(\frac{H_3-H_2}{L_2}+\frac{H_1-H_2}{L_1}\right)$$

When there are no concentrated loads, when I_1 equals I_2, when the supports are all on the same straight line or level, and when there are different spans and uniform loads, we get the well known form

$$-M_1L_1-2M_2(L_1+L_2)-M_3L_2=\frac{1}{4}w_1L_1^3$$
$$+\frac{1}{4}w_2L_2^3$$

For the simplest case of the above equation, when the uniform load and the spans are equal, we get the form

$$-M_1-4M_2-M_3=\frac{1}{2}wL^2.$$

It thus becomes evident that equation (4) will hold for any special cases which may arise.

The Muscatine, Iowa, water department contemplates the installation of 500 water meters this year.

Data on Reinforced Concrete Railroad Bridges and Extent to Which Such Bridges Are Used.

The report of the "Committee on Reinforced Concrete Bridges" of the American Railway Bridge and Building Association, presented at the annual convention of this society, held in Los Angeles, Cal., Oct. 20-22, 1914, contains some interesting and valuable data on reinforced concrete railroad bridges. It was the aim of the committee to determine to what extent reinforced concrete is in use, in the United States and Canada, for railroad bridges, the types developed and in most general use, and the practice of different railroads regarding standard types and specifications for design. The following data were abstracted from the committee's report:

TYPES IN USE AND EXTENT OF USAGE.

Table I gives the types of reinforced concrete structures in use on various railroads, the number and mileage of railroads reporting use of same, and the number reporting no reinforced concrete structures.

It will be noted from this summary that there are no reinforced concrete structures on a large percentages of the mileage reported. It is very likely that if full information could be obtained, it would be found that the proportion of roads on which reinforced concrete is not in use would be greater than that shown in Table I, as some of the railroads failed to send in reports because they had no structures of this kind.

TABLE I. DATA ON USE OF REINFORCED CONCRETE STRUCTURES ON RAILROADS.

	Types of reinforced concrete structures in use.									
	Arches, barrel type	Culverts (rect box type)	Culverts (arch type).	Abutments, solid.	Abutments (hollow or arch).	Piers	Trestles	Deck slabs	Retaining walls	City subways
Number of roads on which type is reported in use.	16	30	15	18	13	15	17	28	23	1[illegible]
Mileage of roads on which type is reported in use.	61,270	106,972	48,559	67,580	52,992	55,932	76,808	104,776	81,120	10,864
Total number of roads reported										54
Total mileage of roads reported										163,449
Number of roads reporting no reinforced concrete structures										13
Mileage of roads reporting no reinforced concrete structures										24,664

The two types of structures most in favor are the box culvert and the deck slab. On two large systems the deck slab is the only type of reinforced structure in use. Following these are the retaining wall and the trestle.

There is considerable diversity among the various railroads in the specifications, design and details of practically every type in use. On only a few points is there anything like uniformity. A 1:2:4 mixture and a moduli ratio of 15 appear to be quite generally accepted as correct for fully reinforced structures.

REINFORCED CONCRETE DECK SLABS.

Table II (p. 30) gives essential data on the design of reinforced concrete deck slabs, applicable to the various railroads using this type. These data cover the concrete proportions, types of reinforcement, allowable stresses in concrete and steel, and loads assumed.

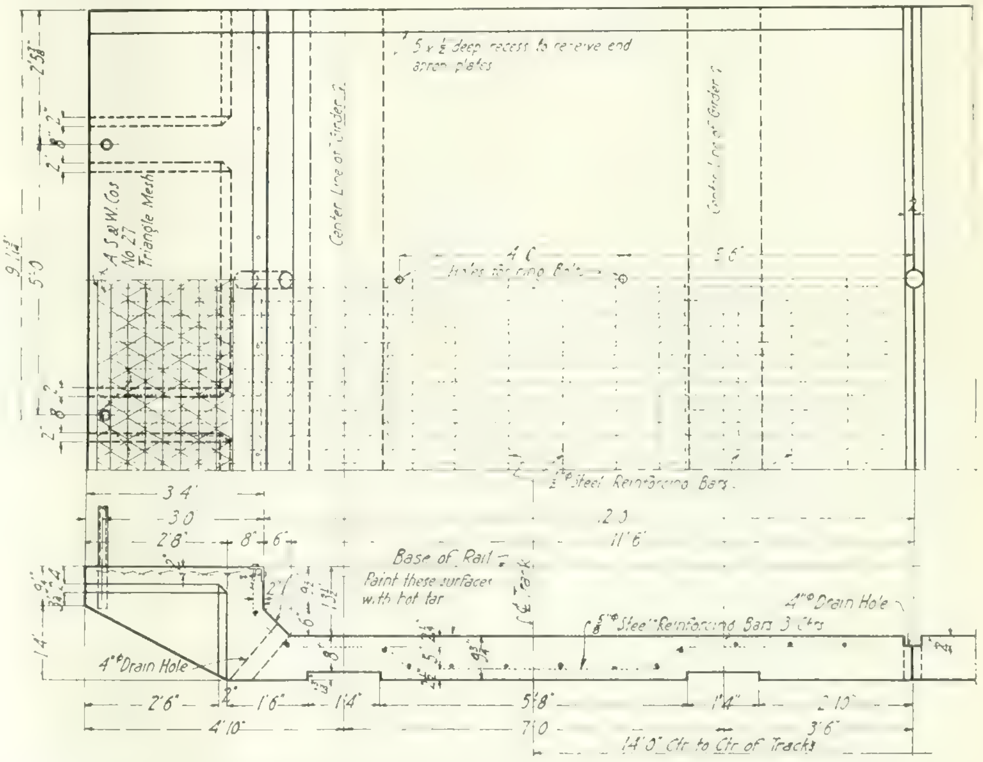

5 x ½ deep recess to receive end apron plates
Center Line of Girder
A S.&W. Co. No. 27 Triangle Mesh
4'0"
Holes for ring Bolts
5'6"
¾" Steel Reinforcing Bars
3'4"
3'0"
2'8"
8"
6"
2'0"
11'6"
Base of Rail
Paint these surfaces with hot tar
4" Drain Hole
⅝" Steel Reinforcing Bars 3" Ctrs
4" Drain Hole
2'6"
1'6"
1'4"
5'8"
1'4"
2'10"
4'10"
7'0"
3'6"
14'0" Ctr. to Ctr. of Tracks

Fig. 1. Details of Reinforced Concrete Deck for Steel Girder Spans in Use on D. M. & N. Ry.

The types of reinforced concrete slabs shown in Figs. 1-6, inclusive, have been selected to bring out distinctive features in design and detail of types in use on different railroads. Figures 1 and 2 show details of the reinforced concrete deck slabs for steel girder spans in use on the D,. M. & N. R. R. and the C., M. & St. P. Ry., respectively. It will be noted that there is considerable difference in the concrete details and in the arrangement of the reinforcement in these two designs of the same type of structure.

Figures 3 and 4 show details of the slab tops for culverts used on the Pennsylvania R. R. (lines west of Pittsburgh) and on the

TABLE II.—DATA COVERING DESIGN OF REINFORCED CONCRETE SLABS ON VARIOUS RAILWAYS.

DECK SLABS										
1	2	3	4	5	6	7	8	9	10	11
RAILROAD	PROPORTION OF INGREDIENTS IN EACH PART OF STRUCTURE	CHARACTER OF AGGREGATE	REIN- [illegible] BAR	MAXIMUM ALLOWABLE STRESS POUNDS PER SQUARE INCH				RATIO OF MODULI OF ELASTICITY OF [illegible]	LIVE LOAD EQUIVALENT TO COOPER'S CLASS E	IMPACT
				TENSION IN STEEL Fs	COMPRESSION IN CONCRETE Fc	SHEAR IN CONCRETE S	ADHESION OF STEEL AND CONCRETE A			
A C L	1:2:4	WASHED GRAVEL 1/4 MAX MIN DIAMETER	DEFORMED BILLET STOCK	6000	600	30	100 175	15	E-60	$\frac{L^2}{L+D}$
B & M	ALL REINFORCED CONCRETE DESIGN IN ACCORD WITH THE AREA SPECIFICATIONS									
A T & S F	1:2:4		DEFORMED BILLET STOCK	15000	700	30	150	15	E 70	
B & O	1:2:4	CRUSHED STONE	PLAIN OR DEFORMED	16 000	600	60	50	15	E-50	50% OF L L
CENT OF GA	1:2:4	CRUSHED STONE OR GRAVEL	TWISTED OR DEFORMED BILLET STOCK	6000	650	120	150	15	E 55	100% OF L.L.
C B & Q	1 CEMENT TO 4 GRAVEL	GRAVEL CONSIST. OF 1 PART FINE & 2 PARTS COARSE MATERIAL WELL MIXED	DEFORMED BILLET STOCK	18000	800	200	200	15	E 56 OR OVER	50% OF L L
C G W	1:2:4	CRUSHED STONE OR GRAVEL, GRADED SIZES 1/4" MIN DIAM	DEFORMED	17000	750	120	100 150	15	E 55	50% OF L L
C M & St P	1:2:4	CRUSHED STONE OR CRUSHED GRAVEL 2" MAX	DEFORMED OR TWISTED BILLET STOCK OR REROLLED	16000	700 FOR EXTREME FIBRE IN BENDING	90	PLAIN BARS, 50 DEFORMED 100		E 55 & E 60	$\frac{8}{10} \times \frac{L^2}{L+D}$
C C C & St L	1:2:4	CRUSHED LIMESTONE	DEFORMED BILLET STOCK	16000	700	50	PLAIN BARS 50 DEFORMED BARS [illegible]	15	E 60	$S\left[\frac{300}{L+300}\right]$
C & N W	1:2:4	CRUSHED STONE MAX DIAM	SQ TWISTED OR DEFORMED BILLET STOCK	12000	660			15	E 55	90% OF L L
C R I & P	1:2:4	CRUSHED STONE GRAVEL	PLAIN AND DEFORMED BILLET STOCK	15000	650	30		15	E 55	50% OF L L
L & N	1:2:4	BROKEN STONE OR GRAVEL	TWISTED BILLET STOCK	RECOMMENDATIONS OF JOINT COMMITTEE				15		30% OF L L
E J & E	1:2:4	WASHED GRAVEL	SQ TWISTED BILLET STOCK	16000	650	40	100	15	E 60	50% OF L L
ILL CENT	1:2:4	CRUSHED STONE OR GRAVEL	DEFORMED OR PLAIN BILLET STOCK	17000	750	40	PLAIN BARS 80 DEFORMED BARS 120	15	E 55	$\frac{1}{2} \times \frac{L^2}{L+D}$
K C SOUTH	1:2:4	CRUSHED STONE OR WASHED GRAVEL	CORRUGATED TWISTED OR PLAIN BILLET STOCK	15000	600	35 TO 100 DEPENDING ON KIND OF REINFORCMT	PLAIN 65 TWISTED 100 CORR 150	15	E 60	40% OF L L
LEHIGH VAL	1:2:4	CRUSHED STONE OR WASHED AND SCREENED GRAVEL	PLAIN AND TWISTED BILLET STOCK	16000	650	30	PLAIN 60 TWISTED 100	15	E 60	$\frac{L^2}{L+D}$
M & St L	1:2:4 BOTTOM 2" OF SLAB BELOW STEEL TO BE 1:2 MORTAR	GRAVEL	DEFORMED BILLET STOCK	18000	650	75			E 55	$S\left[\frac{300}{L+300}\right]$
Mo Pac Sys	1:2:4	CRUSHED ROCK OR GRAVEL	DEFORMED BILLET STOCK	16000	650	120 WITH WEB REINFORCMT	150	15	E 50	$S\left[\frac{300}{L+300}\right]$
N C & St L	1:2:4	CRUSHED STONE PREFERRED AND GRAVEL	PLAIN OR TWISTED	16000	750	40	80	15	E 50	$S\left[\frac{300}{L+300}\right]$
NY NH & H	1:2:4	CRUSHED TRAP ROCK, GRAVEL & 2" MAX DIAM	SQUARE TWISTED BILLET STOCK	14000	650	40	80	15	1200# PER FT	100% OF L L
N Y O & W	1:2:4	CRUSHED LIMESTONE	DEFORMED BILLET STOCK	16000	650	40	50	15	E 50	60% OF L L
PENN EAST	1:2:4	3/4 GRAVEL OR 3/4 CRUSHED STONE	PLAIN TWISTED BARS BILLET STOCK	12000	[illegible]	50	100	15	E 55 (ABOUT)	PER RR CO SPECIFICATION
PENN WEST	1:2:4	CRUSHED STONE PREFERRED	SQ TWISTED OR PLAIN TWISTED PREFERRED	$\frac{15625}{2-\theta}$ $\theta = \frac{\text{DL MOM}}{\text{TOTAL MOM}}$	$\frac{625}{2-\theta}$	50	BARS DEVELOPED PLAIN IN 60 DIA TWISTED IN 25 DIA	15	MAX AXLE LOADING SERV E OR 60000	NONE
NYC & HR	1:2:4	BROKEN STONE OR GRAVEL	TWISTED OR DEFORMED BILLET STOCK	14000	650	30	PLAIN 60 DEFMD 150	15	E 60	$S\left[\frac{200}{L+300}\right]$
SOUTHERN	1:2:4	CRUSHED STONE	PLAIN ROUND BILLET STOCK	6000	650	40 PLAIN 120 REINF	80	15	E 55	50% OF L L
W & L E	1:2:4	CRUSHED STONE OR SLAG	TWISTED OR CORRUGATED	16000	650	120	80	15	AXLE LOAD OF [illegible]	90% OF L L

E., P. & S. W. system. The distinctive feature of the first mentioned slab is the separation into track slabs and side slabs, while the latter plan shows a unique method of carrying the track on pedestals during the construction of the slab. It will be noted that different types of reinforcement are used in these two designs.

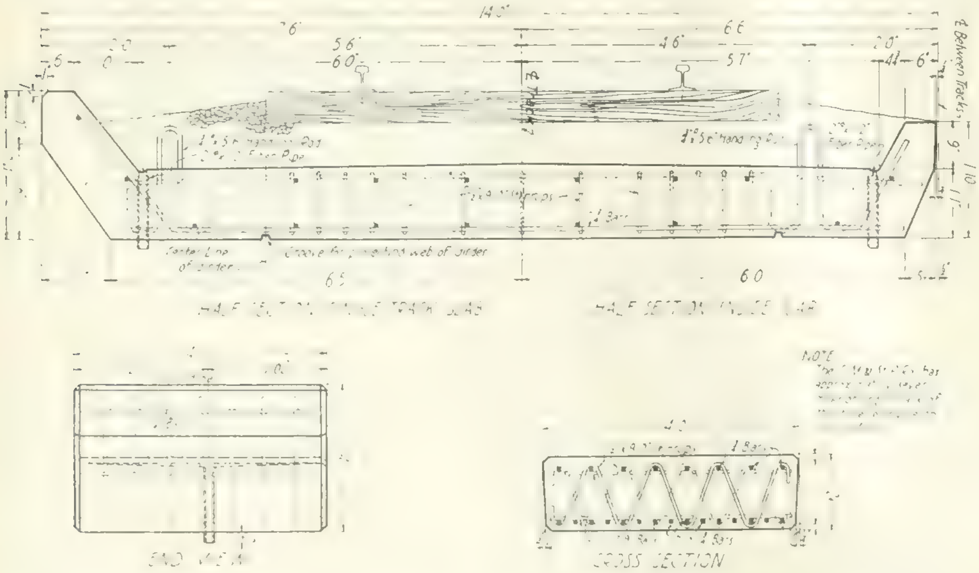


Fig. 2. Details of Standard Reinforced Concrete Deck Slab for Deck Girders of C. M. & St. P. Ry.

Figures 5 and 6 show details of the piers and abutments, and of the floor slabs, respectively, of the reinforced concrete trestle in use on the C., M. & St. P. Ry. These drawings show clearly the distinctive features of this type of construction.

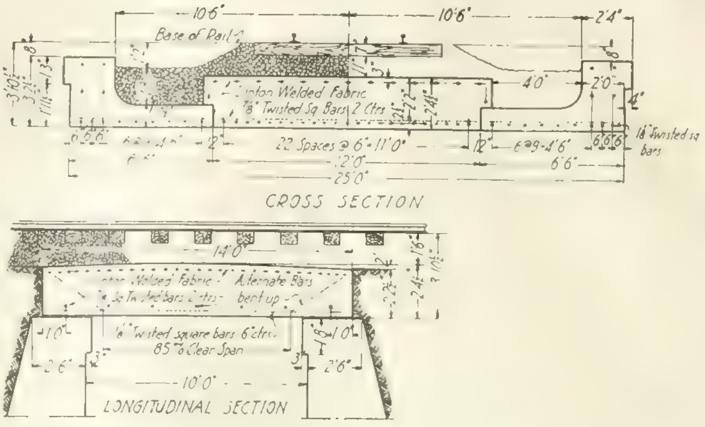


Fig. 3. Details of Typical Reinforced Concrete Slab for Culverts in Use on P. R. R. Lines West of Pittsburgh.

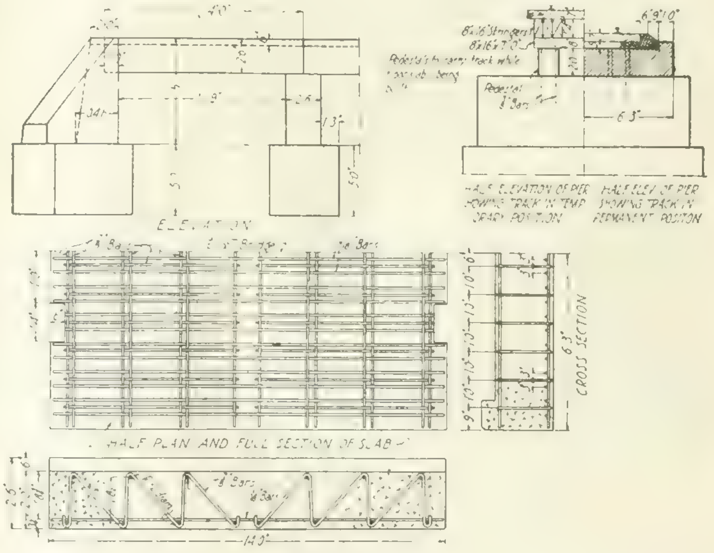

Pedestals to carry track while slab being poured
Pedestal
6'5"
HALF ELEVATION OF PIER SHOWING TRACK IN TEMPORARY POSITION
HALF ELEV. OF PIER SHOWING TRACK IN PERMANENT POSITION
ELEVATION
HALF PLAN AND FULL SECTION OF SLAB
CROSS SECTION
14'0"

Fig. 4. Details of Standard Reinforced Concrete Culvert of E. P. & SW. System.

Figure 7 gives details of street and sidewalk slabs used by the C., B. & Q. Ry. on track elevation work.

REINFORCING STEEL.

Three types of reinforcing bars are in quite general use: (1) plain round bars; (2) square bars, straight and twisted; and (3) deformed bars, Many roads use all three types, the square and the deformed bars being generally preferred to the plain round bars. Unit systems of reinforcement appear to be very little used for railroad bridge work, as none of the reports showed this type in use for bridge construction.

There are marked differences in the arrangement of the bars in the structures of different roads. This is apparently due more to methods of construction than to design. Some roads use only straight bars, or bars with short bends at the ends, while others do not hesitate to use bars with four to six bends.

It is quite generally accepted that bent bars, if made true to form and properly placed in the structure, will fulfill the requirements of design better than a combination of straight bars. They eliminate the sharp turns in the direction of reinforcement, and give a continuity of reinforcement that is not obtainable with straight bars. An advantage in construction from using bent bars is the smaller number of bars to be handled and placed, a single bent bar being made to do duty for several straight ones.

There are, however, other considerations than design that enter into the selection of reinforcement, such as methods of handling, shipping and placing bars, facilities for bending bars in the field, skill and training of the men on the work. Manifestly a road with a good organization of well trained foremen and workmen, and ample facilities for bending and handling bars, would be less restricted in the type of reinforcement than a road dependent on contractors, or with a less effective organization of its own.

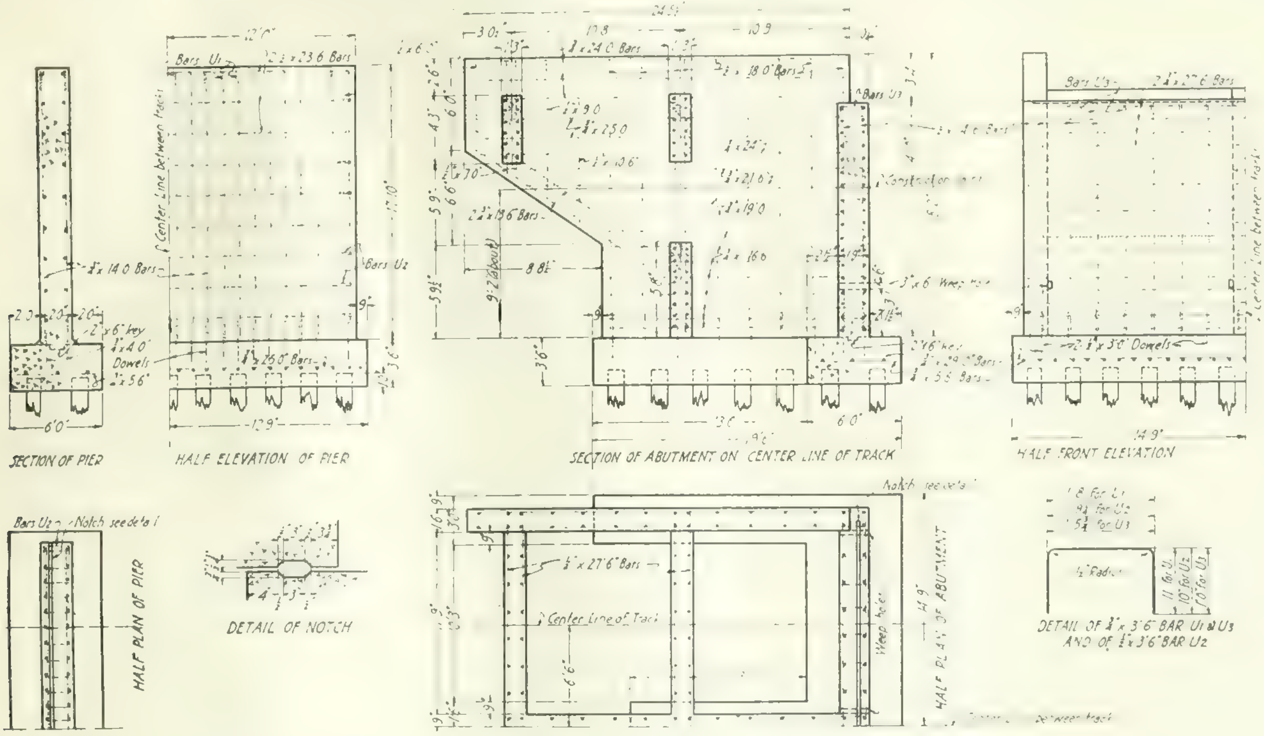


Fig. 5.—Details of Piers and Abutments of Reinforced Concrete Trestle in Use on C. M. & St. P. Ry.—See Also Fig. 6.

All roads except one specify billet stock for reinforcing material. Some go so far as to state specifically that re-rolled steel will not be accepted. The one road which now includes re-rolled deformed bars in its specifications reports that none have ever been used because they have never yet been available.

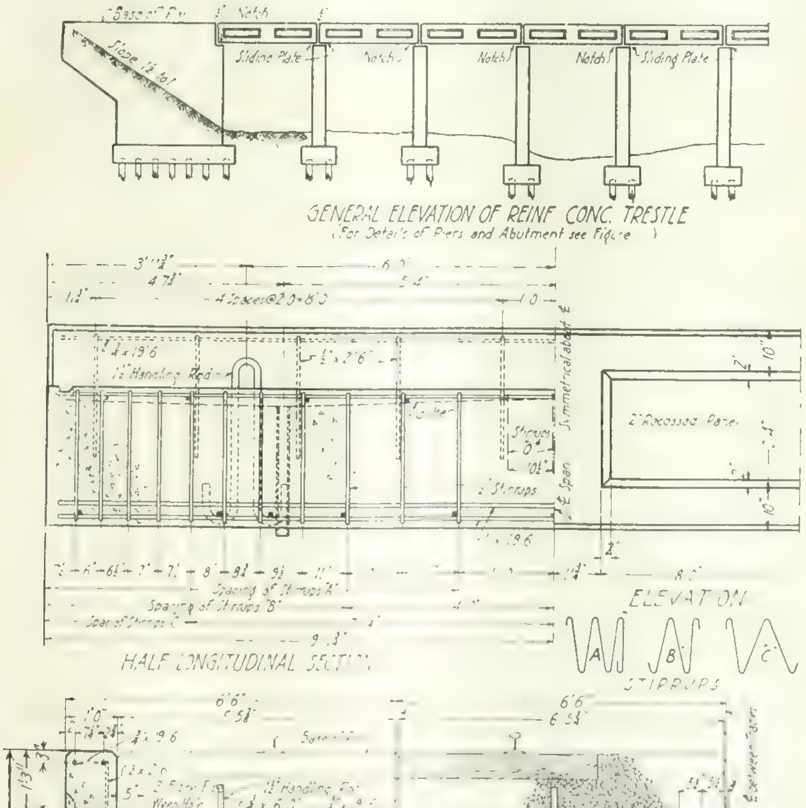

Sliding Plate
Notch
Slope 1½ to 1
GENERAL ELEVATION OF REINF. CONC. TRESTLE
(For Details of Piers and Abutment see Figure)
Handling Rod
Symmetrical about ℄
℄ Span
2" Recessed Panel
Stirrups
HALF LONGITUDINAL SECTION
ELEVATION
A
B
C
STIRRUPS
Stirrups C
Stirrups A
Stirrups B
Alternate rows of stirrups to be inverted as shown
CROSS SECTION

Fig. 6. Details of Typical 20-Ft. Reinforced Concrete Trestle Slab in Use on C. M. & St. P. Ry.—See Also Fig. 5.

There is found considerable variation in the allowable working stresses of both steel and concrete. A certain amount of variation would be expected, due to differences in the material used in the concrete and to the impact allowances in the load, but the wide range of working stresses cannot be fully accounted for by those differences. They must be attributed, in part, to the confidence, or lack of confidence, that designing engineers have in the strength of the material and in their ability to analyze the conditions of the structure under load. It is not to be expected that the working stresses for reinforced concrete can be brought even near the uniformity that obtains in the working stresses specified for steel structures. There are too many uncertainties in both analysis

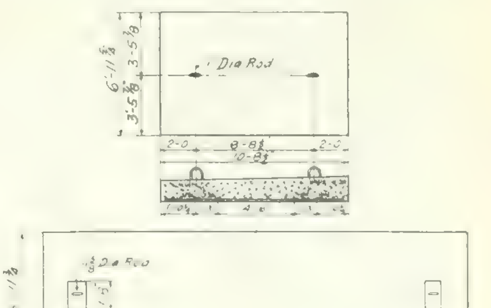


Fig. 7. Details of Standard Street and Sidewalk Slabs for Track Elevation Work on C. B. & Q. Ry.

and construction, and these can best be covered by a liberal excess of strength in the design. Designers will have more confidence in their analyses when they have been verified by the results of exhaustive tests. Such tests can best be carried on at the engineering experiment stations of the universities. To be conclusive, they should be comprehensive and exact enough to eliminate the possibility of abnormal results, and they should be conducted under conditions that approximate actual working conditions as nearly as practicable.

It is evident from the records of tests made at the University of Illinois Engineering Experiment Station, by D. A. Abrams (see ENGINEERING AND CONTRACTING of June 24, 1914, for a summary of these tests) that the value of plain round bars as reinforcing material may have been underestimated, and also that twisted and deformed bars may have been credited with much merit which they do not possess, or which does not become effective under practical working conditions. However, the fact should not be overlooked that vibration, which is so large an element in working conditions, could not enter into the results of the laboratory tests. Designing engineers may feel that the deformed bar offers a security against vibration and initial failure that fully justifies its use in spite of the excellent showing made by the plain round bar in the laboratory tests. However, since the claims for superiority of twisted and deformed bars over plain bars are based on their capacity for developing greater bond resistance, it would not be amiss for designing engineers to review their specifications in the light of these tests, with a view to making such revisions in the working bond stresses of the different types of bars as may be justified.

Instructions to Employees Governing Bridge Work by Pennsylvania State Highway Department.

The following data on the design, construction and maintenance of highway bridges were abstracted from the "Instructions to Employees," issued by the Pennsylvania State Highway Department. They will be found of value to those engaged in the design, construction and maintenance of highway bridges.

Design and Construction.

The sites of all proposed new bridges of 12-ft. span or over, and smaller ones presenting any special difficulties, must be examined by the Bridge Engineer or an assistant designated by him before any requisition for material will be approved by the Maintenance Engineer.

SIZES OF CULVERTS

The usual formula for determining the sizes of culverts is as follows:

$a = C \sqrt[4]{A^3}$, in which,

A = drainage area in acres,

a = cross section of culvert opening in square feet,

C = a coefficient varying in value from $\frac{1}{6}$ to 2, according to the character and slope of the drainage area.

Make $C = 2$ in mountainous districts in which the district drained is short. Make $C = \frac{1}{6}$ where the drainage area is long and level.

Experience with the old bridge, or with others crossing the same stream nearby, is a much better guide than any formula.

STANDARD PLANS

Standard plans will be furnished whenever practicable. If the new bridge is on a skew, the material shown on the standard plan, to be suitable for a bridge of the same span, measured in a parallel direction to the centerline of the road, should be used. Whatever the standard plan calls for, as to the depth of the foundation, should be interpreted to mean either that it should be carried down below frost or to durable rock. If quicksand or any other special difficulty is encountered, the Bridge Engineer should be notified. The same care should be exercised in the foundations of the wing-walls as with the foundation of the abutments. Wing-walls should generally make an angle of 30° with the line of the stream and in general should be finished approximately flush with the abutment, so as not to interfere with the side ditches. They need be made no longer than is necessary to hold the fill, for if the bank requires additional paving it can be done by rip-rapping, at little expense.

PAVING BED OF STREAM.

If a paved slope is built it should be laid on a slope of not more than 45° with the ground, the bend of the stream being excavated to proper depth. It should be finished at right angles with the surface of the paving to prevent the paving from sliding into the stream or being undermined. The paving should generally be extended above high water. If the stream has a rapid current, or heavy ice, it may be necessary to grout the bed.

STEEL REINFORCING.

Plans will be sent to you from time to time showing different types of reinforcing which may be used on state highway bridges and culverts. These are designed to be all of practically the same working strength, and the assistant engineer will be expected to use his best judgment, taking all things into consideration, as to which is the cheapest and the best to build of the different types shown.

UNIT REINFORCEMENT.

The types employing rod reinforcement will generally be found to be the cheaper, but they require more care and skill in their construction. Some types of good reinforcement can be obtained built in units ready to lay in place. This is as convenient to erect as I-beams and effects a considerable saving in the cost of the steel and requires no additional cost for forms or concrete. Reinforcing units can be made of plain bars but they require mechanical skill for their construction. If the assistant engineer intends to use that type to any great extent it would be good economy for him to secure a rod-bending device.

RAIL REINFORCEMENT.

When steel bar reinforcement is shown on the plan it is sometimes practicable to use old rails instead. In that case the amount of steel per square foot would be greater than is the case with plain rods, and if the distance between the rails is greater than the thickness of the slab small rods should be laid crosswise, directly on top of the rails, to prevent the slab from breaking through between the rails.

In buying old rails allowance must be made for defects which may have developed in them. When estimating the cost, allowance should be made for the fact that the purchaser usually has to pay for the cutting of crop ends. The assistant engineer should be careful about such things in making bargains with the dealer.

OTHER REINFORCEMENT

Old pipe or wire rope can sometimes be used for reinforcement, but wire rope is apt to be greasy and may contain many broken wires, and the pipe is apt to be badly wasted by corrosion. Second-hand I-beams can be obtained, but allowance must be made for their weakness due to bolt holes, corrosion, defects, etc. I-beams should never be laid flatwise when intended for reinforcement, owing to the difficulty of filling properly the space under them with concrete and of securing proper bond between the concrete under the beams and that above. I-beams may be purchased directly from the mills or from a dealer. The former method is generally cheaper, but it usually results in considerable delay in delivery.

FORMS.

It is not usually necessary to build forms for concrete foundations. The additional concrete required by the slopes of the excavation will generally cost less than the forms, and, besides, the foundation concrete will be quite useful in preventing scour in the bed of the stream. If it is necessary to deposit concrete under water care must be taken that the water is perfectly still, otherwise the cement will be washed out of the concrete. If an attempt is made to keep an excavation dry by pumping while depositing concrete the cement is almost sure to be pumped out with the water. The best method to deposit concrete under water is what is known as a tremie, which consists of a pipe long enough to reach to the bottom of the excavation and some distance above the water and provided with a funnel into which the concrete is to be poured. The bottom of the pipe should be stopped with a board, the pipe filled with concrete, and the whole lowered to the bottom of the excavation; then remove the board and move the pipe slowly from one part of the excavation to the other, keeping it always filled with concrete above the surface of the water. The work should be kept going continuously until the excavation is filled. If the water comes in entirely at the bottom of the excavation it is often sufficient to seal up the bottom with a foot or more of concrete, deposited under the water, allowing that to set and then pump out the excavation, finishing the work in the dry.

Forms for concrete which is not exposed, may, of course, be made of rough lumber and the cracks luted with clay, but the forms for exposed concrete should be made of dressed lumber usually 1½ ins. or over in thickness, and with the edges slightly beveled so that the joints are closed. Tongued and grooved lumber may be used for sections of forms that are to be handled in one place, but if it has to be taken apart it is liable to split and be damaged in the process. If the lumber is dry trouble is sometimes caused by its absorbing moisture from the concrete and swelling or binding and even cracking off copings and other projecting concrete. The inside of the forms should be covered with soap or petroleum to prevent adhesion to the concrete. It is sometimes lined with paper to prevent leakage and to prevent the form lumber from absorbing water. The paper, however, is likely to adhere to the concrete, entailing some difficulty in its removal. An excellent way to make the joints tight is to calk them with oakum, but clay can usually be made to answer the purpose. Exposed corners should be filleted to prevent them from spalling off when using forms, or afterwards.

Acute angles, whether salient or re-entrant should be chamferred or rounded for the same purpose, sharp re-entrant angles being liable to start cracks. The forms should be designed with a view to easy removal with a minimum damage to the lumber and to the concrete. They can be tied across with wires, but care should be taken to cut the wires somewhat below the surface before the concrete has set hard. Great care should be taken to build the forms accurately to line and to brace them firmly, because a slightly inaccuracy in alignment spoils the appearance of the finished structure.

Vertical surfaces should be carefully spaded during the placing of the concrete, and forms should be removed from such surfaces as soon as the concrete is set hard enough to permit it, which will genrally be from 12 to 48 hours, according to the weather. Concrete sets much more slowly in cool weather than in warm. After the forms are removed the surface should be dampened and rubbed with a wooden float to get a sand finish. Forms supporting the floor should generally be left in place above two or three weeks, and longer in cold weather, after the pouring of the concrete, and still longer before permitting it to carry traffic. It is well to design forms so that they may be used on different bridges with as little cutting as possible.

CONCRETE.

Concrete must be made of 1 part American Portland cement, 2 parts clean, sharp river sand and 4 parts broken stone or gravel of a size that will pass through a 1¼-in. screen and not pass a ¼-in. screen, and it must be mixed as herein specified.

Machine mixed concrete will be preferred. When necessary to mix concrete by hand a smooth, clean and close fitting wood or metal platform of ample area must be used. The volume of gravel, stone or slag must be spread out on one side in a flat layer not over 1 ft. in thickness, and the dry sand and cement mixed adjacent thereto until of a uniform color. The stone or gravel, previously wet, must have the cement and sand spread over it in a uniform layer and properly moistened with a rose sprayer. The batch so prepared must be turned over 4 times by shovelers approaching each other from opposite sides. Care must be taken not to heap up the batch in turning, but to maintain its uniform thickness after each turning.

Concreting must be carried on continuously and if, for any reason, the work is delayed, before resuming concreting, the old surface must be roughened, cleaned, dampened, and skim coated with mortar.

When a concrete mixing machine is used the cement and sand must be mixed as above and precaution must be taken to insure the proper portion of each of the materials so that the results of the mixture will be uniform in quality.

No concrete must be used in the construction if, in the opinion of the enginer, it is in poor condition either from imperfect mix or initial set. Rapid transportation of concrete must be made from the mixer to the work so that only freshly mixed concrete shall be put in place.

CEMENT.

All cement used must be Portland cement. Briquettes of neat cement 24 hours in air and 6 days in water, must show a tensile strength of at least 500 lbs. per square inch; when mixed with sand in proportion of 3 parts sand and 1 part cement, at least 200 lbs. per square inch. On a 28-day test of sand and cement mixture it must show a gain in strength of at least one-third over the 7-day test. Pats of neat cement with thinned out edges kept 24 hours in moist air and then immersed in water and maintained at a temperature of as near 70° F. as practicable, or exposed in air, and observed at intervals for 28 days, must show no signs of cracking or checks at any interval of time. All cement must be finely ground, and 92 per cent must pass through a No. 100 sieve and 75 per cent must pass through a No. 200 sieve. The cement must be delivered in sound barrels or well protected packages and kept thoroughly protected from the weather. A sufficient amount must be kept in store, ahead of requirements, to permit of proper testing without undue haste.

When broken stone is used in composing concrete it must be of trap-rock, granite, gneiss, hard sandstone or limestone acceptable to the State Highway Commissioner and must be free from dirt or dust or any foreign materials and must have a crushing strength of not less than 8,000 lbs. per square inch.

All sand used must be river sand and must be clean, sharp, free from loam, coal, oil, mud or other foreign materials or impurities.

When gravel is used it must be a clean river gravel, of mixed sizes, free from loam, coal, oil or other foreign matter.

Crushed slag, acceptable to the State Highway Commissioner, may be used in composing concrete for foundation work and the size of the same must be from 1 in. to sand, and it must weigh at least 2,400 lbs. to the cubic yard.

All water used must be free from sulphur, oil, and muddy solution.

General Inspection, Maintenance and Repair.

All bridges on state highways should be inspected at least once a year and complete report (Form No 901) filed prior to May 1 each year. Careful notes should be taken as to the material, length of span, construction of abutments, sufficiency of foundation as far as can be learned, character of the bottom of stream, exposure to destruction, obstruction or damage by high water, driftwood, floating ice, special traffic, etc. If the abutments are of stone note whether or not they are laid with mortar. Bridges which appear to be weak should be examined at least once in every two months. Abutments which appear to be in danger of falling down should be examined at least once in every two months, or, preferably, arrangements should be made with people living in that vicinity to look at them frequently and report to the department any changes they may note.

BRIDGES LIABLE TO DANGER FROM HIGH WATER

Bridges which appear to be liable to danger from high water should be examined after every heavy rainfall or period of high water, and when the ice goes out in the spring. Wooden bridges which are submerged by high water should be examined immediately afterwards, to see if any planks or other parts have been floated or washed away. This should be done before traffic is permitted to be resumed over them.

UNDERMINING.

Bridges which appear to be liable to undermining should be examined with a view to ascertaining whether or not that has happened. Tests should be made after every period of heavy rain or high water, preferably by long poles or iron rods. It should be remembered that the deeper the water in the stream, the more rapid and the greater liability to scour.

INSPECTING FLOORS.

In inspecting the floors, examine every plank and look for rotten spots, cracks and large or loose knots or knot holes.

If the stringers are of wood, one or more planks should be lifted in order to ascertain if the stringers are decayed, remembering that the stringers may appear sound from below, but be decayed within and from the top down.

STEEL BRIDGES IN NEED OF PAINT.

Steel bridges should be examined as to their need of paint, also to ascertain if they are materially weakened by corrosion. Take special care to examine parts which are, or were, covered by dirt, being careful to remove all dirt from the abutments and from around the steelwork.

CRACKS, ETC., IN STONE AND CONCRETE BRIDGES.

Examine stone and concrete bridges for cracks and signs of undermining, as it sometimes happens, in the case of a stone or concrete bridge, that the head-wall breaks loose from the remainder of the bridge. In such a case the bridge engineer should be notified.

FLOOR PLANKS AND STRINGERS.

If floor planks or stringers show signs of decay or weakness, send a requisition for the material required to the engineer, stating the facts of the case.

SPIKING FLOOR PLANKS.

All floor planks should be securely spiked to the stringers. This strengthens the structure and reduces the noise. Use 30-penny spikes for 2-in. planks, 40-penny for 2½-in., and 60-penny for 3-in. planks.

RAILINGS

See that railings are reasonably firm and rail is of such a character that horses can see it in a dim light. If there is a liability of children or others falling into the water and being injured or drowned, one board should be nailed to the side of the railing 1 ft. clear above the floor, and another 2 ft. 6 ins. clear.

BRIDGE ABUTMENTS AND PIERS.

Many bridge abutments are built of good square stone, well laid, with or without mortar, but entirely too thin. If they show signs of weakness, or of falling down through this cause, it is usually sufficient to dig out the back of the abutment, a section at a time, clean the stone thoroughly and back with concrete, care being taken to bond the concrete well with the stones. The thickness of the wall at every point should not be less than four-tenths of the height of the top of the abutment above that point.

SCOUR UNDER ABUTMENTS OR WING-WALLS.

If water has scoured out under the abutment or wing-walls at any point, and the remainder of the abutment is in first-class condition, it is often feasible, with care, to extend the wall down to proper foundation without disturbing it, by excavating a short section at a time, supporting individual stones with small props, filling with concrete, and removing the props as the work progresses if possible. Props should be made of green wood, because dry wood absorbs moisture rapidly and swells with great force.

FOUNDATIONS.

Foundations in general should be carried below frost or down to durable rock.

STONE WALLS.

If a stone wall laid dry shows signs of weakness it is usually cheaper to tear it down and rebuild it on proper foundation than to repair it. In doing so it should be rebuilt with cement mortar.

OBSTRUCTIONS IN CHANNEL.

All obstructions should be removed from the channel of the stream, as far as practicable, in order to make the channel as smooth and as straight as possible. Waterfalls, even though low, scour rapidly if on earth, and isolated stones in the channel, even though of moderate size, reduce the velocity of the water considerably. A fence rail across the channel of the stream will often reduce the velocity of the water's flow 25 per cent. Where persons wish to fence up a bridge, the fence must be placed at the downstream end and so arranged that it will be lifted up when the channel fills. If waterfalls are encountered in such a position as to threaten the bridge masonry, stones of ample size should be placed under the falls in such a position as to prevent erosion. If flat stones are used each stone should lap over the next one on the downstream side.

WING-WALLS.

Wing-walls should generally make an angle of about 30° with the line of abutment. This not only prevents reducing the velocity of the water, which occurs with a square abutment, but also reduces the formation of eddies, which often cause erosion, whether at the upstream or downstream end of the abutment.

STONE ARCHES.

If stone arches show signs of weakness they can often be very effectively repaired by removing all of the earth fill from above the defective spot, putting forms under the inner side of the arch, filling the loose stone with grout and the large openings with concrete.

STEEL BRIDGES.

If steel bridges show signs of weakness or of deterioration, the engineer must notify the bridge engineer, who will inspect all steel bridges at as early a date as possible. Special care should be taken to report to the bridge engineer steel bridges in need of painting, giving length of span, etc.

WASHOUTS.

Washouts should be reported immediately to the Assistant Engineer and to the Engineer of Bridges, stating whether the abutments are beyond repair and if there is any considerable salvage in the steelwork. In such cases the questions of line and grade of improved roads and of the length of span required must be settled before any permanent work can be done.

ESTIMATING COST OF PAINTING STEEL BRIDGES

In making estimates of the cost of painting, the following may serve as a guide:

For each per 100 sq. ft. of surface covered			
Cleaning	$0.50	to	$1.50
Paint, first coat	0.50	to	0.75
Paint, second and third coat	0.30	to	0.50
Labor, first coat	1.00	to	2.00
Labor, second and third coat	0.75	to	1.25

RIVERS AND HARBORS

Certain Cost Data on the Work of Improving the Neponset River in Massachusetts.

Contributed by Edmund M. Blake, Engineer in Charge.

The work of improving the Neponset River has been in progress under the Massachusetts State Board of Health since Jan. 28, 1913, on which date dredging operations were begun. Under the Legislative authority of 1911, this work covers the deepening, rectifying and enlarging of the old channel from the dam at the paper mill of Tileston & Hollingsworth at Mattapan up to a point above Traphole Brook in the towns of Sharon and Norwood, passing through Hyde Park, Milton, Dedham, Westwood and Canton in addition to the above two towns.

The contractor for this work is the Barge Canal Construction Co. of New York. The plant in use consists of a 1¼-cu. yd. dipper dredge with a 60-ft. boom, a 1-cu. yd. orange peel bucket dredge with a 50-ft. boom and an hydraulic sluicing boat for leveling the spoil banks. The dipper dredge was installed for use on the meadow divisions of the work while the smaller orange peel bucket dredge was designed for the two divisions of the work through Hyde Park where many bridges, buildings and pipe crossings interfere, requiring "knocking down" at seven points for passage under bridges.

TABLE I.—SUMMARY OF TIME LOST BY DIPPER DREDGE FOR TWELVE MONTHS.
(January 28, 1913, through January 27, 1914.)

Month.	Working days Total.	Working days Actually worked.	Working days Lost.	Working hours Total.	Working hours Actually worked.	Working hours Lost.
1913—						
January	4	3.75	0.25	32	30	2
February	24	22.25	1.75	376	348	28
March	26	24.00	2.00	416	384	32
*April	26	0.00	26.00	416	0	416
May	27	15.50	11.50	432	248	184
June	25	24.00	1.00	448	424	24
July	27	25.00	2.00	648	600	48
August	26	22.00	4.00	624	528	96
September	26	20.17	5.83	624	484.08	139.92
October	27	18.25	8.75	512	372	140
November	25	14.50	10.50	400	232	168
December	26	22.00	4.00	416	352	64
1914—						
January	23	22.00	1.00	368	352	16
Totals	312	233.42	78.58	5,712	4,354.08	1,357.92

Percentage of total working days in operation....... 74.8%
Time lost in percentage of total working days....... 25.2%
100.0%

Percentage of total working hours in operation....... 76.2%
Time lost in percentage of total working hours....... 23.8%
100.0%

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*During this month the dredge was being moved overland around Pauls Bridge in Milton. If the time thus lost were not taken into account in the above table, the relative percentages would be changed, making the time lost in percentage of total working days 18.3 per cent, and in percentage of total working hours, 17.7 per cent. This lost time was due to breakdowns, minor repairs and replacements, injury to electric lighting system, etc. One, two and three shifts of 8 hours each were in operation at various times.

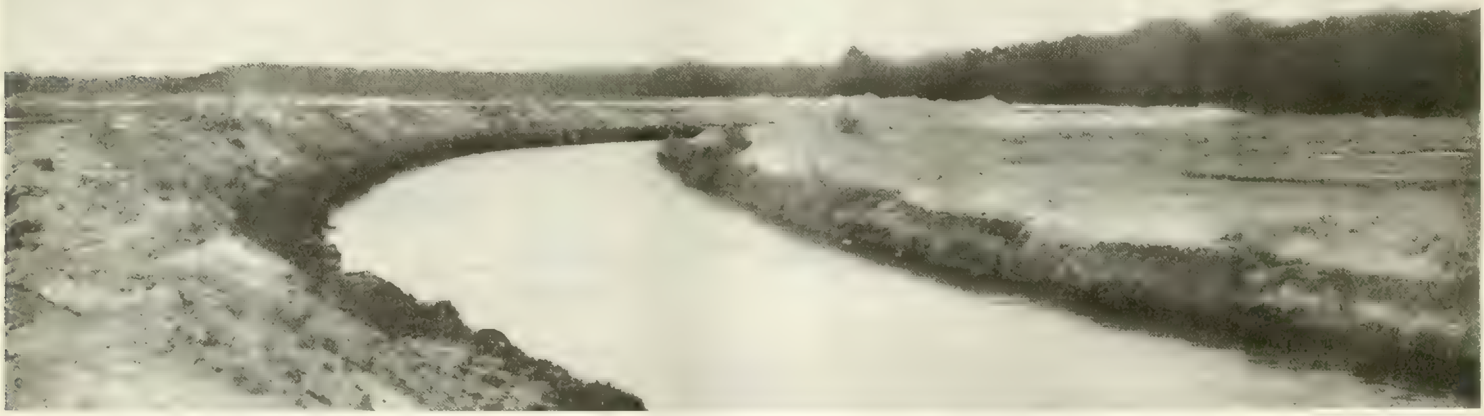


Fig. 1. View of Dredged Channel, Neponset River Improvement, Massachusetts. (Bank on Left as Deposited by Dipper Dredge; on Right as Leveled by Hydraulic Jet Boat.)

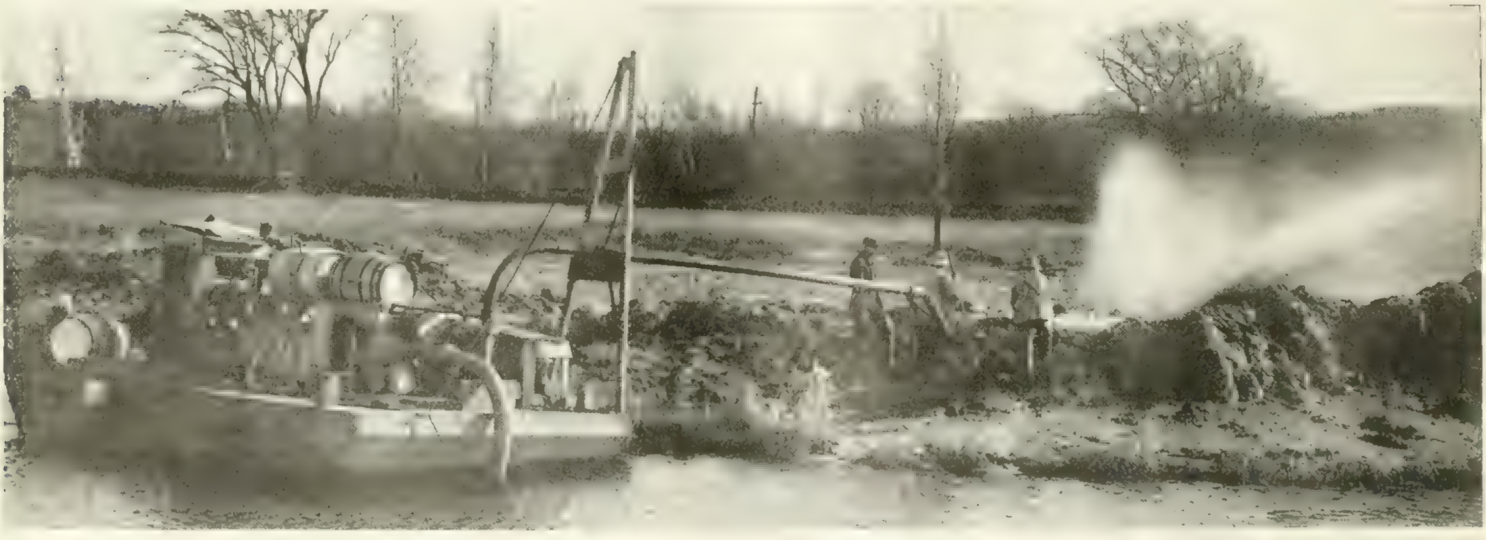


Fig. 2. View Showing Hydraulic Jet Boat Leveling Spoil Banks, Neponset River Improvement, Massachusetts.

The approximate total yardage to be removed by both dredges is 300,000 cu. yds. and the length of river to be improved is about twelve miles. The dredging of meadow cutoffs will reduce this original length to about 10.4 miles, thereby increasing the available head and rectifying the alignment with the resultant decrease in loss of head at sharp bends.

The data contained in this article covers

TABLE II.—SUMMARY OF TIME LOST BY ORANGE PEEL BUCKET DREDGE FOR 12 MONTHS.
(June 3, 1913, through January 27, 1914.)

Month.	Working days Total.	Working days Actually worked.	Working days Lost.	Working hours Total	Working hours Actually worked.	Working hours Lost.
1913—						
June	24	18	6	240	192	48
July	27	15.50	11.50	432	248	184
August	26	23	3	416	368	48
September	26	18	8	416	288	128
October	27	19	8	432	304	128
November	25	20	5	400	320	80
December	26	26	0	416	416	00
1914—						
January	23	20.75	2.25	368	332	36
Totals	204	160.25	43.75	3,120	2,468	652

Percentage of total working days in operation	78.5%
Time lost in percentage of total working days	21.5%
	100.0%
Percentage of total working hours in operation	79.1%
Time lost in percentage of total working hours	20.9%
	100.0%

This lost time was due to breakdowns, minor repairs and replacements, injury to electric lighting system, rigging for dragging under bridges and knocking down for passage under bridges and re-rigging above them.

TABLE III.—SUMMARY OF RESULTS OF DREDGING OPERATIONS FOR TWELVE MONTHS FROM JANUARY 28, 1913, THROUGH JANUARY 27, 1914.

Item—	Dipper dredge.	Orange peel bucket dredge.	Total for both dredges.
Gross yardage dredged	187,335.4 cu. yds.	18,495.0 cu. yds.	205,830.4 cu. yds.
Net yardage, paid for	153,199.2 cu. yds.	18,495.0 cu. yds.	171,694.2 cu. yds.
Excess yardage	34,136.2 cu. yds.	00.00 cu. yds.	34,136.2 cu. yds.
Percentage of gross yardage not paid for.	19.87 %	00.00 %	16.58 %
Total distance dredged	23,800.00 ft.	3,886.00 ft.	27,686.00 ft.
Average gross yardage per lineal foot	8.0 cu. yds.	4.76 cu. yds.	(av.) 7.5 cu. yds.
Average net yardage per lineal foot	6.4 cu. yds.	4.76 cu. yds.	(av.) 6.2 cu. yds.
Average net yardage per working day	491.02 cu. yds.	90.66 cu. yds.	581.68 cu. yds.
Average gross yardage per working day	600.43 cu. yds.	90.66 cu. yds.	691.09 cu. yds.
Average net yardage per day actually worked	656.32 cu. yds.	115.41 cu. yds.	771.73 cu. yds.
Average gross yardage per day actually worked	802.57 cu. yds.	115.41 cu. yds.	917.98 cu. yds.
Largest record yardage for 3 continuous 8-hour shifts	1,800.00 cu. yds.	400.00 cu. yds.	2,200.00 cu. yds.
Average net yardage per working hour	26.78 cu. yds.	5.93 cu. yds.	32.71 cu. yds.
Average net yardage per hour actually worked	35.12 cu. yds.	7.49 cu. yds.	42.61 cu. yds.
Possible monthly rate, net yardage for—			
24 days actually worked	15,750.00 cu. yds.	2,775.00 cu. yds.	18,525.00 cu. yds.
25 days actually worked	16,400.00 cu. yds.	2,875.00 cu. yds.	19,275.00 cu. yds.
26 days actually worked	17,050.00 cu. yds.	3,000.00 cu. yds.	20,050.00 cu. yds.
27 days actually worked	17,700.00 cu. yds.	3,125.00 cu. yds.	20,825.00 cu. yds.
Possible monthly rate, gross yardage for—			
24 days actually worked	19,250.00 cu. yds.	2,775.00 cu. yds.	22,025.00 cu. yds.
25 days actually worked	20,050.00 cu. yds.	2,875.00 cu. yds.	22,925.00 cu. yds.
26 days actually worked	20,850.00 cu. yds.	3,000.00 cu. yds.	23,850.00 cu. yds.
27 days actually worked	21,650.00 cu. yds.	3,125.00 cu. yds.	24,775.00 cu. yds.
Total, boulders larger than 9.0 cubic feet.	32.90 cu. yds.	78.90 cu. yds.	111.80 cu. yds.
Price paid for earth, per cu. yd. in place.	42 cts.	42 cts.	42 cts.
Price paid for boulders larger than 9.0 cu. ft., per cu. yd	$ 7.50	$ 7.50	$ 7.50
Average amount earned per working day.	207.02	40.98	248.00
Average amount earned per day actually worked	276.71	52.17	328.88
Average amount earned per working hour	11.29	2.68	13.97
Average amount earned per hour actually worked	14.81	3.39	18.20
Note: The above four items include earth and boulders.			
Total labor cost, not including superintendent	11,752.55	4,150.15	15,902.70
Average labor cost per working day	37.67	20.34	58.01
Average labor cost per day actually worked	50.35	25.90	76.25
Average labor cost per working hour	2.06	1.33	3.39
Average labor cost per hour actually worked	2.70	1.68	4.38
Average labor cost per cu. yd. of net yardage	7.7 cts.	22.4 cts.	(av.) 9.3 cts.
Average labor cost per cu. yd. of gross yardage	6.3 cts.	22.4 cts.	(av.) 7.7 cts.
Total coal consumed, both operating and banking, approximately	681.95 tons	409.88 tons	1,091.83 tons
Total coal cost at $6 per ton on either dredge, approximately	$4,091.70	$2,459.28	$6,550.98
Average coal cost per working day	13.11	12.06	25.17
Average coal cost per day actually worked	17.53	15.35	32.88
Average coal cost per working hour	71 cts.	79 cts.	1.50
Average coal cost per hr. actually worked	94 cts.	$1.00	1.94
Average coal cost per cu. yd. of net yardage	2.6 cts.	13.3 cts.	(av.) 3.8 cts.
Average coal cost per cu. yd. of gross yardage	2.2 cts.	13.3 cts.	(av.) 3.2 cts.
Total labor and coal cost	$15,844.25	$6,609.43	$22,453.68
Average labor and coal cost per working day	50.78	32.40	83.18
Average labor and coal cost per day actually worked	67.88	41.24	109.12
Average labor and coal cost per working hour	2.77	2.12	4.89
Average labor and coal cost per hour actually worked	3.64	2.68	6.32
Average labor and coal cost per cu. yd of net yardage	10.3 cts.	35.7 cts.	13.1 cts.
Average labor and coal cost per cu. yd. of gross yardage	8.5 cts.	35.7 cts.	10.9 cts.

The labor cost for both dredges, as given above, includes the cost of labor employed by the contractor in filling in the cut offs on the meadow areas and in leveling and grading the spoil banks above Pauls Bridge by use of the hydraulic sluicing boat, as both of those items are covered in the agreement by the price paid to the contractor per cubic yard of earth dredged. The cost of gasoline used in the operation of the hydraulic sluicing boat has not been taken into account.

The labor cost also includes the runners of the two motor boats installed by the contractor, used for towing coal on a small scow, for transferring the dredge crews and for various other purposes. One of these motor boats is used and operated largely by the superintendent. The gasoline used by these two boats has not been charged against the above costs. In the case of the orange peel bucket dredge, coal was sometimes placed directly on it from the banks of the river in the lower Hyde Park section.

The labor costs above stated do not include labor employed on any special work, for which written orders were given at a fixed price, or under the terms of the agreement providing for "Extra Work."

the work done by both dredges from Jan 28, 1913, to Jan. 28, 1914, a period of twelve months. The dipper dredge started operating on Jan. 28, 1913, while the orange peel bucket dredge did not begin work until June 3, 1913. Very careful records have been kept of the time lost during the daily working periods and of the causes for this loss of time; of the amount of coal used for operating and banking; and through the courtesy of the Barge Canal Construction Co., access has been had to their labor pay rolls from which exact data have been obtained on the labor cost for each dredge. This labor cost covers the dredge runners, cranesman, fireman and deck hands, the foreman and crew engaged in filling in cut-offs, the motor boat runners and the foreman and crew on the hydraulic sluicing boat, but does not include the contractor's superintendent. No exact figures have been secured on the cost of repairs and general maintenance, nor on plant cost, interest and insurance charges, overhead charges or the amounts charged off to depreciation. It is hoped that the data given here will prove of direct interest and value to engineers and others engaged upon or contemplating similar work under conditions which may be reasonably compared with these.

WORK ACCOMPLISHED BY THE DIPPER DREDGE.

The dipper dredge covered the drainage divisions from the railroad bridge south of Glenwood Ave. in Hyde Park up as far as the railroad bridge at Dedham Road on the main line of the Providence Division of the New York, New Haven & Hartford R. R., with the exception of the east half of the channel for a short distance above Green Lodge St., a total distance of about 23,800 ft. or about 4.5 miles. In this section is the heaviest yardage on the entire work, approximating to an average of 8 cu. yds. per foot of river center line. In general, it was deposited by the dredge in about equal quantities on both banks of the river.

The nature of the material encountered was of five general classes as follows:

Mud, including river silt and the accumulated deposit from factory and mill wastes, besides top-soil at the cut-offs.

Gravel, including large beds of pure river gravel, sandy gravel and partly cemented gravel, all containing scattered boulders both large and small.

Sand, including gravelly sand, very extensive beds of clean, sharp sand, much of it almost white in sunlight after drying, some of it being of a brown color and coarser.

Clay, tough and bluish in color, underlying gravel and in some cases sand.

Hardpan, most of it in one extensive outcrop, a large percentage of which was very compact and difficult to handle, with many large and small boulders embedded therein.

The total amount of mud was relatively small in the above work, it being expected that much more will be encountered above Dedham Road. The gravel deposits were met with below Pauls Bridge and in two outcrops just below the railroad bridge at Dedham Road. The hardpan was all encountered in a section extending about 1,000 ft. each way above and below Pauls Bridge, the bridge itself being located on one of the hardest ridges of that material. The clay was found in scattered strata underlying the gravel below Pauls Bridge and at a few points underlying sand above Pauls Bridge. By far the largest amount of material dredged was sand, a few deposits being encountered below Pauls Bridge, but the main part running from the disappearance of the hardpan about 1,000 ft. above Pauls Bridge to the gravel out-crops just below Dedham Road, a distance of about 17,850 ft. or about 8.4 miles.

While accurate data on the total quantity of each of the above classes of material removed by the dipper dredge are not available, information which may be relied upon with a fairly close degree of accuracy is at hand and the results of the study of this information show the following as the probable percentages of the total quantity dredged:

Material	Pct.	Cu. yds. approx.
Mud, silt and top soil	7	13,100
Hardpan	[illegible]	9,400
Gravel	15	28,100
Sand	73	136,800
Totals	100	187,400

With this relative proportion between the quantities of the different classes of material removed by the dipper dredge in mind, a clearer interpretation can be made of the figures contained in the accompanying tables.

It should also be noted that the contractor used a special gasoline motor boat for towing coal to the dipper dredge in a small scow from the various points along the line selected for the storage of his coal supply.

During this period of twelve months, aside from all other causes, the dipper dredge was held up as follows:

From March 27, 1913, to May 8, 1913, for removal from the river just below Pauls Bridge, transferring overland around Pauls Bridge and launching again in the river above the trolley trestle bridge about 150 ft. above Pauls Bridge.

From Nov. 22 to 25, 1913, for pulling piles in the trestle bridge above Pauls Bridge, the superstructure having been removed previously.

On Dec. 8, 1913, for pulling 18 old piles at the Green Lodge St. highway bridge, the center span of the bridge having been previously removed so that the delay to the dipper dredge was reduced to a minimum.

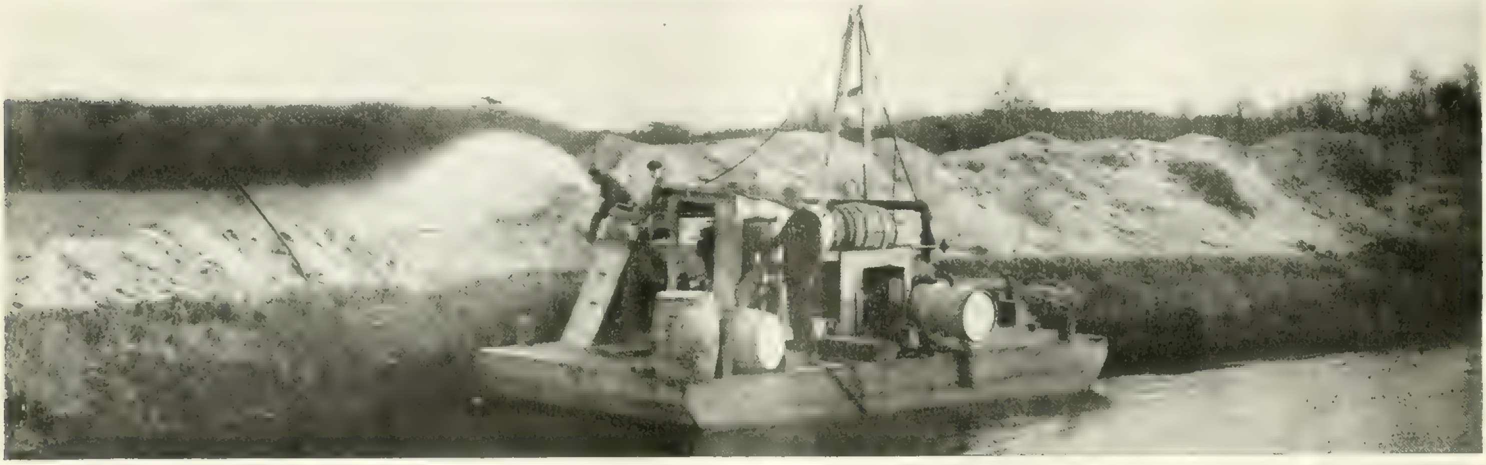


Fig. 3. View of Hydraulic Jet Boat Leveling Spoil Bank, Neponset River.

The transfer around Pauls Bridge was let to a sub-contractor who was not equipped with the proper machinery for removal of the dredge body from the river channel, this accounting for the rather long time required for this transfer. The moving overland was accomplished rapidly by the use of blocking, capstans and horses as in moving a building.

Filling in of all cut-offs to a distance of 200 ft. from either river bank and the leveling of the deposited material to a grade 4 ft. above the average meadow level was required by the contract under the price paid for material dredged. The former has been done so far by the use of men, teams and wheelbarrows and was stopped in the fall of 1913 when the meadows became too wet for that work. The latter has been done by use of the hydraulic sluicing boat and was stopped in December, 1913, when the weather became too cold for operation of the gasoline engine.

WORK ACCOMPLISHED BY THE ORANGE PEEL BUCKET DREDGE.

The orange peel bucket dredge covered the river channel in the Hyde Park district from the railroad bridge north of Fairmount Ave. through the foot bridge at B St. near the plant of the American Tool Co. The work has been completed between the above limits with the exception of a small amount of dragging yet to be done under the single arch concrete highway bridge at Fairmount Ave. and under the double arch concrete highway bridge at Dana Ave. The total distance is about 3,886 ft. or about 0.73 miles. The yardage has approximated to an average of 4.76 cu. yds. per foot of river center line. The downstream terminal of this work was at the plate girder bridge of the Midland Division of the New York, New Haven & Hartford R. R. below Fairmount Ave. in Hyde Park. Four bridges were encountered above that one—the highway bridge at Fairmount Ave., the plate girder railroad bridge above Fairmount Ave., the highway bridge at Dana Ave. and the reinforced concrete foot bridge at B St. This section is fairly closely settled and all of the material deposited upon the banks was required to be graded and leveled. Many trees had to be cut down or trimmed. Two sets of old pile bents had to be removed, one on each side of the railroad bridge above Fairmount Ave. The city of Boston installed four new brick catch basins of the largest type to prevent the deposit of material in the river from four surface drains from the steep slopes of the Fairmount Hill and Mount Neponset districts. The New Haven Railroad removed the old stone center pier in the bridge north of Fairmount Ave. and replaced it with a new concrete pier running down about 4 ft. deeper to allow us later to get the hydraulic cross section required at that bridge.

Less than 5 per cent of mud and silt deposits were encountered here, the balance of the material being coarse, clean river gravel of varying grades of compactness and with many large and small boulders embedded in it. Much debris was removed in this section.

During the period of twelve months, the orange peel bucket dredge was held up, aside from all other minor causes, for passing under the above four bridges. In each case this required the knocking down of the dredge below the bridge and its re-rigging above. As it was designed and built with these difficulties in mind, the lost time was reduced to a minimum. As each bridge had to be dragged under first to secure sufficient water depth for the passage of the hull, additional time was lost for the special rigging required for dragging. It was decided that a dipper dredge would not be as satisfactory as the orange peel type, largely on account of the many bridges to be encountered. In the compact gravel met with, however, the rate of progress by the orange peel bucket dredge has been relatively slow but the results have been extremely satisfactory in the accuracy of the channel obtained, its conformity to the base and side slope lines given being rather unusual.

The data contained in the Tables I to III have been very carefully compiled and refer to the operating records and labor and coal costs for both dredges, individually and combined. The figures on labor and coal costs for work under the conditions prevailing in this particular contract are given for their own isolated value as contributing to the fast accumulating volume of authentic cost data and are to be interpreted from that standpoint. The labor and coal costs on this work actually represent but a small part of the total actual cost to the contractor in carrying out the terms of his agreement with the Commonwealth of Massachusetts. The repair and maintenance charges have been unusually high and the plant installation costs on an inland river, with no direct connection with tidal water, have been largely in excess of the costs of installing a similar plant for harbor or tidal river work. Also, as stated above, no allowance has been made for interest and insurance charges, depreciation of plant and machinery, nor for the important item of "overhead charges."

Acknowledgment is made here of the courtesy of the Barge Canal Construction Co. in allowing access to their labor payrolls. That company is now composed of Mr. George W. Beeman, who has recently completed several dredging contracts in the State of New York and has others under way there at present, and Mr. Charles Longenecker, of New York city, a designer and constructor of dredging and stone crushing machinery. Mr. O. S. Proctor is the company's superintendent for this work.

The Neponset River Improvement is under the supervision of Mr. X. H. Goodnough, Chief Engineer of the Massachusetts State Department of Health, with the writer as Engineer in Charge in the field with local offices in Hyde Park. The engineering assistants are Mr. Newton L. Hammond, Principal Assistant, and Mr. Harry S. Wright, Mr. William G. Norteman and Mr. Chester C. Topham.

(Editor's Note.—At the time of publishing the above article we are advised that the work of improving the Neponset River will probably be completed early in 1915, the Massachusetts Legislature having appropriated an additional sum of $10,000 in July, 1914. Very nearly 90 per cent has been finished at the present time.)

Decision in Sewer Case.—An opinion handed down by the Circuit Court at Towson, Md., recently, set aside an order of the Maryland State Board of Health, which demanded that the county commissioners build a sewerage system at Govans, Md. The order was issued Oct. 23, 1914, and the commissioners filed a petition asking the court to vacate the order. In the opinion the court deems that the order was unreasonable, and that such systems should be built under local law.

The act of the last legislature, by which the State Board of Health was given full authority to issue such orders, provided for bond issues, and the court holds that this is unconstitutional. The court also holds that the act of 1912, giving the county commissioners the right to construct sewerage systems subject to the approval of the State Board of Health, is still in effect. The decision will result in tying up all sewerage work under the state law throughout the state until the question is settled by the Court of Appeals.

SEWERAGE

Design, Construction and Cost of New Sewage Disposal Plant at Aberdeen, S. D.

Aberdeen, S. D., is a prairie town of 12,000 population, four square miles in area, with an extreme variation in elevation of 15 ft. The only stream available for sewage discharge is Moccasin Creek, a small, sluggish stream. Both storm and sanitary sewage discharge into this creek, and for the larger part of the year the only current in the stream is from this flow of sewage, increased from the waste and overflow from the artesian wells from which the entire city water supply is drawn.

Aberdeen, being in the artesian belt of South Dakota, derives all of its water, both for the municipal supply and for a large number of private supplies, from artesian wells. The pressure from these wells is very high, the static pressure amounting in some instances to as much as 240 lbs., while the hydrant pressure around town usually runs about 60 lbs., with a night pressure sometimes up to or over 100 lbs. One city well of 8 ins. diameter gave at first about 2,300 gals. per minute discharge from a depth of 1,270 ft. Many of these wells of smaller size are left flowing all the time, and because the storm sewer system is as yet very limited, this overflow goes into the sanitary sewers, thus greatly increasing the volume to be pumped and purified. Aside from this the sanitary sewers contain very little except domestic sewage and the wastes from several laundries.

The present article describes the design and construction and gives some unit costs of the new sewage disposal plant. The information given is from a paper before the Western Society of Engineers by W. G. Potter, which is published in full in the journal of the society, Vol. XIX, No. 8, October, 1914.

THE OLD DISPOSAL SYSTEM.

The system in use heretofore was as follows: All sewage had to be pumped. The pump station was located within a mile of the business district, and the sewage of the city was collected at this place in a 36-in. concrete sewer about 25 ft. deep. From this main the sewage entered three concrete wells inside the pump house, each 8 ft. in diameter, and each extending about 5 ft. below the 36-in inlet pipe. In these wells were three centrifugal pumps, operated not continuously, but with periods of rest lasting not over three hours, during which the sewage rose some 10 ft. or more in the wells and backed up in the main sewer correspondingly. The pumps were all submerged and hard to get at for repairs. They were operated by a vertical shaft and belted to a countershaft under the floor. The engine was a 55 H.P. Muenzel gas engine, deriving its power from one 60 H.P. and one 100 H.P. gas producers. With this engine the sewage was lifted about 19 ft., run through a 16-in. force main about 1,000 ft. and then again lifted about 10 ft. into the septic tank. This tank was of concrete, partly with flat concrete roof and partly covered with a concrete block building. The windows and doors were all boarded up, and there was absolutely no ventilation, with the result that in places the concrete was entirely disintegrated by the sewage gases, leaving holes through the roof. There was no further treatment, and the sewage entered the stream almost as foul as it entered the tank, this pollution continuing for a mile below the outlet of the stream and emitting an odor that often reached the residence district. Both the pump station and the septic tank were of poor concrete or concrete blocks, and as the former was in a dangerous condition it was considered advisable to build an entirely new plant.

THE NEW DISPOSAL SYSTEM

The new disposal system was planned to consist of a new pump house with larger pumping capacity, a force main to the new plant, a sedimentation tank, a sprinkling filter, sludge filter, and final settling tank.

The location decided upon was about two miles south of the town at the junction of Moccasin Creek with another small stream, Foote Creek, where some little additional flow would be obtained, at least in the spring and in wet seasons.

Pump House.—Because of the concrete pump wells and the main sewer being in good condition it was decided to locate the new pump house upon the site of the old one. The problem became to remove the old building, erect the new one, put in an additional engine and producer, put in three new pumps, and change the position of the old engine and producers, and still keep the pumps going with no shutdown of over the three-hour period. The first thing done was to remove the old building and erect the new one with the walls on new foundations just outside the old ones, thus making the new building slightly larger than the old one. This new building was made of brick with concrete roof on steel girders. Then the old pumps were removed one at a time, the wells were filled with concrete to the grade of the incoming sewer, and cast-iron inlet pipes and gates were concreted into the old terra cotta inlets. Connected with these inlet pipes are the three pumps—one 8-in. and two 10-in. Lawrence centrifugal pumps—so that all will be operated in the dry, and easily accessible for repair. Each pump has a vertical shaft running to a beveled gear connection with a horizontal shaft above the floor. This horizontal shaft is built in three sections so that either pump may be operated independent of the other. By direct belts this horizontal shaft is connected to the old 55 H.P. and the new 100 H.P. engines. Both are of the Muenzel type of gas engine, built by the Minneapolis Steel and Machinery Co. The horizontal shaft is also connected to a 30 H.P. motor for emergency, and this receives its power by wire from the Aberdeen Light and Power Co. In the producer room of the pump house the old producers have been changed in position and a new producer and wet scrubber added. Adjoining the producer room is a hopper-bottomed coal room, from which the coal is elevated to a point above the producers and distributed to each. Another room is equipped with a forge and small tools for repairing, cutting pipe, etc., for the city forces. A soft-water well of 2-in. size, about 1,000 ft. deep, was bored to furnish water to the producers, as it was found that the hard water from the deeper wells had a corrosive effect on the steel pans.

The reason for continuing the use of the producer gas engines was that this method has been very successful and very cheap for the old plant, and we did not wish to discard the old machinery. While I can give no accurate cost figures for the operation of the pumps, the cost has been within 1½ cts. per kw.-hr., against a 6-ct. rate from the light and power company for electricity. The pumpage from the new station will be continuous instead of periodical.

Force Main.—From the pump station the new system will utilize about 300 ft. of the old 16-in. force main, and will then connect to the plant with a new 14-in. main about 9,400 ft. long. The pumpage through this main will be normally about 1,500,000 gals. per day, which will give a barely self-cleansing velocity. It is considered that this pipe will carry the sewage without excessive friction until the discharge is about doubled, when another parallel pipe will be necessary. The force main is laid on a gravity grade from the pump station to the plant with a by-pass at the plant, so that in case of not being able to pump into the plant at any time they could either pump through the main to the stream, or they could empty the main entirely by force of gravity.

Sedimentation Tank.—The sedimentation tank is rectangular in shape, 64 ft. by 73 ft. outside, and consists of three units, any one or all of which may be used at one time. Each unit has three pockets 20 ft. by 23 ft. at the top and 2 ft. by 5 ft. at the bottom, in the shape of an inverted square pyramid. Suspended angle walls form the upper story from which the sludge falls into the pockets. As the sewage is almost altogether domestic in quality, no grit chambers are used, and the entrance of the sewage will be at one end of the tank only, through a 14-in. pipe in each unit from the force main, this pipe turning up inside the tank to a point about 6 ins. below the flow line. The depth of pockets and of sewage will be 17 ft. The flow line of the tank is about 10 ft. above the natural ground line. The outside walls of the tank are 15 ins. thick at the coping near the top and 24 ins. at the bottom, with piers extending well below the frost line at the corners and at the intersection of the unit walls with the pocket cross walls and outside walls. All are heavily reinforced. Above the coping of the outside walls the concrete is 3 ft. high and about 8 ins. thick, with a facing of brick outside. Above the concrete is a building of brick and hard-burned tile for the purpose of keeping the sewage warm and accessible during the winter. This building covers both the sedimentation tank and siphon tanks, and has a roof of wood construction supported by posts on the unit walls and covered with Carey roofing. Ventilation is secured by means of doors, windows and three ventilators in the roof.

No waterproofing was necessary, except painting the inside surfaces with asphalt paint. Very few seeps were found on filling the sedimentation tank, and those were caused by water following the wires used in holding the forms together. All seeps were easily stopped by using a little pitch on the inside at these places.

Each pocket has its sludge pipe and an 8-in. valve, and the pipes from the corresponding pockets in the three units combine, forming three main sludge pipes which extend through the east wall of the sedimentation tank to the sludge filter.

The Sludge Filter.—The sludge filter is located 30 ft. east of and parallel to the sedimentation tank. It is 32 ft. by 67 ft. in size, uncovered, and built of plain concrete with 12-in. walls. It is laid with a 6-in. floor, in which are shaped concrete drains about 5 ft. apart. The walls of the filter come up to about the natural ground line, and the depth is 4½ ft. at the north end and 5 ft. at the south end. The filter material consists of about 18 ins. of crushed stone from 2 to 4 ins. in size, above which is 12 ins. of coarse gravel. The three mains from the sedimentation tank enter the filter just below the top of the wall on the west side, and each divides into a system of 4-in. cast-iron laterals supported on piers just above the surface of the gravel. Each of these laterals is slotted for nearly its full length and open at the end to facilitate cleaning. In operation, after receiving the charge from the sedimentation tank, the sludge is allowed to dry on the filter. The liquid filters down to the sub-drains and is carried away through a 12-in. main to the filter by-pass, and runs through that around the outside of the sprinkling filter to the filter trough, thus getting the benefit of passing through the final settling tank. To facilitate removal of the dried sludge two tracks of 24-in. gage for industrial cars are laid on concrete piers over the surface of the filter. The dried sludge will be spaded by hand into the cars and then removed to low ground and used for filling material.

Siphon Tanks.—The liquid, after passing through the sedimentation tank, passes over an 8-ft. weir in each unit, and into a trough, from which it goes through two 18-in. sluice gates into the two siphon tanks. These are adjoining the sedimentation tank, and are covered by the same building. They are each 16 ft. square at the top, with three sides sloping, 10 ft. square at the bottom, and are fitted with a 14-in. Miller siphon of 5 ft. maximum discharge depth. Each one of the siphon tanks contains about 7,000 gals. when at discharge depth, and when running together each will discharge about once in 15 minutes. Veeder trip counters will be used with float attachments to register the number of discharges of each siphon.

The siphons discharge into a 14-in. main between siphon tanks and sprinkling filter, and branch 14-in. mains enter the filter in two places. By control of the gate valves either siphon may be used for either half of the sprinkling filter, or all of it; and, if necessary, the discharge of the siphon may by-pass the filter altogether and come into the final settling tank.

Sprinkling Filter.—The sprinkling filter is 143 ft. by 209 ft. inside, with plain concrete walls 8 ins. thick at the top and 16 ins. at the bottom. A 6-in. concrete floor is laid throughout, and in it about 4 ft. apart are 8-in. terra cotta half tile sub-drains. Each sub-drain has a flat concrete cover 18 ins. long, 10 ins. wide and 1½ ins. thick, with two ribs which raise it 1½ ins. above the floor to allow the water to enter. These covers were designed and cast in Aberdeen, and were well seasoned before using. The filter floor has a fall to the south of 1 ft. in the width of 143 ft. On this floor crushed granite of 2 in. to 4 in. in size was spread to a depth of 5½ ft. at the north end and 6½ ft. at the south side. One hundred and seventy-two carloads of rock were necessary to fill the filter to the required depth.

The 14-in. main distributer enters the filter from the siphon tank in two places, each controlled by its gate valve. These mains run south through the filter on concrete piers about 1 ft. above the floor. Every 13 ft. on each main a 6-in. lateral extends east and west, and at each 13 ft. on each lateral is a 3-in. riser pipe, on which is a Taylor square nozzle. There are 88 of these nozzles on each main, or 176 altogether in the filter. Each lateral is laid on a grade to drain to its main, and each main drains to the south end. There each main has a 2-in. drain running to the filter trough, which may be opened by a stopcock, thus draining the entire distribution system if necessary at any time.

On account of the usual extreme cold during the winter season some precautions were necessary to prevent freezing of the nozzles and filter. For this purpose concrete piers were built midway of the nozzles and 13 ft apart in each direction. On these piers, rising above the surface of the stone about 6 ins., 4x4-in. posts were erected with 4x6-in. stringers across the post tops, and on this framework a temporary winter cover of 2-in. plank is laid. The plank cover only will be removed during the warm season, the framework being left in place, although this framework is so built as to be removable without drawing a nail. This roof is of a flat hip roof construction, with 3 ft. rise to the center. All wood used on this was painted with a wood preservative before using.

The sprinkling filter covers 0.68 acre, and with the present normal flow of about 1,500,000 gals. per day it will have a loading of about 2,200,000 gals. per day per acre.

Collecting Trough.—Running along the south side of the sprinkling filter, and separated from it by the filter wall only, is the collecting trough. It is 3 ft. wide, with a floor slightly below the filter floor; the outer wall is about 4 ft. lower than the filter wall and comes up only to the ground line. Arches are built in about 25 ft. apart over the trough to counteract earth pressure from the outside.

All of the filter sub-drains pass through the filter wall and empty into this trough. At the east end of this trough also the filter bypass mentioned above enters, carrying the water from the sludge filter and from the siphon tanks in case the filter should for any reason be put out of service. Likewise, the force main by-pass has a connection by which the entire plant above this point could be put out of service, if necessary, and still give the sewage the benefit of the final settling tank. This trough could also, in case of a typhoid epidemic or similar trouble, be used for a hypochlorite trough. After the liquid passes into this trough it flows from either way to the center, and then through a covered trough to the final settling tank.

Final Settling Tank.—This is a plain concrete tank 63 by 103 ft. in size, divided into two parts by a middle longitudinal wall. From the collecting trough the flow enters a shallow, reinforced hanging trough, the flow into either half being controlled by a gate. From this trough it passes over a weir the entire width of the tank to the tank proper. Here it passes slowly through under several reinforced baffle walls to the outlet end. The tank is about 4 ft. deep below the flow line, and it takes the normal flow about two hours to pass through, thus allowing the suspended solids a final chance to settle to the bottom. The floor of the final tank is below the outfall creek, and when either compartment is emptied for cleaning it will have to be done by gasoline pumps. From the final tank the effluent passes over two weirs in each half into a final trough, and from there through about 200 ft. of 20-in. terra cotta pipe to the final outfall into the stream.

HEAD CONSUMED THROUGH PLANT.

The elevation of the main sewer at the pumping station is about 74. The sewage is pumped up to elevation 100 at the flow line of the sedimentation tank. The discharge of the siphon tanks is at about 99.5 and the elevation of the sprinkler sprays is 91.5. The floor of the sprinkling filter is 84.5 at the south end, the flow line of the final settling tank is 84.0, and the grade of the pipe at the final outlet is 83.2. This makes a total head consumed in the disposal plant of 16.8 ft.

AUXILIARY WORK.

Part of the auxiliary work connected with the proposition was the construction of two small reinforced dams across the two streams for the purpose of preventing the backing up of the effluent towards town in case of a south wind and no current. A 2-in. artesian well was also bored about 1,000 ft. deep to furnish water for construction and for other uses. A living house was moved from the site of Aberdeen's new city hall, about three miles to the disposal plant, set up on a concrete foundation and remodeled. It was connected with the well and given sewer connection, and is being used by the caretaker as a residence.

About 1,800 ft. of railroad track was put in by the M. & St. L. Railroad to facilitate unloading material.

CONSTRUCTION AND COST.

All concrete was composed of Northwestern States Portland cement and pit-run Kampeska gravel, in proportions varying from 1 to 4½ to 1 to 6. This gravel was taken from below the water of Lake Kampeska, about 100 miles from Aberdeen, and is remarkably free from dirt or other foreign material. It made a very dense and solid concrete.

In construction a 35-ft. tower was erected between the main sedimentation tank and the sludge filter, and all concrete for these and for the siphon tanks was spouted from the tower to position. Gravel and cement were brought to the mixer by Koppel cars. The concrete was raised in the tower and the gravel was drawn up an incline to a pocket above the mixer by the use of one team.

For the sprinkling filter and the final tank the mixer was erected along the railroad spur and all gravel was shoveled direct from the railroad car to the mixer. The concrete was run from the mixer into Koppel cars on 24-in. gage tracks, and pushed by hand to the place of dumping. The crushed stone for the filters, of which 175 carloads were used, was unloaded mostly by rigging up a block and tackle so that a drag scraper could be pulled lengthwise of the car, dumping at the end over a trip into a Koppel car beneath. This arrangement cut the cost of unloading and moving the stone into position by about 50 per cent from unloading by hand.

Labor was paid 22½ cts. per hour at first, followed for the most of the work by 25 cts. per hour, and was very hard to get during the summer and fall seasons. Form carpenters were paid from 35 cts. to 45 cts. per hour, and brick masons from 70 cts. to 80 cts. per hour.

The total cost of the plant is about $130,000, of which about $20,000 is for reconstruction of the pump house and its new machinery, $9,000 for land and right-of-way costs, about $20,000 for the force mains, $17,000 for crushed stone, and the balance for concrete materials, labor, etc. The bond issue for this work was $200,000, so that there is an unexpended balance of $70,000. Sewage was started through the new plant about April 1, 1914.

The entire work, excepting part of the excavation, part of the pipe hauling and the construction of the pump house building above the foundation, was done for the commissioners of the city of Aberdeen by city forces without contract, Mr. Potter being the designing and constructing engineer, and W. D Northen of Chicago the general foreman Most of the changes of machinery in the pump station were made by Mr. W. F. Hoberton, superintendent of water and sewers at Aberdeen. It is a good example of non-political municipal work, and politics was one of the incidental troubles that was entirely absent from this work.

The cost of concrete work ran from $3.25 for the concrete floor in the sprinkling filter up to about $8.25 on part of the reinforced concrete work. The cost of unloading stone in the sprinkling filter at first ran from 45 cts. to 60 cts. per cubic yard. This was later cut down to 19 cts. to 24 cts. per cubic yard by working the drag scraper lengthwise of the car and dumping through a trap into Koppel cars. Most of the cars used were gondolas. The average final cost was about 32.4 cts. for unloading stone from the cars and putting it in place in the filter.

The sprinkling filter cost $35,000, including the rock in place. The rock amounted to 5,500 cu. yds. The rock cost was $2.96 per cubic yard f. o. b. cars. The cost of unloading it, including placing, was about 32 cts. per cubic yard. The sedimentation tank cost $13,000. These figures are approximate only. The siphon tank cost $1,500, the sludge tank $2,000, and the final settling tank about $4,000. The pumping station, including the new machinery and changing the position of the old machinery, cost $25,000. The cost of land was $9,000 for 80 acres, of which about three acres are in use.

Recommended Procedure in Disposal of Wastes from the Stockyards and Packingtown in Chicago.

A report on industrial wastes from the stockyards and Packingtown in Chicago has just been made to the engineering committee of the Sanitary District of Chicago. The report contains about 350 pages devoted to the study of the packing industry, its units and its wastes, and to a project for the improvement of the famous Bubbly Creek into which sewage from Packingtown is now discharged. The report, which is preliminary, is based on a study extending over three years. The full report will be of great value to all interested in the treatment of industrial wastes. We give an abstract of its summary and conclusions.

The original testing station layout was equipped with a coarse screen with ⅝-in. clear openings, a 2-in. centrifugal pump, a grit chamber, an Emscher and a Dortmund tank. To this has been added a fine-mesh rotary screen of the Weand type, having 30 meshes to the inch; a sprinkling filter and a chemical precipitation tank with devices for mixing and applying chemicals. A screen testing device was also added, as well as sedimentation cans.

The crude sewage tested is very strong, containing large amounts of both suspended and soluble matter. At different hours of the day the strength varies greatly, according to the discharge of wastes from the stockyards and Packingtown. Night and Sunday strengths are practically identical. The sewage was weakest during spring and summer and strongest during late fall and early winter. The biologic oxygen consumption of this crude sewage (daytime strength) was roughly 1,000 p. p. m. The corresponding figure for crude purely domestic sewage was 100 to 150 p. p. m.

At present there is practically no treatment of the industrial sewage from Packingtown other than a partial removal of fat by grease-skimming basins. The basins are seldom built to retain settling material, except at the hog houses, and then are insufficient. The screens in use are very coarse and hold back little except intestines.

GENERAL CONCLUSIONS.

The operation of the testing station has demonstrated that it is entirely practicable to treat to any desired degree sewage mixed from industrial and domestic origin as it issues from the sewer outlet. Of the devices tried fine screening, sedimentation in double-deck tanks, and sprinkling filters appear most suitable. The combinations are: 1. Fine screening. 2. Fine screening in combination with sedimentation. 3. Fine screening in combination with sedimentation, followed by biological treatment on sprinkling filters and secondary sedimentation.

Under any circumstances the removal of settling suspended matter from industrial wastes is needed. Fine screening alone does not appear adequate to meet this test. In almost every case screens can be installed at the individual houses, and on the fresh sewage will undoubtedly be more effective. Hence screening appears to be an individual problem for each house or firm. Sedimentation requires more space, both for equipment and disposal of sludge, and hence is best handled as a community problem, because at most houses space is lacking.

In any case, fine screening is the logical first step to remove the coarser suspended matter, and will fit with sedimentation in that it materially reduces the scum-forming material.

Ultimately biological treatment of industrial wastes is a necessity. Sprinkling filters followed by secondary settling tanks seem most desirable. But with a gradual installation opportunity is afforded on a large scale to watch the effect of the removal of suspended matter from a gross source of pollution. Preliminary screening and settling are necessary as a preparatory treatment for sprinkling filters, and would be advantageous in the operation of a long intercepting sewer by preventing deposits from a sewage so heavily laden with settling suspended matter.

From the sanitary standpoint the filling of Bubbly Creek would be desirable, although mere filling alone would simply transfer the nuisance from one locality to another. With suitable treatment of the industrial wastes it is entirely proper that this channel be filled and that the area thus reclaimed be used as a site for sedimentation tanks.

Consideration of various alternatives led to the belief that the best project comprises an intercepting sewer for industrial wastes and domestic sewage, fine screening at the individual houses or firms, sedimentation at the outlet of the intercepting sewer in a community plant built in the present bed of Bubbly Creek, and an outfall sewer to the Thirty-ninth street conduit for the effluent from the treatment plant.

Such a project for screening and sedimentation handles the wastes as separately as possible, with the presence of some domestic sewage, and is flexible with regard to the future.

The ultimate solution will require biological treatment. As space is lacking in the immediate vicinity of Packingtown, this means an extended intercepting sewer running westward from the outfall of the sedimentation plant, which would carry the screened and settled sewage to a pumping station where the sewage would be pumped onto sprinkling filters. The effluent would require settling in secondary settling tanks. Sludge drying beds, an outfall sewer, and other collateral works are required. This fits directly onto the settling plant just described. Screening and sedimentation are necessary as a preliminary treatment, and will materially aid in maintaining the intercepting sewer free from deposits.

The results observed at the testing station do not indicate hope of recovering much material of value, from the commercial standpoint, other than grease. It is possible that use may be found for the sludge as filler for fertilizer, and that the screenings may be burned. The smaller houses should endeavor to save all offal or other material now reaching the sewers, which is saved by the larger houses, by some co-operative arrangement. The chief object to attain, however, is not commercial recoveries, but the destruction of a nuisance of long standing.

The report represents the work of the sanitary division which is under the direction of Mr. Langdon Pearse, division engineer. Mr. George M. Wisner is chief engineer.

ROADS AND STREETS

The Cementing Value of Bituminous Binders and Results Obtained in Some Commercial Tests.

A modification and improvement of the ductility test for bituminous road materials has been made by Lester Kirschbraun which is described fully in the Journal of Industrial and Engineering Chemistry, Vol. 6, No. 12, page 976. A portion of his paper is given here.

PRIMARY CONSIDERATIONS.

During the past ten years there has been a great development in the methods of valuating paving bitumens. Early attempts at determining these values were directed towards chemical determinations of properties or constituents which were thought to have an influence upon the quality of materials of this kind. Later developments have indicated that, with few exceptions, the valuable properties of paving materials are included more directly in their physical characteristics. The present status of the determination of paving values includes physical tests as the more important ones, leaving a few chemical tests directed towards determining the permanency of these products, asd the care with which they have been prepared.

It will be generally agreed that a most important, if not primary physical property, which paving bitumens must possess is that of cementitiousness. For a long time efforts have been directed towards devising a means of measuring cementitiousness of bituminous binders, but so far nothing has been offered in this direction which has met with general approval. Among the tests commonly employed, that of ductility has been assumed to measure, or to be, in a general way, an indication of cementitiousness. While possibly there is some relationship between ductility and the cementing value of a given type of bitumen, it will be admitted that no mathematically direct relationship, if any, exists at all. So far, then, as our present means of determining cementing values are concerned, this most important feature must be arrived at by indirect interpretation of data which afford no exact means of determining such values.

DEVELOPMENT OF TEST.

The writer has for the past four or five years directed his attention to the development of a method for directly and mathematically expressing the cementing value of plastic binders. Various means have been employed in the effort to determine this factor, but all have been discarded as it developed that they fell short of measuring the properties sought for. The writer has, at various times, devised bending or shearing tests; has investigated the tensile strength of briquettes of binders and mixture of same with mineral particles; has investigated the strength of briquettes joined together by films of binder, and has experimented with methods of determining adhesiveness and cohesiveness. These various attempts, while in some cases giving valuable information, have failed, either through the inability to devise a means of obtaining concordant results, or for the reason that the properties actually measured in these efforts did not directly represent the cementing value property sought for. For example, in making tests of briquettes of non-bituminous material stuck together with a film of binder, it is not only difficult, if not impossible, to obtain concordant results on account of variations in thickness of film, etc., but results obtained do not measure binding value, but measure cohesiveness. When tests of this kind are made, the briquettes fracture with a cleavage, leaving a film or part of a film on either end of the briquette. The property so recorded is *cohesiveness* or the ability of the material to stick to itself. Any method which measures strain endured by the film of asphalt in detaching itself without cleavage or fracture from a foreign surface measures *adhesiveness.* In either case, the operation fails to determine the cementing value or the ability of the material to bind particles together under the conditions of service.

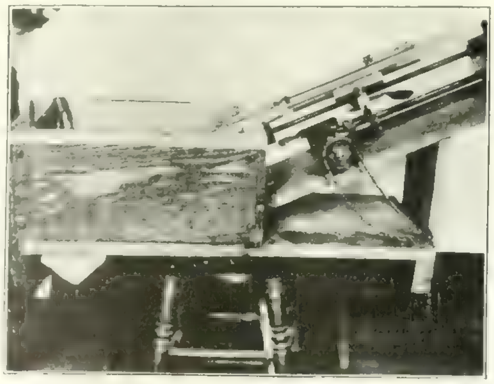


Fig. 1. Apparatus Used in Making the Cementing Value Test.

Cohesiveness.—If we analyze the results obtained upon a number of materials through a series of tests for tensile strength (meaning in this case the maximum strain endured in fracturing a briquette of bitumen) we shall find that two different materials may sustain the same maximum stress and indicate the same cohesiveness, but that one material will sustain this strain for but a short time before fracture, while another material will not only sustain the same maximum strain, but will endure it during a longer period or through a much longer distance of elongation. For example, a given type of asphalt cement at a certain penetration will, during application of strain, withstand a maximum of say, three units before fracturing. Another asphalt of certain penetration will withstand the same strain. In the former case, however, after this maximum is reached, an appreciable strain can be sustained for many times the elongation that may be sustained with the latter material. Cohesiveness results in such cases would indicate equality, but as a practical consideration, the latter material might be entirely unfit for paving purposes, and even from superficial observation might not indicate nearly the cementing qualities of the former. Such results, then, not only become misleading and contrary to practical observations, but fail entirely to give us an indication of the property sought for.

Adhesiveness.—The adhesiveness of bituminous binders may be determined by means of a suitable apparatus. While the adhesiveness is a matter of importance in the effectiveness of bituminous application to cold road metal by pouring process, nevertheless, in considering hot mechanical mixtures, the adhesiveness appears to play little part in holding together the mineral aggregate. When asphalt pavement cracks or fractures or displaces, an examination of the points of fracture discloses that the films of bitumen coating the particles have fractured or cleaved, and not that the bitumen has pulled off the mineral particles through lack of adhesiveness. In other words, the adhesiveness is always greater than the cohesiveness and the binding value. No mechanically measured results of adhesiveness need therefore be considered as a factor in this discussion, although the adhesiveness is a factor in considering pavements built by penetration method.

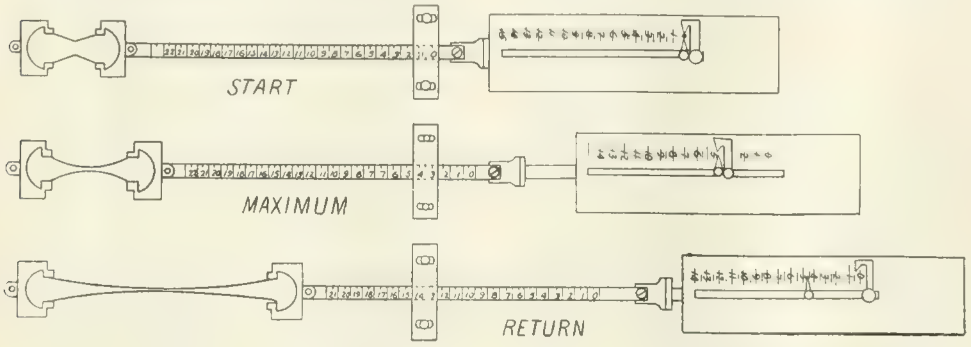


Fig. 2. Position of Briquette and Dynamometer at Various Stages of Test.

Basis of Test.—What, then, represents the cementing value of a material of this kind? Cementing value must mean the ability of the bitumen to bind, or hold together against rupture, particles of mineral matter which it coats or covers. Upon analyzing the conditions applying, it becomes evident that to break apart the bond between any two mineral particles held together by a coating of plastic bitumen a certain tension must be applied for a certain time or space of action. The application of a tension over a certain distance infers the necessity for the film of binder to elongate at the point of contact of the two particles. The actual amount of elongation may be extremely small, but the relative amount in proportion to the thickness of the coating may be very great. That elongation does necessarily take place must be admitted from practical experience which has taught us that a certain degree of plasticity or softness of our binders is essential to prevent cracking of pavements. The effect of advancing the softness of the binders is to favor their ability to yield and elongate under strains. Cracking is therefore minimized by superior ability of a soft binder to elongate over a hard binder of the samt kind. If this ability to elongate were not essential, and if it actually did not take place in the binder between the particles of aggregate, it is apparent that the hardest binders would be the best, as they would be capable of sustaining greater strains than the softer binders. It will be seen therefore that the ability to elongate is an essential feature, and must operate, otherwise our conclusions would lead us in the direction contrary to actual experience.

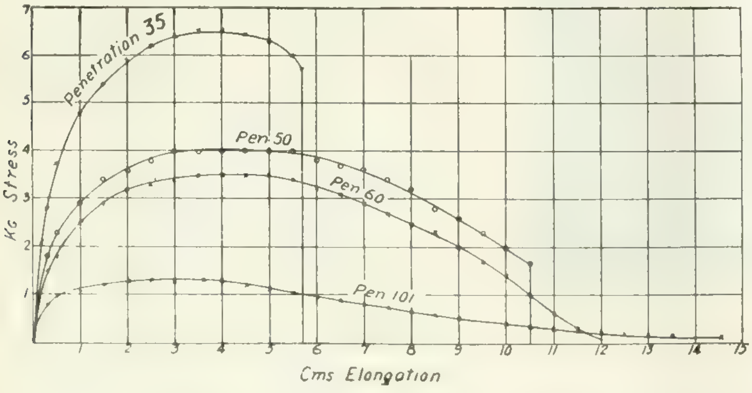


Fig. 3. Results Obtained from Same Material at Different Consistencies.

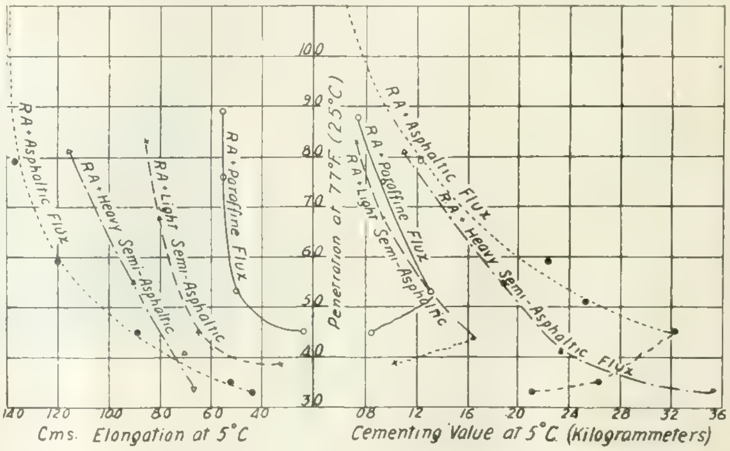


Fig. 4. Results Cbtained from Various Fluxes at Different Consistencies.

Referring again to our consideration of two particles of aggregate bound together, it is necessary, in order to produce fracture or to disrupt the bond, to apply a certain tension over a necessary distance. The product of these factors is work done. The binding value of a plastic binder is then limited to the amount of tension it can sustain over a given distance, or is directly proportionate to the work done in producing fracture or failure of a given unit of material.

APPARATUS.

An apparatus was accordingly devised for the purpose of recording the factors above mentioned, namely, strain applied over distance. The apparatus in its final form is shown in Fig. 1. It consists of a rectangular box insulated and lined with galvanized iron or copper. An inclined plane or runway is attached to the box, the lower end of which reaches the bottom of the box, and the other end projects an equal distance outside. This runway carries a carriage through which passes a screw actuated by a set of gears adjustable to the desired speed. Upon the carriage is maintained a dynamometer, to the end of which is connected a flat brass rod, which extends along the runway to within a few centimeters of the end, and of the bottom of the box. This rod is graduated in metric units, and passes under an adjustable bridge at which the readings are recorded during travel of the rod. The runway is edged with guides of sufficient width for the free passage of the briquettes. The arrangement and position of the carriage makes it possible to apply a tension through the rod in a straight line to briquettes at the lower end of the runway with the box filled with water. At the lower end of the runway is permanently fastened a small boss or projection to which one end of the briquette is attached, the other end being attached to the rod connected with the dynamometer. The position of the bridge gives readings of elongation of the briquette, regardless of the movement of the carriage and dynamometer. The form of briquette adopted is that commonly known as the "Dow" moulds which are used for making ductility tests. These moulds have a minimum cross section of 1 sq. cm.

In working out the method of manipulation, it was of course necessary to determine a constant temperature at which the test should be made. The temperature selected was 5° C. or 41° F. This was selected for several reasons. In the first place it was necessary to obtain sufficiently large readings upon the dynamometer. At normal temperatures, bituminous materials of this kind are ordinarily capable of withstanding but very little strain. Secondly, the strains which produce fracture and cracking in a pavement in actual service are greatest during cold weather. Again, a low temperature being necessary, the temprature of 5° C., was selected as being easy to maintain constantly with ice and water.

On account of the plastic nature of the material operated upon, and its tendency to elongate under strain, it was necessary to determine upon a uniform means of application of load. It was evidently impossible to set a uniformly increasing load for the reason that, as the material elongated, and its cross section became smaller, it would be necessary to rapidly accelerate the rate of elongation or travel of the dynamometer towards the end of the operation, in order to increase the strain. This would become impracticable as a matter of manioulation, and would be subject to large variation through personal equation and through inability to take the required readings sufficiently rapidly. It was found necessary after many trials to adopt a *uniform rate of travel of carriage and dynamometer.* This is in accord with practical conditions, inasmuch as any strain set up in a pavement would be induced at a variable rate of application, depending on the ability of various binders to yield or elongate without fracture. It is apparent that under the same conditions of volume change in a pavement a soft binder would yield and conform more easily to the necessary change, thereby allowing much less strain to be set up than with a hard binder.

Various trials were made at different speeds in order to determine what speed was most adapted to securing concordant results, and distinguishing to the greatest degree the differences between various materials. Speeds between 1 to 10 cm. per minute were tried upon the same materials. It was found that the higher speeds had a tendency to effect too sudden application of strain, and, with the harder materials, to produce fracture in the corner of the briquettes rather than at the point of minimum cross section. Again, at the faster speeds, it became difficult to take the readings near the time of fracture owing to the rapid travel of the rod and the pointer of the dynamometer. After various trials it was found that a speed of travel of the carriage and dynamometer at the rate of 1 cm. per minute provided to the greatest extent for the factors indicated above. It will be understood that in applying strain to the briquette by means of a dynamometer traveling at a uniform speed, the briquette has at first slight tendency to elongate under application of strain, until a maximum is reached, when the rate of elongation of the briquette exceeds the rate of travel of the carriage and dynamometer, at which point the dynamometer begins to register values below the maximum attained, until finally the briquette is either fractured at a reduced cross section through elongation of the material, or the dynamometer returns to zero without fracture of the briquette. An essential difference from the method of determining ductility is that during the entire period of elongation the material is under substantial strain. Ductility or elongation values that include the distance traveled by an extremely fine thread or filament of bitumen are misleading and immaterial.

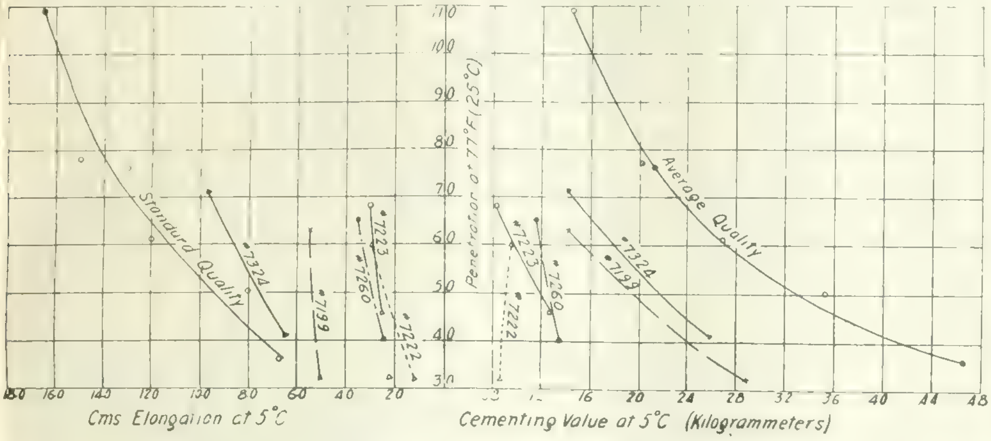


Fig. 5. Cementing Value and Elongation of Commercial Material at Different Consistencies.

In making the test, as finally adopted, the briquettes are prepared in the usual manner as for ductility test, and are placed in the test box at 5° C. They are held for about three-quarters of an hour at this temperature before making the test. When ready, one end of the briquette is hitched to the fixed post at the bottom of the box on the runway, and the dynamometer brought into position so that the end of the rod attached to same may be fastened to the other end of the briquette. The apparatus is driven mechanically, and the carriage is started by closing the split-nut which brings it into contact with the screw. When the end of the dynamometer begins to move over its zero mark, the bridge over the rod is adjusted to the zero mark on the rod. Carriage and dynamometer continue to travel at the rate of 1 cm. per minute, and readings of the dynamometer are taken at every half centimeter of elongation as shown by the rod. This is continued until the briquette fractures or elongates through its maximum back to zero strain. The dynamometer carries a maximum pointer and is graduated in tenths of a kilogram, and the zero mark is taken as one-tenth kilogram, which includes the weight of the briquette and the frictional resistance of parts. The position of the rod and boss are such as to lift the briquette slightly off the runway when the strain is applied, so that no friction results on this account during the application of strain. Fig. 2 illustrates the position of the briquette and dynamometer at various stages of test.

The results of the data obtained in these determinations may be graphically recorded. The distances elongated are recorded as abscissae, and the strain as ordinates. Fig. 3 gives a typical example of results obtained upon the same material of different consistencies under this method of test. The areas enclosed by these curves represent the product of the strain applied and the distance of its application, or the work done. The unit of value is expressed as kilogrammeters. This area may be obtained from the graphical plot of the result, or may be secured much more quickly, and sufficiently accurately, by addition of the ordinates. The readings are taken for every 0.5 cm. or 0.005 a meter. Every unit of ordinate therefore represents 0.005 kilogram meters, and the sum of the ordinates multiplied by this factor gives the area or the work done in kilogram meters. Expressed mathematically, the formula for calculating the result is $\Sigma Y \times 0.005$. This is sufficiently accurate for practical purposes. Referring again to Fig. 3, it will be noted that the same material at different consistencies requires widely varying amounts of work for failure. With the harder materials, a comparatively sharp curve is obtained, which reaches a certain maximum, and then becomes less as the material elongates faster than the carriage travels. When the cross section is reduced to a point at which it is unable to withstand the strain induced, it breaks. With the materials of the softer consistency there is a tendency of the curve to flatten and to become larger as the material is more plastic. A consistency is finally reached at which the material is able to progress through to its maximum and back to zero (or 0.1 kg.) without fracture. All tests were obtained in duplicate, and the results indicate a limit of accuracy of 0.02 kg. meter from an average, on the highest results, to a much closer agreement upon the lower values. Exception to this accuracy is noted upon the hard brittle materials, which are unable to elongate uniformly without setting up internal strain, due to the corners of the briquettes.

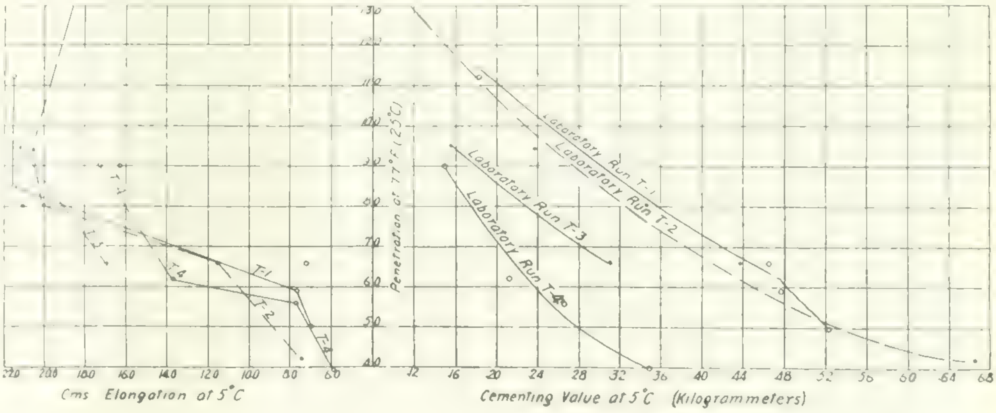


Fig. 6. Cementing Value and Elongation of Cracked Materials at Different Consistencies.

Having established a satisfactory method of determining the value sought for, it was desired to outline a series of investigations covering the following points:

1. Survey of the characteristics of commercial products with special reference to determining the degree of differentiation possible with the various materials.
2. The possibility of valuating fluxes by this method.
3. Test of the commercial products, the chemical characteristics of which indicate inferior preparation.
4. The determination of a possible effect upon cementing value induced by improper preparation upon a series of products made known under known conditions.
5. The determination of standards of value necessary for practical application.

TABLE I.—FLUX TESTS—FIG. 4.
Refined Asphalt and Paraffine Flux.

Pen. at 77° F.	Maximum strain.	Average.	Cementing values.	Average.	Elongation, cms.	Average.
45	3.9-4.0	3.95	0.082-0.083	0.083	2.5- 2.3	2.4
53	3.0-3.1	3.05	0.115-0.144	0.130	4.6- 5.0	5.0
88	1.7-1.7	1.7	0.072-0.075	0.074	5.5- 5.5	5.5
76	2.1-2.1	2.1	0.093-0.095	0.094	5.5- 5.5	5.5
R. A. and Light Semi-Asphaltic Flux.						
39	3.8-3.9	3.85	0.092-0.114	0.103	3.0- 3.7	3.35
68	1.5-1.5	1.5	0.096-0.096	0.096	8.2- 8.0	8.1
53	1.2-1.1	1.15	0.077-0.067	0.072	8.5- 8.5	8.5
41	3.0-3.0	3.0	0.188-0.141	0.165	7.4- 5.5	6.45
R. A. and Heavy Semi-Asphaltic Flux.						
34	5.8-6.5	6.15	0.325-0.379	0.352	6.5- 7.0	6.75
55	2.7-2.6	2.65	0.191-0.185	0.188	9.0- 9.0	9.0
81	1.3-1.5	1.4	0.105-0.121	0.113	11.5-12.0	11.75
R. A. and Asphaltic Flux.						
130	0.4-....	0.4	0.043-.....	0.043	14.0-....	14.0
79	1.4-1.3	1.35	0.119-0.125	0.122	13.0-14.5	13.75
59	2.7-2.6	2.65	0.246-0.198	0.222	13.0-11.0	12.0
45	4.1-4.2	4.15	0.316-0.327	0.322	9.0- 8.8	8.9
35	6.0-5.8	5.9	0.282-0.246	0.264	5.0- 5.5	5.25
51	3.6-3.6	3.6	0.254-0.249	0.252	8.5- 8.5	8.5
33	....	..	....	0.210	....	4.4

In order to take complete information of the characteristics of commercial products, it is necessary to collect such data as would represent a wide range of consistency for each material. The refined asphalt was accordingly used and fluxed with the kind of flux ordinarily used in practice. Determinations were made upon each material at a number of different consistencies, and these cementing values were graphically expressed as abscissae and the consistencies as ordinates. The various materials examined were grouped into three classes according to their origin. Record was made of the cementing value as determined by the data presented before, together with the elongation and the maximum strain sustained. (These data were included in the paper but are not given here.)

TESTS OF FLUXES.

Table I is given showing the results of investigations made in the effort to determine the possibility of valuating various fluxes. In this series of tests the same asphalt was used throughout, and was fluxed with different fluxes, the cementing values and other data being determined as indicated before.

Graphical results are shown in Fig. 4. It will be noted that the cementing values of these materials are progressively greater as the fluxes tend towards asphaltic base, with this exception that the paraffine combination shows slightly better values than the light-semi-asphaltic. This is due to the fact that much less paraffine base flux was used to produce the consistencies noted than in the case of the light semi-asphaltic flux. When, however, the elongation curves are examined, a progressive increase without exception is noted in ability to elongate as the fluxes used partake more of an asphaltic character. It will be noted that the ability to elongate would become even a more sensitive indication of the character of the flux itself than the cementing value. The practical necessity for considering this ability to elongate is aptly illustrated here. This refined asphalt used with paraffine fluxes has proven unsatisfactory in practice. Under light traffic, pavements laid with this have shown sufficient binding qualities to hold the mineral particles together, but the tendency to crack is very decided. On the other hand, this refined asphalt with light semi-asphaltic flux has shown, in a practical way, that the cracking tendency is greatly reduced in laying at a sufficiently high penetration, and it has been much more satisfactory than the previous combination, even though its cementing value is not greater. The material with the asphaltic flux and the heavy semi-asphaltic flux have been eminently successful under service conditions. It is evident from the above that the method described furnishes a means of determining the value of various fluxes and their suitability in asphalt combinations.

TESTS FOR POOR PREPARATION.

During the course of commercial practice, various materials have been encountered which gave indication, from analysis, of having been poorly prepared—so much as to warrant their rejection for use. A few of these samples were on file, and were available for cementing value tests. These materials were generally refined asphalts of from 30 to 40 penetration, reduced from liquid bitumen. They were subjected to the cementing value test at the consistency at which they were obtained, and then fluxed with the same asphaltic flux to a consistency corresponding to paving penetration, in order to afford comparison with normal products of the safe type. The determination of cementing value and elongation are given in Table II, together with the principal analytical characteristics.

These results are graphically shown in Fig. 5, and are given in connection with a curve showing the quality of an average acceptable commercial sample of material prepared from similar crude. It is evident from the study of these results that the chemical indications of inferior preparation shown by the high fixed carbon and per cent insoluble in carbon tetrachloride are confirmed by actual lowering of the cementing qualities, and elongation values.

TABLE II (FIG. 5).—CEMENTING VALUE AND ELONGATION OF ACCEPTABLE COMMERCIAL MATERIAL AND POOR MATERIAL.

No.	7199	Flxd.	7222	Flxd.	7223	Flxd.	7260	Flxd.	7324	Flxd.
Pent. at 77° F.	32	63	32	60	46	68	40	65	41	71
Duct. at 77° F.	60 cm.		4.5 cm.		7.5 cm.	....	7.0 cm.		1.2 %	.....
5 hr. loss	0.4 %		0.6 %		0.8 %	.....	....		65 cm.	.....
% hardening	25.0		25.0		36.9		....		43.9	.....
CS_2 soluble	99.7		98.9		99.0		99.0 %		99.7	.....
Mineral	0.2		0.2		0.2		....		0.2	.....
Difference	0.1		0.9		0.8		...		0.1	.....
CCl_4 soluble	97.0		90.0		94.4		95.9		97.9	.....
Fixed carbon	16.6		18.6		17.7	....	...		16.9	....
Cementing value at 5° C.	0.289	0.141	0.085	0.096	0.126	0.082	0.136	0.117	0.258	0.141
Elongation at 5° C.	5.0	5.5	1.2	2.9	2.5	3.0	2.5	3.75	6.5	9.75

In order to confirm the indications of lowering of cementing qualities with accompanying evidences of poor preparation, products were made in the laboratory from the same asphaltic base crude oil under known conditions. These were made in a small still, and were prepared at temperatures of 525°, 700° and 825° to 850° F. at the end of the distillation. Four runs were made, two of which were conducted at the last named temperature. In the first three runs, the materials were not pushed to a hard penetration, but of the last two runs at 850° F., one was pushed to a very hard consistency. In order to obtain an indication as to the comparative extent of cracking which took place, composite samples of the distillate were tested for gravity. In the first two runs, samples were taken from the still at various points of consistency indicated hereafter. In the fourth run, the material, as stated, was pushed to a very hard penetration and fluxed back with well prepared asphaltic base flux from the same crude. All of these samples were tested for cementing value, and those samples most nearly corresponding in consistency or penetration were examined for their main chemical characteristics. These results are given in Table III and are shown graphically on Fig. 6. On account of the insufficient number of points of elongation secured, no attempt was made to draw a smooth curve covering these points. Inspection of the above tabulated results shows that very little change or decomposition has occurred under 700° F., in running down to the consistencies noted. The material prepared at 850° F. gives evidences of substantial decomposition. This is indicated by a lighter gravity of distillate and falling off in solubility in carbon disulfide. The gravity of distillate in runs T-3 and T-4 hard are, of course, not strictly comparable owing to the different consistencies to which these were pushed. As a consequence of the decomposition that has occurred, there follows a substantial increase of fixed carbon *over normal*, and the conversion of part of the bitumen to a form insoluble in carbon tetrachloride. The differences between products obtained in the two T-4 runs show that not only is temperature a factor in decomposition, but also the degree to which the operation is pushed, or the degree of "concentration" resulting. This latter is in confirmation of the investigations made by the writer some time ago.

TABLE III (FIG. 6).—CEMENTING VALUE AND POOR PREPARATION.

Sample.	T-1	T-2	T-3	T-4 hard.	T-4 fluxed.
Temperature still	552° F.	700° F.	850° F.	850° F.	....
Gravity of distillate at 60° F.	21.2	21.2	26.2	25.6	....
Pushed to penetration	50	42	66	2	....
Fluxed to penetration at 77° F.	59	66	....	....	62
Ductility at 77° F.	115 + cm.	115 + cm.	102 cm.	....	57.0 cm.
Fixed carbon	5.5 per cent.	7.0 per cent.	13.1 per cent.	26.4 per cent.	15.2 per cent.
Soluble in CS_2	99.6	99.7	98.9	85.3	93.3
Soluble in CCl_4	99.6	99.7	97.5	67.9	87.3
Cementing value at 5° C.	0.478	0.439	0.311	....	0.212
Elongation at 5° C.	7.7 cm.	11.5 cm.	17.0 cm.	....	13.75
Melting point	.....	....	....	217° F.	....

It will be observed from the inspection of the graphical data that the most cementitious materials were produced at the lower temperatures, and that the cementing values decrease as the conditions of preparation become more severe. While the differences in cementing value between materials produced at 525° and 700° F. are slight, there is a substantial difference between these results and those obtained with the materials produced at 850° F., and between these latter, prepared at substantially the same temperature, but pushed to a varying degree of hardness. There is marked loss in cementing value in the material pushed to hard penetration and fluxed back, and the evidences of decomposition are very decided. In fluxing this hard material (T-4) back with well prepared flux, approximately equal quantities of flux were required to bring it back to 62 penetration. The effect of the introduction of so large a quantity of well prepared flux has, of course, minimized the loss of cementing value. Nevertheless, it is astonishing to note the persistency with which material prepared from this crude retains its cementing value even when badly decomposed; and although showing evidences in this direction which would cause its rejection under standard specifications, its cementing value has not been reduced below an acceptable minimum. As to whether or not materials so prepared, and possessing the characteristics of the last named product would *retain* the cementing value indicated, is a matter requiring investigation before any conclusion can be drawn as to the effect of the features noted. It will be seen, in referring to commercial products prepared from crude of this character, that the loss of cementing value is much greater with slighter evidences of decomposition than is obtained from the products prepared in the laboratory. No explanation of these variations is offered, aside from the indications given by these commercial products of having been prepared by other methods, than those involving straight distillation.

CONCLUSIONS.

It is evident that this method of determining cementing values is capable of distinguishing between products prepared with more or less care, and that a reduction in cementing properties follows as a consequence of decomposition occurring during preparation.

In the previous discussion, various commercial asphalts which have been used in paving work have been examined, together with their appropriate and inappropriate fluxes. There has also been observed the effect on asphalt derived from liquid bitumen, of improper conditions of preparation. It remains, therefore, to analyze the data obtained, in connection with practical results, and to determine, if possible, what cementing characteristics appear to be necessary for the successful binder. Discussion of this phase of the matter will be confined to only one form of construction, namely, sheet asphalt pavements.

From long experience with various materials observed in this discussion, and in segregating those binders which, in the writer's observations, have been successful and unsuccessful, certain tentative values may be set which should differentiate the successful or acceptable cement from the non-acceptable. Carefully considering this matter in connection with practical results, the lowest cementing value which is considered acceptable under conditions of light traffic is set at 0.08 kilogrammeters. This value, if taken alone, will include some materials which, although able under light traffic to bind the mineral particles in a sheet asphalt pavement together, are prone to develop cracking. As stated previously, it is necessary not only to consider the cementing value alone, but also to consider the ability of the binder to elongate, in order to prescribe those which have the property of holding together mineral aggregate without undue tendency to cracking. For light traffic, this elongation value is set between the limits of 8 cm. and 14 cm. for the pure bitumen. Below these values are found, in the writer's experience, unsuccessful materials for the class of construction referred to, and corresponding to these values are found those which have demonstrated satisfactory use under light traffic.

As previously indicated, pavements under heavy traffic require stronger and more cementitious binders with less need of these binders to elongate. It is difficult to describe accurately conditions which would be understood by all to be designated as heavy traffic. Keeping in mind, however, service records of materials laid under traffic, calling for a penetration of 35 to 40, with materials of the first group, the writer would prescribe for such traffic a minimum cementing value for the bitumen used of about 0.24 kilogrammeters, and elongation limits between four and six centimeters. Maximum limits of elongation are set as well as minimum limits for the reason that above the maximum limits of elongation, is the accompanying higher consistency, which results in too soft a cement under conditions of hot weather. These limits are, of course, suggestive, and will be modified according to the individual experience and ideas of those who might employ these tests. It is probable that an empirical formula may be devised giving the relationship between traffic units and cementing-elongation values in such a way as to indicate the necessary characteristics applicable for any intensity of traffic.

There remains another factor which may influence the valuating of materials in accordance with these characteristics, and that is, the possible rate of loss of cementing value which will be shown upon tests carried out over a prolonged period of time. As is well known, various bituminous materials harden with age and suffer marked loss of ductility upon standing, sometimes for comparatively short periods of time. It is likely that the materials here examined would likewise show variable rate of loss of cementing value and elongation with age, particularly those materials showing the effects of severe treatment in preparation. Data of this kind covering a period of time or indicating the same effect of accelerated tests will be of considerable importance in fully determining the relative values of various types of binders.

It is the intention of the writer to take up these phases of the subject, but owing to the time necessary to compile complete data, it is considered advisable to present the foregoing in the expectation that the methods employed may be improved upon by others interested, and that the features indicated may be simultaneously investigated by independent observers.

It is suggested that this test not only covers all of the data heretofore furnished by the ductility test, but in addition furnishes direct information as to the cementing values of the materials examined. The elongation values determined during the cementing value tests afford a more accurate and truly representative indication of ductility than the test usually employed. The elongation values determined by this method have an advantage of being taken at a temperature at which such properties come into play most effectively in pavements, and are recorded only while the binder is capable of withstanding an appreciable strain. These values are not clouded by the fine hair-like filaments into which bitumen is drawn at normal temperatures, and which have no significance in determining any valuable property. In addition, it is difficult, if not impossible, by the usual method, to differentiate between materials having a ductility in excess of certain limits fixed by the devices usually employed, which cannot be extended much beyond 100 centimeters with any significant results.

Analyses of Asphaltic Concrete and Asphalt Block Laid in Washington, D. C., in 1914.

Average analyses of asphaltic concrete mixtures used for paving work in Washington, D. C., during 1914 are given in the report of the Engineer Department of the District of Columbia for 1914. The specifications under which this pavement was laid were given in ENGINEERING AND CONTRACTING, Vol. XLI, p. 678.

ASPHALTIC CONCRETE.

During the year there were laid by the Cranford Paving Co. under contract about 57,833 sq. yds. of asphalt concrete, laid on crushed stone, or 6-in. concrete base. The asphalt concrete mixture consisted of two parts trap rock, crushed to a size from ¾ in. to dust, and one part concrete sand, to which was added 5 per cent limestone dust.

The stone and sand were heated to a temperature of about 300° F., the limestone being added in the cool state to the hot mixture and thoroughly mixed in an asphalt mixer. Hot asphalt cement (Bermudez) was then added and the whole thoroughly mixed for about five minutes; it was then hauled from the paving plant to the site of the work and spread over the roadbed to a thickness of 3 ins., then rolled with 5 and 10-ton steam rollers until thoroughly compact. Over this surface was then spread a thin coating of asphalt cement for the purpose of filling voids. A light coating of trap-rock screenings ⅜ to ⅛ in. was then spread on the surface as a top coating and rolled with a 10-ton steam roller.

The following is a table showing average of laboratory tests of asphalt cement and mineral aggregate used in the preparation of the asphalt concrete:

Asphalt Cement.

Bitumen soluble in carbon bisulphide (not including flush coat)	7.5
Penetration at 77° F., 5 seconds, 100 grams	59.0

Concrete Mixture—Mineral Aggregate Mesh Composition.

Retained on—	
1-in. mesh screen, per cent	0.0
¾-in. mesh screen, per cent	5.0
½-in. mesh screen, per cent	13.7
¼-in. mesh screen, per cent	25.0
8 mesh per linear inch, per cent	14.5
10 mesh per linear inch, per cent	2.9
20 mesh per linear inch, per cent	7.9
40 mesh per linear inch, per cent	12.2
60 mesh per linear inch, per cent	6.0
80 mesh per linear inch, per cent	3.3
100 mesh per linear inch, per cent	.9
Passing 100 mesh per linear inch, per cent	8.6
Specific gravity of stone	2.900
Specific gravity of sand	2.632
Voids in aggregate, per cent	19.9

ASPHALT SURFACE MIXTURE (ASPHALTIC CONCRETE)—MUNICIPAL ASPHALT PLANT.

During the year there were examined 4 samples of asphaltic concrete, representing about 70 cu. yds. This material was a mixture composed of traprock screenings 74 per cent, fine sand 15 per cent, limestone dust 4 per cent, and asphalt cement 7 per cent (penetration at 77° F., 5 seconds, 100 grams, 51). The average mesh compositon of this mineral aggregate is shown in the table below. The stone, sand, and limestone dust were heated to a temperature of about 350° F., in the heating drum of a Warren portable asphalt mixer. The hot asphalt was then added and the whole thoroughly mixed for about five minutes; it was then discharged into carts and hauled to the site of work, which consisted principally of repairs to asphalt pavements. Examination of the material produced showed an average of bitumen soluble in carbon bisulphide 6 per cent (not including flush coat).

Mineral Aggregate Mesh Composition.

Retained on—	Per cent.
¾-in. mesh	4.2
½-in. mesh	18.6
¼-in. mesh	26.2
8 mesh per linear inch	9.6
10 mesh per linear inch	1.4
20 mesh per linear inch	3.2
40 mesh per linear inch	10.9
60 mesh per linear inch	11.7
80 mesh per linear inch	4.4
100 mesh per linear inch	1.0
Passing 100 mesh per linear inch	8.8

There were examined 230 samples of asphalt concrete mixture, representing about 6,375 cu. yds. This material was a mixture composed of old asphalt surface mixture (topping and binder) which, after being removed from the street, was hauled to the municipal asphalt plant and crushed in a Noyes rotary crusher to a fineness ranging from 1 in. to dust; to this material was then added trap-rock screenings, fine sand, limestone dust, and asphalt cement in about the following proportions: Old asphalt surface material, 66 per cent; fine sand, 23 per cent; trap-rock screenings, 6 per cent; limestone dust, 2 per cent; and asphalt cement, 3 per cent (penetration at 77° F., 5 seconds, 100 grams 53), the whole being mixed as above described, under asphalt concrete, and used for the same purpose.

Following are average results of tests showing percentage of asphalt and mesh composition of mineral aggregate of the old asphalt surface material:

Old Asphalt Surface Mixture (After Crushing).

	Per cent.
Bitumen soluble in carbon bisulphide	6

Mineral Aggregate, Mesh Composition.

Retained on—	Per cent.
½-in. mesh	11.3
¼-in. mesh	18.9
8 mesh per linear inch	11.6
10 mesh per linear inch	1.3
20 mesh per linear inch	3.9
40 mesh per linear inch	14.7
60 mesh per linear inch	14.6
80 mesh per linear inch	8.5
100 mesh per linear inch	2.2
Passing 100 mesh per linear inch	13.0

Asphaltic Concrete Mixture (After Production Average).

Bitumen soluble in carbon bisulphide	8

Mesh Composition, Mineral Aggregate.

Retained on—	Per cent.
½-in. mesh	3.2
¼-in. mesh	12.2
8 mesh per linear inch	10.0
10 mesh per linear inch	1.7
20 mesh per linear inch	5.1
40 mesh per linear inch	19.8
60 mesh per linear inch	20.1
80 mesh per linear inch	10.1
100 mesh per linear inch	2.5
Passing 100 mesh per linear inch	15.3

ASPHALT BLOCK.

About 882,609 paving block manufactured by the Washington Asphalt Block & Tile Co. were used in the paving of avenues, streets, and alleys of this city during the year, in the manufacture of which was used Trinidad Lake asphalt fluxed with petroleum residuum and a mineral aggregate composed of Potomac granite, trap rock, and limestone.

Mesh Composition of Aggregate Used in Mixture.

Retained on sieve having—	Per cent.
20 mesh per linear inch	6.8
40 mesh per linear inch	23.1
60 mesh per linear inch	28.8
80 mesh per linear inch	15.6
100 mesh per linear inch	6.9
Passing 100 mesh per linear inch	18.8

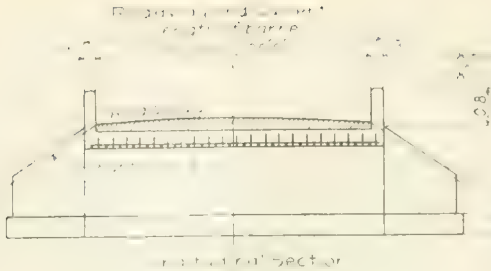
Asphalt Block Mixture.

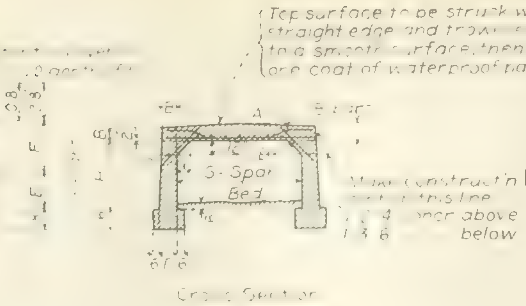
Specific gravity (manufactured block)	2.430
	Per cent.
Bitumen soluble in carbon bisulphide	7.0
Mesh composition of mineral aggregate:	
Retained on ¼-in. mesh sieve	1.8
Retained on 20 mesh per linear inch	59.0
Retained on 100 mesh per linear inch	16.3
Passing 100 mesh per linear inch	22.9

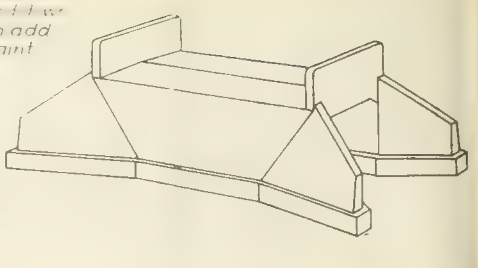
TABLE I.—AVERAGE RESULTS OF TESTS OF THE ASPHALT CEMENT AND MINERAL AGGREGATE USED IN THE MANUFACTURE OF PAVING BLOCK.

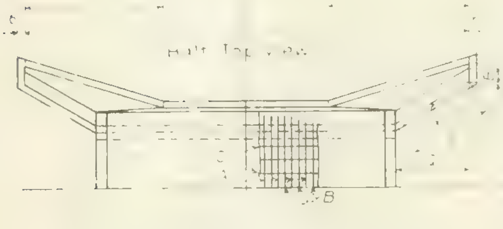
Asphalt Cement.	As originally used in mixture.	Reduced to 50 per cent purity by addition of limestone dust for laboratory test.
Bitumen soluble in carbon bisulphide, per cent	60.44	50.86
Penetration at 77° F., 100 grams	22	17
Penetration at 115° F., 50 grams	115	71
Per cent of hardening after heating 300° F. for 18 hours	10.8	4
Per cent of loss after heating 300° F. for 18 hours	[illegible]	.4
Brittleness in centimeters, drop of 25 grams, weight at 32° F.	15	15

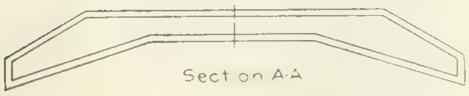
Limestone Dust Used in Surface Mixture.—This material is used as a filler to reduce the void in the sand used in asphalt surface mixtures. During the year there were examined 14 samples, all of which passed the required degree of fineness, i. e., all to pass a 30 and not less than 85 per cent to pass a 100-mesh sieve.

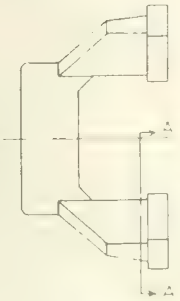


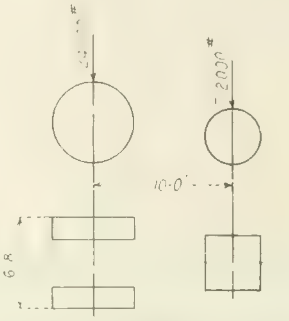

Top surface to be struck with a straight edge and trowel to a smooth surface, then add one coat of waterproof paint
S-Span
Bed
above
below
Cross Section



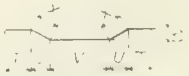



Section on A-A





18 Ton Road Roller Loading


Detail of A Bars

Standard Concrete Culverts Recommended By the Michigan Highway Department.

The standard type of concrete culvert for spans varying from 6 ft. to 15 ft. are shown in the accompanying drawings. The tables and drawings are self-explanatory.

In reference to Table No. I, it may be added that No. 18 wire is required to wire all reinforcement securely in place; all reinforcement to be structural steel with either a round or square section. If other bars are used the total number of bars and the total area of steel must not be reduced.

TABLE I.—RODS REQUIRED FOR 21' 0" LENGTH OF BARREL

Span ...	6' 0"	7' 0"	8' 0"	9' 0"	10' 0"	11' 0"	12' 0"	13' 0"	14' 0"	15' 0"
A Bars—										
Number.	17	18	20	21	14	14	16	17	18	20
Size ...	¾" sq	¾" sq	¾" sq.	¾" sq.	1" sq.	1" sq.	1" sq.	1" sq.	1" sq.	1" sq
Length..	7' 4"	8' 7"	9' 9"	11' 0"	12' 2"	13' 2"	14' 2"	15' 7"	16' 9"	18' 0"
Spacing..	1' 3"	1' 2"	1' 1"	1' 0"	1' 7"	1' 6"	1' 4"	1' 3"	1' 2"	1' 1"
T	1' 7"	1' 8"	1' 9"	1' 10"	1' 11"	1' 11"	1' 11"	2' 0"	2' 1"	2' 2"
U	0' 10"	1' 0"	1' 2"	1' 4"	1' 6"	1' 6"	1' 6"	1' 8"	1' 10"	2' 0"
V	2' 4"	3' 0"	3' 8"	4' 4"	5' 0"	6' 0"	7' 0"	7' 8"	8' 4"	9' 0"
W	0' 5"	0' 6"	0' 7"	0' 8"	0' 9"	0' 9"	0' 9"	0' 10½"	0' 11½"	1' 0½"
X	0' 11"	1' 1½"	1' 3½"	1' 6"	1' 8"	1' 8"	1' 8"	1' 11½"	2' 1½"	2' 4"
B Bars—										
Number..	17	18	19	21	13	14	16	17	18	19
Size	¾" sq.	¾" sq.	¾" sq	¾" sq.	1" sq.	1" sq.	1" sq.	1" sq.	1" sq.	1" sq.
Length..	7' 2"	8' 1"	3' 6"	10' 8"	11' 10"	12' 10"	13' 10"	15' 0"	16' 2"	17' 4"
Spacing..	1' 3"	1' 2"	1' 1"	1' 0"	1' 7"	1' 6"	1' 1"	1' 3"	1' 2"	1' 1"
C Bars—										
Number..	4	5	6	7	8	9	10	11	12	13
Size	½" sq	½" sq.	½" sq.	½" sq.	⅝" sq.	⅝" sq.	⅝" sq.	⅝" sq.	⅝" sq.	⅝" sq.
Length..	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"	21' 0"
Spacing..	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"	1' 0"
D Bars—										
Number..	68	72	78	84	54	56	64	68	72	78
Size ..	½" sq	½" sq	½" sq	½" sq	⅝" sq	⅝" sq.	⅝" sq.	⅝" sq.	⅝" sq.	⅝" sq
Length..	3' 0"	3' 3"	3' 4"	3' 6"	[illegible]	4' 0"	4' 0"	4' 3"	4' 6"	4' 9"
Spacing..	0' 7½"	0' 7"	0' 6½"	0' 6"	0' 9½"	0' 9"	0' 8"	0' 7½"	0' 7"	0' 6½"

TABLE II.—DIMENSIONS AND QUANTITIES.

Size of culvert. Span.	Height	A	B	D	E	F	G	K	M	N	P	Q	Cu. yds. per linear ft. of barrel.	Cu. yds. in two wings and one guard wall.	Good for fills up to—
						Dimensions for concrete									
6' 0"	3' 0"	0' 11"	0' 9"	1' 0"	2' 0"	2' 3"	7' 1½"	3' 0"	1' 11½"	0' 10"	3' 11"	3' 4½"	0.684	2.96	10' 0"
6' 0"	4' 0"	0' 11"	0' 9"	1' 0"	2' 6"	2' 9"	8' 1"	3' 0"	2' 4½"	1' 1"	4' 9"	4' 1½"	0.748	4.16	10' 0"
6' 0"	5' 0"	0' 11"	0' 9"	1' 3"	3' 0"	3' 3"	9' 5"	3' 0"	2' 9¾"	1' 3"	5' 7½"	4' 10½"	0.888	5.68	10' 0"
6' 0"	6' 0"	0' 11"	0' 9"	1' 6"	3' 6"	3' 9"	10' 10½"	3' 0"	3' 3"	1' 6"	6' 6"	5' 7½"	1.044	7.94	10' 0"
7' 0"	4' 0"	1' 0"	0' 10"	1' 0"	2' 6"	2' 10"	8' 4"	3' 6"	2' 5½"	1' 1"	4' 11"	4' 3"	0.827	4.37	7' 0"
7' 0"	5' 0"	1' 0"	0' 10"	1' 3"	3' 0"	3' 4"	9' 6"	3' 6"	2' 10¾"	1' 4"	5' 9½"	5' 0"	0.967	6.16	7' 0"
7' 0"	6' 0"	1' 0"	0' 10"	1' 6"	3' 6"	3' 10"	10' 10"	3' 6"	3' 4"	1' 6"	6' 8"	5' 9"	1.130	8.13	7' 0"
7' 0"	7' 0"	1' 0"	0' 10"	1' 9"	4' 0"	4' 4"	12' 2½"	3' 6"	3' 8"	1' 9"	7' 6"	6' 6"	1.307	10.68	7' 0"
8' 0"	4' 0"	1' 1"	0' 11"	1' 0"	2' 6"	2' 11"	8' 7½"	4' 0"	2' 6½"	1' 1"	5' [illegible]	4' 4½"	0.908	4.70	4' 0"
8' 0"	5' 0"	1' 1"	0' 11"	1' 3"	3' 0"	3' 5"	10' 0½"	4' 0"	2' 11½"	1' 4"	5' 11"	5' 1½"	1.051	6.55	4' 0"
8' 0"	6' 0"	1' 1"	0' 11"	1' 6"	3' 6"	3' 11"	11' 1½"	4' 0"	3' 4¾"	1' 7"	6' 9½"	5' 10½"	1.216	8.76	4' 0"
8' 0"	7' 0"	1' 1"	0' 11"	1' 9"	4' 0"	4' 5"	12' 5½"	4' 0"	3' 10"	1' 9"	7' 8"	6' 7½"	1.397	11.16	4' 0"
9' 0"	4' 0"	1' 2"	1' 0"	1' 0"	2' 6"	3' 0"	9' 0"	4' 6"	2' 7¼"	1' 2"	5' 2½"	4' 6"	0.995	5.32	3' 0"
9' 0"	5' 0"	1' 2"	1' 0"	1' 3"	3' 0"	3' 6"	[illegible]	4' 6"	3' 0½"	1' 4"	6' 0¾"	5' 3"	1.142	6.85	3' 0"
9' 0"	6' 0"	1' 2"	1' 0"	1' 6"	3' 6"	4' 0"	11' 4"	4' 6"	3' 5½"	1' 7"	6' 11"	6' 0"	1.310	9.09	3' 0"
9' 0"	7' 0"	1' 2"	1' 0"	1' 9"	4' 0"	4' 6"	12' 9"	4' 6"	3' 10¾"	1' 9"	7' 9½"	6' 9"	1.493	11.91	3' 0"
10' 0"	5' 0"	1' 3"	1' 1"	1' 3"	3' 0"	3' 7"	10' 4½"	5' 0"	3' 1¼"	1' 4"	6' 2½"	5' 4½"	1.248	7.50	3' 0"
10' 0"	6' 0"	1' 3"	1' 1"	1' 6"	3' 6"	4' 1"	11' 10"	5' 0"	3' 6"	1' 7"	7' 0"	6' 1½"	1.416	9.83	3' 0"
10' 0"	7' 0"	1' 3"	1' 1"	1' 9"	4' 0"	4' 7"	13' 1"	5' 0"	3' 11½"	1' 9"	7' 11¼"	6' 10½"	1.606	12.63	3' 0"
10' 0"	8' 0"	1' 3"	1' 1"	2' 0"	4' 6"	5' 1"	14' 3½"	5' 0"	4' 4¼"	1' 11"	8' 9½"	7' 7½"	1.810	15.95	3' 0"
11' 0"	5' 0"	1' 4"	1' 1"	1' 3"	3' 0"	3' 8"	10' 7"	5' 6"	3' 2"	1' 4"	6' 4¼"	5' 6"	1.311	7.69	3' 0"
11' 0"	6' 0"	1' 4"	1' 1"	1' 6"	3' 6"	4' 2"	11' 11½"	5' 6"	3' 7½"	1' 7"	7' 2¾"	6' 3"	1.478	9.81	3' 0"
11' 0"	7' 0"	1' 4"	1' 1"	1' 9"	4' 0"	4' 8"	12' 11"	5' 6"	4' 0½"	1' 9"	8' 1"	7' 0"	1.669	12.78	3' 0"
11' 0"	8' 0"	1' 4"	1' 1"	2' 0"	4' 6"	5' 2"	14' 6"	5' 6"	4' 5¾"	1' 11"	8' 11½"	7' 9"	1.874	16.36	3' 0"
12' 0"	5' 0"	1' 5"	1' 1"	1' 3"	3' 0"	3' 9"	11' 0½"	6' 0"	3' 3"	1' 4"	6' 6"	5' 7½"	1.376	8.15	3' 0"
12' 0"	6' 0"	1' 5"	1' 1"	1' 6"	3' 6"	4' 3"	12' 2"	6' 0"	3' 8¼"	1' 7"	7' 4½"	6' 4½"	1.544	10.48	3' 0"
12' 0"	7' 0"	1' 5"	1' 1"	1' 9"	4' 0"	4' 9"	13' 3½"	6' 0"	4' 1½"	1' 9"	8' 3"	7' 1½"	1.735	13.13	3' 0"
12' 0"	8' 0"	1' 5"	1' 1"	2' 0"	4' 6"	5' 3"	14' 11½"	6' 0"	4' 6½"	1' 11"	9' 1"	7' 10½"	1.938	17.09	3' 0"
13' 0"	6' 0"	1' 6"	1' 2"	1' 6"	3' 6"	4' 4"	12' 5"	6' 6"	3' 9"	1' 7"	7' 6"	6' 6"	1.662	11.02	3' 0"
13' 0"	7' 0"	1' 6"	1' 2"	1' 9"	4' 0"	4' 10"	13' 10½"	6' 6"	4' 2¼"	1' 9"	8' 4½"	7' 3"	1.855	14.08	3' 0"
13' 0"	8' 0"	1' 6"	1' 2"	2' 0"	4' 6"	5' 4"	15' 2½"	6' 6"	4' 7½"	1' 11"	9' 2¾"	8' 0"	2.062	17.93	3' 0"
13' 0"	9' 0"	1' 6"	1' 2"	2' 3"	5' 0"	5' 10"	16' 4"	[illegible]	5' 0½"	2' 2"	10' 1¼"	8' 9"	2.288	22.05	3' 0"
14' 0"	6' 0"	1' 7"	1' 3"	1' 6"	3' 6"	4' 5"	12' 9½"	7' 0"	3' 10"	1' 7"	7' 8"	6' 7½"	1.795	11.66	3' 0"
14' 0"	7' 0"	1' 7"	1' 3"	1' 9"	4' 0"	4' 11"	14' 0½"	7' 0"	4' 3"	1' 9"	8' 6"	7' 4½"	1.988	14.90	3' 0"
14' 0"	8' 0"	1' 7"	1' 3"	2' 0"	4' 6"	5' 5"	15' 3½"	7' 0"	4' 8¼"	1' 11"	9' 4½"	8' 1½"	2.200	18.53	3' 0"
14' 0"	9' 0"	1' 7"	1' 3"	2' 3"	5' 0"	5' 11"	16' 8"	7' 0"	5' 1½"	2' 2"	10' 3"	8' 10½"	2.433	23.02	3' 0"
15' 0"	6' 0"	1' 8"	1' 4"	[illegible]	3' 6"	4' 6"	13' 1½"	7' 6"	3' 10¾"	1' 7"	7' 9½"	6' 9"	1.926	12.20	3' 0"
15' 0"	7' 0"	1' 8"	1' 4"	1' 9"	4' 0"	5' 0"	14' 3"	7' 6"	4' 4"	1' 9"	8' 8"	7' 6"	2.143	15.40	3' 0"
15' 0"	8' 0"	1' 8"	1' 4"	2' 0"	4' 6"	5' 6"	15' 8½"	7' 6"	4' 9"	1' 11"	9' 6¼"	8' 3"	2.335	19.40	3' 0"
15' 0"	9' 0"	1' 8"	1' 4"	2' 3"	5' 0"	6' 0"	16' 11"	7' 6"	5' 3"	2' 2"	10' 5¾"	9' 0"	2.572	23.75	3' 0"

LENGTH OF BARREL REQUIRED FOR 20-FT. ROADWAY AND DEPTHS OF FILL UP TO 10-FT.

Depth of fill	1' 0"	2' 0"	3' 0"	4' 0"	5' 0"	6' 0"	7' 0"	8' 0"	9' 0"	10' 0"
Length of barrel	21' 6"	24' 6"	27' 6"	30' 6"	33' 6"	36' 6"	39' 6"	42' 6"	45' 6"	48' 6"

Engineering and Contracting

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Alignment and Grader on Country Roads Requiring a Pavement Not Readily Replacable 21

Discusses editorially the importance of securing the best possible location prior to paving a country road. Gives a comparison with railroad conditions. E. & C., Jan. 13, 1915; 1 col.

WATER WORKS, OPERATION: Unprofitable, Philadelphia.

Is the Philadelphia Water Works System Profitable? 21

An editorial pointing out that the Philadelphia water system is not operated at a profit in the ordinary business sense. Depreciation and construction costs are not properly allowed for. E. & C., Jan. 13, 1914; ½ col.

GROUTING: In Engineering Construction.

Grouting as a Method of Engineering Construction 21

Editorial commenting on the increasing use of cement grouting in engineering construction work, and a brief account of its development and of present practice. E. & C., Jan. 13, 1915; 5½ cols.

AQUEDUCTS: Hartford, Conn. (Nepang.)

Design and Construction of the New Supply Conduit (Nepang) of the Hartford, Conn., Water Works 23

Describes conditions calling for this aqueduct and describes features of design. Gives many details of handling the construction work. Conduit consists of tunnel, cut-and-cover horseshoe section and 42-in. cast iron pipe. E. & C., Jan. 13, 1915; 7½ cols.

WATER WASTE: Prevention of; Washington, D. C.

Increasing Precision in Pitometer Survey Work at Washington, D. C. — Meter Reading 26

Describes improved methods made necessary by decreasing leakage after eight years of work. Describes meter reading methods in connection with waste curtailment. E. & C., Jan. 13, 1915; 2 cols.

WATER MAINS: Laying at San Diego, Cal.

Field and Office Methods in Connection With the Laying and Repair of Large Water Mains at San Diego, Calif. 26

Describes procedure from the ordinance of council to the completion of the work in the field. A description by the foreman of construction. E. & C., Jan. 13, 1915; 2½ cols.

BEAMS, CONTINUOUS: Simplified Derivation of Theorum of Three Moments.

A New and Simplified Derivation of the Most General Form of the Theorem of Three Moments 27

Gives a new and simplified derivation of the most general form of the theorem of three moments. This derivation consists in making use of a property of the M/EI curve. E. & C. Jan. 13, 1914; 4½ cols.

BRIDGES: Reinforced Concrete; Use on Railroads.

Data on Reinforced Concrete Railroad Bridges and Extent to Which Such Bridges Are Used 29

Gives some important data on the extent to which various types of reinforced concrete bridges are used on railroads. Also gives concrete proportions, allowable stresses and loads used in designing reinforced concrete deck slabs, and shows design drawings of distinctive types used on various railroads in the United States and Canada. E. & C., Jan. 13, 1915; 8½ cols.

BRIDGE WORK: Instruction to Employes on.

Instructions to Employes Governing Bridge Work by Pennsylvania State Highway Department 32

Gives, in condensed form, the instructions to employes engaged in bridge work, issued by the Pennsylvania State Highway Department. These instructions contain much of value to those engaged in the design, construction and maintenance of highway bridges. E. & C., Jan. 13, 1915; 5½ cols.

DREDGING: Records and Costs.

Certain Cost Data on the Work of Improving the Neponset River in Massachusetts 34

Outlines improvement; describes conditions of work and materials dredged; gives account and tabulations of delays; tabulates complete operating records of dredges. E. & C., Jan. 13, 1915; 9 cols.

SEWAGE TREATMENT: Aberdeen, S. Dak., Plant.

Design, Construction and Cost of New Sewage Disposal Plant at Aberdeen, S. Dak. 37

Describes details of design of new treatment plant comprising pump house, pumping equipment, producer gas plant, sedimentation tank, sprinkling filter, sludge filter and final settling tank. Plant all housed in to permit of operation under severe winter conditions. Construction plant and methods are described, and wages paid and unit costs are given. E. & C., Jan. 13, 1915; 5½ cols.

INDUSTRIAL WASTES: Chicago Stockyards; Disposal of.

Recommended Procedure in Disposal of Wastes From the Stockyards and Packingtown in Chicago 38

Brief digest of summary and conclusions of a 350-page report on the packing industry, its units and wastes, on the tests of promising methods of treatment, and on a project for the improvement of Bubbly Creek. E. & C., Jan. 13, 1915; 1½ cols.

PAVEMENTS: Bituminous, Cementing Value Test.

The Cementing Value of Bituminous Binders and Results Obtained in Some Commercial Tests 39

Describes in detail apparatus for and results obtained from a modification of the ductility test. The new test is named the cementing value test. The various steps in the development of the test are given and typical results are shown by means of tables and diagrams. E. & C., Jan. 13, 1915; 10 cols.

PAVEMENTS: Asphaltic Concrete, Asphalt Block.

Analyses of Asphaltic Concrete and Asphalt Block, Laid in Washington, D. C., in 1914 43

Gives data on mixtures used in asphaltic concrete and asphalt block pavement derived from tests of material used in the construction of pavements in Washington, D. C. E. & C., Jan. 13, 1915; 2 cols.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Machinery, Steels, Etc.—Italian firm wishes to act as local representative for American manufacturers of and dealers in steel, metals, industrial machinery, tools, and technical instruments, etc. No. 15137.

Brick Machinery.—Merchant in Spain wishes to communicate with American manufacturers of machines for making brick. Catalogues, prices, etc., should be sent immediately. Correspondence should be in Spanish. No. 15149.

Railway Motor Cars.—Business man in South America desires to establish commercial relations with American manufacturers of gasoline and electric motor cars for railroad service. No. 15058.

Spruce Wood.—English firm wishes to purchase spruce wood. No. 15070.

Catalogs, Publications.—The Russian-American Chamber of Commerce, Miasnitsky Proiesd No. 1, Moscow, would appreciate the receipt, regularly, of leading American commercial publications for the use of its members. Catalogues of manufacturers of all goods imported by Russia will also be acceptable.

Presses for Tile Making.—Russian company desires to be put in touch with manufacturers of hydraulic presses for making terra-cotta tiles. Correspondence should be in Russian, French, or German. No. 15115.

Tools.—Firm in southern Europe, which has hitherto imported its stock of tools and machine tools from European countries, informs an American consul that it desires to purchase similar supplies from the United States. The firm solicits catalogues, prices, etc. Correspondence may be conducted in English. No. 15124.

Wire, Nails, Etc.—Firm in United Kingdom desires to purchase wire netting, barbed wire, strand wire, round and oval wire nails, and carriage bolts. No. 15117.

Wire Nails, Fencing, Etc.—Spanish Commission agent is desirous of importing tool grinders, plumber's supplies, wire nails, wire, and wire fencing. Catalogues and correspondence should be in Spanish. No. 15087.

Wire Nails.—British firm desires to place an order for wire nails to be shipped to the East Indies. No. 15068.

Machinery.—European firm is interested in gear cutters, milling machines, and cylindrical grinders, and is anxious to represent reliable American manufacturers. If possible, prices should be quoted in English currency, and be made c. i. f. British ports. No. 15048.

Lathes.—A firm in the British Isles is interested in turret, capstan, and automatic bar lathes. The firm wishes to represent American manufacturers. Prices should be quoted in English currency, if possible. Quotations should be c. i. f. British ports. No. 15050.

Locomotive Boiler Tubing.—Firm in Southern Europe desires to communicate with American manufacturers of steel boiler tubing for railway locomotives. The tubing should be 1½ ins. in diameter. Catalogues, etc., should be sent at once. Correspondence may be in English. No. 15159.

INDUSTRIAL NOTES

The name of the Utah Culvert Co. of Woods Cross, Utah, has been changed to the Utah Corrugated Culvert & Flume Co.

Mr. E. G. Ladd, for the past 20 years in the Contracting Department of the Chicago Bridge & Iron Works, Chicago, Ill., has been placed in charge of a new office which the company has opened at Monticello, Fla. He will look after the interests of the company in the states of Georgia, Florida and Alabama.

The Aetna Powder Co., of Chicago, has recently become part of the newly organized merger of several independent explosive concerns. The new name of the company is the Aetna Explosive Co., 2 Rector St., New York. Among the companies absorbed is the Miami Powder Co. The new corporation also takes over the Aetna Co.'s two plants at Thebes, Ill.; the dynamite mills at Aetna, Ind., and factories at Xenia and Goes, O. In addition it acquires the entire town of Aetna, three miles east of Gary, Ind., and 650 acres of land. It is said that in the future the Aetna plant also will make chemicals.

Mr. George P. Du Bose has been appointed superintendent of the plant of the Holt Manufacturing Co. at Stockton, Cal. Mr. Du Bose has been with the Holt Co. only a short while in charge of constructing exhibition machines for the two 1915 Expositions, but the ability shown here and his record elsewhere made him a choice for the position. Since the retirement of Geo. W. Haines from active work several years ago, no general superintendent had been appointed, and the selection of Mr. Du Bose comes only after a very careful canvass of available men in various parts of the country. Mr. Du Bose has had extended experience in construction work. He also has had a variety of experience in modern shops, all of which will be applied to the Holt plant as occasion arises. No other changes in shop personnel are involved in this move, the need of a superintendent for simplifying routine and exercising a general supervision over production work having been demonstrated repeatedly during the almost continuous rush of the last year.

NEW CATALOGUES

Road Leveler and Grader.—Paper, circular. Bresee Manufacturing Co., Mattoon, Ill.

Describes the Uncle Jim road machine and shows a number of views of work being done by this leveler and grader. Also gives a few testimonial letters.

Wire Rope.—Paper, 8x10½ ins.; 8 pp. A. Leschen & Sons Rope Co., 914-926 N. First St., St. Louis, Mo.

The January number of Leschen's Hercules, consisting of articles and photographs showing work done with Leschen wire rope.

Vanadium.—Paper, 8x10 ins.; 12 pp. American Vanadium Co., 341 Vanadium Bldg., Pittsburgh, Pa.

The December number of American Vanadium Facts, containing articles on the use of vanadium steel in locomotives, for piston rods, stamping and forming dies, etc. Illustrated.

Dump Wagons.—Paper, 10¾x7¾ ins.; 12 pp. A. Streich & Bro. Co., Oshkosh, Wis.

Illustrates and describes Streich steel body sanitary garbage wagons, built in one and two-horse sizes. Shows wagons equipped with various attachments and in loading and dumping positions. Gives tables of sizes, weight, capacity, etc., for the several types.

Segment Block Sewers.—Paper, 5x7 ins., 16 pp. American Sewer Pipe Co., Akron, O.

The December number of The Segment Block, a little publication devoted to the advancement of Amco Segment Block for Sewer Construction. It is composed of cheerful philosophy, quips and rhymes, together with photographs and brief descriptions of Amco construction.

White Portland Cement.—Paper, 6x9 ins.; 18 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

The January number of the Medusa Review, consisting of photographs, articles and brief notes showing the uses of Medusa White Portland Cement. This number shows its application to barns, reservoir, bathing pool, silo and residence construction.

Asbestos Protected Metal.—Paper, 8¼x10¾ ins.; 32 pp. Asbestos Protected Metal Co., 100 Main St., Beaver Falls, Pa.

"Asbestosteel for Roofs and Walls" is the title of Bulletin No. 54, a handsome publication devoted to the type of concrete and steel construction called "Asbestosteel." Contains views and diagrams, reports of tests, brief specifications and a number of tables giving pertinent data.

Electrical Apparatus.—Paper, leaflets, 6x9 ins. Steel City Electric Co., 1207-1219 Columbus Ave., Pittsburgh, Pa.

Four leaflets for insertion in the loose leaf binder furnished by the company. Bulletin No. 25, Superior Fish Wire; No. 26, Star Fixture Stems and Beam Strips; No. 27, "Steel City" Outlet Boxes for Concrete Work; No. 28, Conduit Bushing Adapters and Hickey Fixture Hangers. All illustrated.

Cableways, Hoists and Derricks.—Paper, 8½x7¾ ins.; 20 pp. S. Flory Mfg. Co., Bangor, Pa.

Illustrations showing the work of Flory productions used in construction of the Kensico dam of the Catskill water supply system and a brief description of the work comprise this booklet. The apparatus shown include Flory cableways, traveling towers, derricks and boom swingers.

CATALOGUE REVIEWS

Steam Shovels.—Paper, 9x16½ ins.; 36 pp. The Thew Automatic Shovel Co., Lorain, O.

Catalogue No. 9, issued by the Thew Shovel Co., describes the full circle swing steam shovels with horizontal crowding motion manufactured by that company. A general description of the Thew type, illustrated by views of typical Thew shovel operations, is followed by a brief sketch of the theory and practice of the horizontal dipper crowding motion and a summary of its advantages. The various types are then shown and described in detail with data as to weight, size of dipper, etc.

The mechanism of the Thew shovel is explained, and then the various modifications are taken up. Illustrations of the shovels equipped with clam shell buckets, sewer trench boom, jackknife boom, etc., accompany these descriptions. Electrically operated shovels are shown and described, as are also Thew shovels for electric railroads, for handling clay and shale, for road construction and street grading and for contractors' requirements in general. Some data as to operating costs, labor, fuel, etc., are also given. The book concludes with views and notes on the work of Thew shovels for mining and ore handling.

Hoists and Derricks.—Paper, 6½x9½ ins.; 112 pp. Minneapolis Steel & Machinery Co., Minneapolis, Minn.

Twin City hoists and derricks are presented in catalogue B-201 with great detail and elaborately illustrated. The first part of the book is devoted to Twin City hoists. General construction details with cuts showing the various parts, the boiler, patent friction device and splash lubricating device, etc., are followed by cuts and description of the various types. Tables of dimensions are given. Electric, gasoline and oil motor hoists and a number of special applications are described; also Twin City car pullers, tractor hoists and tractors for road construction and street paving work.

Twin City derricks are then described with numerous illustrations and diagrams showing construction. Tables of sizes, descriptions and cuts showing the equipment, boom, buckets, bull wheel, sheaves, step and foot blocks, etc., are given. Specially designed derricks for various kinds of work are shown in operation. The latter part of the book is given over to the equipment used, such as wire rope and fastenings, buckets, blocks, trolleys, post cranes, etc.

CURRENT NEWS

The Doings of the Week.

General business conditions have shown a steady improvement during the past week. An important feature of the industrial situation has been the return of the railways to the buying market. Orders placed by the steam lines since Jan. 1 for equipment, rails and supplies are estimated to amount to fully $7,000,000, and inquiries from the larger systems calling for an addition of perhaps $10,000,000 are pending. The money market is becoming more favorable for new enterprises and the sale of bonds for constructive improvements. Some of the larger railways are preparing for new financing. The Pennsylvania System will bring out a $100,000,000 bond issue in March, while the Chicago, Milwaukee & St. Paul Ry. has made an offering of $29,000,000 of securities. Both of these roads intend to apply some of the funds for improvements. In the construction field there has been decided improvement over the previous week. Bids were opened on several good sized contracts and a great deal of new work came up for advertising. In the south a number of municipalities are asking proposals on water works, sewers, and street paving. Northern cities have not as yet began asking bids to any great extent on this season's construction activities, but prospects are good that a great deal of this work will be ready for figuring in the next few weeks. In the Iron and Steel trade the buying of the railroads has brought out considerable activity. Prices are firmer, more inquiries are being received, and mill operations are showing better schedules. Increased activity in new structural work is reported. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Jan. 6 were as follows:

Finished Iron and Steel.	Jan. 6.	Dec. 30.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.17½	1.17½
Iron bars, Pittsburgh	1.15	1.15
Iron bars, Chicago	0.97½	0.95
Steel bars, Pittsburgh	1.10	1.05
Steel bars, New York	1.26	1.21
Tank plates, Pittsburgh	1.10	1.05
Tank plates, New York	1.26	1.21
Beams, etc., Pittsburgh	1.10	1.05
Beams, etc., New York	1.26	1.21
Skelp, grooved steel, P'gh	1.10	1.10
Skelp, sheared steel, P'gh	1.15	1.15
Steel hoops, Pittsburgh	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No 28, P'gh	2.75	2.75
Wire nails, Pittsburgh	1.50	1.50
Cut nails, Pittsburgh	1.50	1.50
Fence wire, base, P'gh	1.30	1.30
Barb wire, galv., P'gh	1.90	1.90

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.10 cts. Extras on other shapes and sizes are as follows: I-beams over 15 ins., H-beams over 8 ins., angles over 6 ins., on one or both legs, 0.10 cts. per pound. Tees, structural sizes, 0.05 cts. per pound; channels and tees under 3 ins. wide, 0.20 to 0.80 cts. per pound; deck beams and bulb angles, 0.20 cts. per pound.

Railways.—No developments of particular importance in the railroad construction field have taken place during the past week. As noted elsewhere in this column the carriers are now showing considerable activity in placing orders for equipment and supplies. Later on it is likely that they will take up their construction needs. One good sized contract has been placed in the last few days and bids are in on several smaller undertakings. The work let calls for 7 miles of double tracking from Ogden, Utah, to the Gateway bridge for the Oregon Short Line R. R. Phelan & Shirley, Omaha, Neb., secured the work, and have sublet part of it to the Christensen Construction Co., Salt Lake City, Utah.

Roads and Streets.—No especially large highway or street paving contracts appear to have reached the call for bids stage during the past week. The State Roads Commission of Maryland is asking proposals on two jobs. Ohio opened bids on several good sized highway improvements, and will call for bids shortly on several other undertakings. In Indiana a number of counties are advertising road improvements, some of the work calling for brick and concrete pavements. Lake County, Florida, has postponed its 200-mile road letting for possibly 60 days. A fair amount of highway construction was placed under contract, none of these undertakings, however, being especially large. Owens Construction Co., Vicksburg, Miss., secured a $66,500 contract for 14 miles of road near Bonham, Tex.; Betz & Boyce, Albany, N. Y., were awarded a $42,272 concrete road job by the Maryland Roads Commission; Garver & Wirtz, Hamilton, O., secured the Synnes Corner road in Butler County, Ohio, at $57,470; Bryant & Austin, Los Angeles, obtained a $127,000 paving contract at Los Angeles; Levy & Levy, Muskogee, Okla., were awarded 4 miles of street paving for Muskogee, Okla.

Bridges.—Most of the new work that has come up for bids during the past week is for comparatively small structures. Six small concrete bridges in Illinois are being advertised, the estimated cost of the largest being $6,450. Bradentown, Fla., is calling for proposals on a lift bridge; the State Roads Commission of Maryland opens bids Jan. 19 on a reinforced concrete bridge of 16 30-ft. spans and one 32-ft. span and a similar structure of seven 15-ft. spans; Calgary, Alberta, is asking tenders for steel superstructure consisting of four Pratt truss spans each 135 ft. long, requiring 400 tons of steel.

Waterworks and Sewerage.—A considerable amount of work in both the waterworks and sewerage field reached the call for bids stage in the last few days. St. Louis, Mo., is asking proposals for furnishing a 20,000,000-gal. steam turbine driven centrifugal pump; Columbia, S. C., is calling for bids for 10 miles of water main extensions and a like amount of sewer extensions; Eastover, S. C., opens bids Jan. 18 on tank and tower and water mains; Sweetwater, Tex., is asking proposals on 250,000-gal stand pipe, supply of hydrants, etc., and lay 6¾ miles pipe line; Augusta, Ga., opens bids Jan. 19 on 3,000 ft. of brick and concrete sewer, the work including 960 lin. ft. 7x4½ reinforced concrete box sewer. Ledingham & Cooper at $115,662 were low bidders for the waterworks for West Vancouver, B. C.

Rivers and Harbors.—Bids were opened last week on several large government river and harbor contracts. For the breakwater for the proposed harbor of refuge at Cape Lookout, N. C., D. L. Taylor & Co., N. Y., at $2,435,400 was the low bidder. The American Dredging Co., Philadelphia, Pa., at $209,575 was low bidder for 2,525,000 cu. yds. of dredging in Delaware River on Bellevue Light House Range. R. A. Perry, San Francisco, was low bidder at 5.69 cts. for 800,000 cu. yds. of dredging in Oakland Harbor; H. B. Blanks Levee Co., Vicksburg, Miss., at 12.24 cts. was low bidder for 630,000 cu. yds. of levee in Lower Yazoo Levee District. W. H. Ellis & Son Co., 749 Meridian St., East Boston, Mass., were awarded the contract for the pier and 2-story steel shed at New Bedford, Mass., for the State Harbor and Land Commission. Baltimore, Md., is asking bids for 2,000,000 cu. yds. of dredging; Augusta, Ga., opens proposals Jan. 19 on 250,000 cu. yds. earth fill.

Good Time to Call for Bids.

Competition from contractors for construction undertakings has been unusually active this winter. Nearly every letting of any size has received careful attention from many prospective bidders. On certain jobs an exceptionally large number of bids have been obtained. Recently proposals were asked for constructing warehouses, the work calling for an expenditure of something like $1,000,000. Between 40 and 50 sets of plans and specifications for this improvement were sent out to prospective bidders, each of whom put up a deposit of $100 for their safe return. For a recent Government contract for the construction of a concrete storehouse for the Bureau of Yards and Docks, over 155 sets of plans and specifications were taken out by contractors. A letting for the construction of a destructor plant for the Borough of Queens, New York City, was postponed because the demand for blanks and bidding forms was greater than the supply. The competition for these three improvements was unusual, but almost as satisfactory results have been obtained at practically every other letting held in the past two months. This is the dull period in the construction field and many contractors are looking for chances to figure on work. Municipalities by taking bids at the present time on their undertakings will secure decidedly better contract prices than if they wait until later in the season for advertising their improvements. Materials are cheaper now than they will be later on, labor is abundant, and contractors are willing. This combination makes possible a saving on almost any construction job.

Alien Labor Law.

Most of the state laws regarding the employment of citizens of a foreign country have had reference only to their labor on public works. Contractors, therefore, have been practically the only persons affected by alien labor legislation. At the general election last November, the citizens of Arizona decided to remove the construction profession from the privileged class, and accordingly voted in favor of a law extending the alien labor provisions to all classes of employers. This statute provided that at least 80 per cent of the employes on the pay roll of any concern employing more than five persons, must be American citizens. The British and Italian governments entered protests against the Arizona law and the matter was taken to the Federal District Court at San Francisco for adjudication. The court rendered a decision last week, declaring the law unconstitutional, on the ground that it was in conflict with the fourteenth amendment to the United States Constitution, which guarantees equal protection to all in this country. An appeal will be taken to the United States Supreme Court in order to obtain a final decision from the highest judicial body in the country.

Sand Oil Roads.

Many miles of modified asphalt improved roads, patterned somewhat after the celebrated sand oil highways of the Cape Cod section of Massachusetts, may be constructed in Florida in the next few years. Already Lake County, Florida, thinks well enough of the possibilities of this surfacing to ask bids on over 1,000,000 sq. yds. of it. Polk County, Florida, also is considering this method of improving its sandy highways, and last week opened bids for constructing experimental quarter mile sections of sand oil road in each of its five commissioner districts, with the understanding that if the pavement proved a success, several hundred miles of highway would be surfaced with the material. A short time ago a section of modified asphalt pavement was laid at Eustis, Fla., by a contracting company which has done considerable work of this sort in Massachusetts. This development of southern highway construction should be of interest to many contractors, as well as to manufacturers of portable and semi-portable asphalt plants and dealers in asphalt.

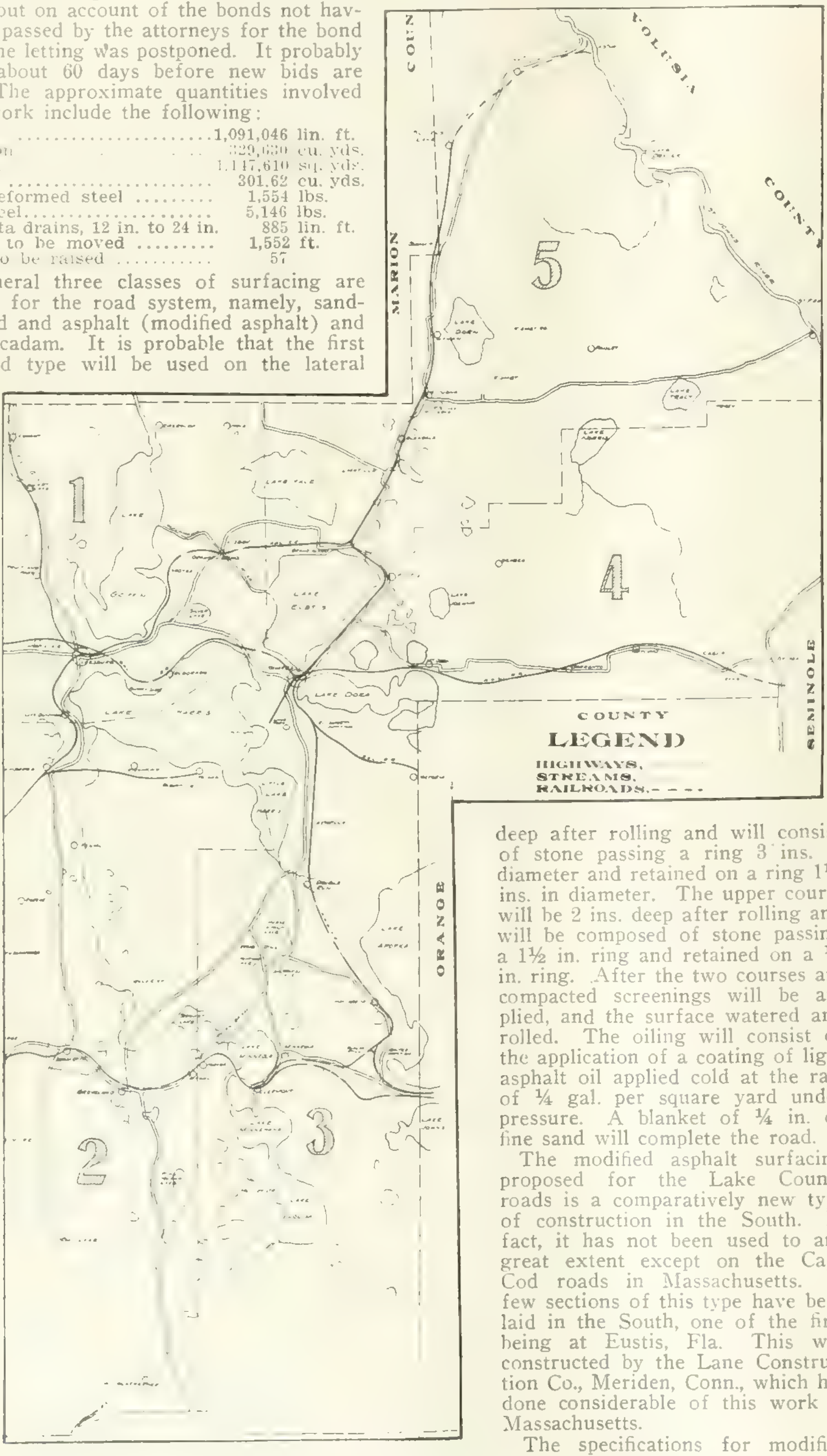
ROAD SYSTEM FOR LAKE COUNTY, FLORIDA.

About 200 Miles of Highway to Be Improved.

Modified Asphalt Surfacing — Sand-Clay — Oil Macadam.

Some 200 miles of highway improvement will be placed under contract shortly by the Commissioners of Lake County, Florida. Bids on this undertaking were to have been opened Dec. 31, but on account of the bonds not having been passed by the attorneys for the bond buyers, the letting was postponed. It probably will be about 60 days before new bids are asked. The approximate quantities involved in this work include the following:

Roadway	1,091,046 lin. ft.
Excavation	329,630 cu. yds.
Pavement	1,147,610 sq. yds.
Concrete	301.62 cu. yds.
Square deformed steel	1,554 lbs.
R. C. Steel	5,146 lbs.
Terra cotta drains, 12 in. to 24 in.	885 lin. ft.
Pole line to be moved	1,552 ft.
Bridges to be raised	57



Lake County Road System.

In general three classes of surfacing are proposed for the road system, namely, sand-clay, sand and asphalt (modified asphalt) and oiled macadam. It is probable that the first mentioned type will be used on the lateral roads, and the last two on the main and semi-trunk highways, the oiled macadam being employed on those having the heaviest traffic. In the bidding sheets, however, alternate bids were asked on all three classes of pavement, and in addition bids on shell surfacing on one road were requested. All roads, regardless of the surfacing used, are to be graded and provided with proper drainage facilities.

The sand-clay is to consist of a layer of 10 in. of clay placed on the prepared roadbed and watered and rolled. During the rolling, sand, if necessary, will be added. The shell road surfacing will consist of a layer of shell obtained from a bank about 1 mile from Crown Bluff Ferry, spread on the prepared road bed to a thickness of 8 in., thoroughly wetted and rolled.

The oiled macadam will be composed of local stone. The lower courses will be 4 in. deep after rolling and will consist of stone passing a ring 3 ins. in diameter and retained on a ring 1½ ins. in diameter. The upper course will be 2 ins. deep after rolling and will be composed of stone passing, a 1½ in. ring and retained on a ½ in. ring. After the two courses are compacted screenings will be applied, and the surface watered and rolled. The oiling will consist of the application of a coating of light asphalt oil applied cold at the rate of ¼ gal. per square yard under pressure. A blanket of ¼ in. of fine sand will complete the road.

The modified asphalt surfacing proposed for the Lake County roads is a comparatively new type of construction in the South. In fact, it has not been used to any great extent except on the Cape Cod roads in Massachusetts. A few sections of this type have been laid in the South, one of the first being at Eustis, Fla. This was constructed by the Lane Construction Co., Meriden, Conn., which has done considerable of this work in Massachusetts.

The specifications for modified asphalt for the Lake County work provide that the asphalt cement shall be composed of refined asphalt or asphalts and flux. The refined asphalts must be prepared from a natural mineral bitumen, either solid or liquid, or a combination. The fluxes must be residues obtained by the distillation of paraffin, asphaltic or semi-asphaltic petroleum. The sand will be of the best quality locally available. It will be tested and graded for size so that the fine sand will as nearly as possible fill the voids in the coarse sand. In grading the sand, the contractor will not be called upon to combine more than three different sands to secure the desired sand grading, unless otherwise arranged between the contractor and the officials. The amount of asphalt cement to be used will be governed by the sand grading selected and will be sufficient to cover the surface of all particles. Particles of stone, granite, gravel or other hard substances not larger than ½ in. in their largest measurements will be accepted in the mineral aggregate, but must not exceed 15 per cent of such aggregate. With the mineral aggregate 3 per cent of mineral matter passing a 200 in. mesh will be mixed.

The construction requirements are as follows:

After the road bed has been graded it will be thoroughly watered and rolled with a roller weighing at least 10 tons. The sand and asphalt will be mixed in a regulation asphalt paving plant, having twin pug mixers with revolving blades, rotating in opposite directions to secure a complete mixture of the sand and asphalt. Heating kettles and appurtenances for heating the asphalt and sand must be supplied by the contractor. In fact, the plant must be of such character and capacity that the work can be carried out in accordance with the best asphalt construction practice. The mineral aggregate complete when heated and mixed with the asphalt cement in mixing plant will be at a temperature of from 250° F. to 375° F. The mixture will be hauled to the road at a temperature of not less than 200° F. The modified asphalt surfacing mixture will be spread so that it will have a finished depth of 3½ in. After the mixture is in place and shaped with hot rakes, etc., it will be rolled with a roller weighing not less than 1 ton and then re-rolled with a tandem roller weighing 5 to 6 tons. After final rolling the finished surface will be lightly dusted with Portland cement or other inorganic dust.

In their report on the proposed system of improved roads for Lake County, the engineers estimated the cost of the modified asphalt surfacing at 80 cts. per square yard, or $4,224 per mile for a 9-ft. road. Analysis of sands in the county were made and it was found that in general there were two classes of this material available: the coarser sands or underlying material, and the finer sands or surface material represented by samples obtained in the present highway. The former, while showing some distribution on the various screens were deficient in the 80 and 100 mesh particles. The latter, however, was decidedly better in this respect in some cases, showing a total of 20 per cent passing the two screens. The report states that it is believed that by the proper selection of these sands, which can be done at no great expense, and increasing the asphalt content to 9 to 10 per cent and by the use of an asphalt having a penetration of 77° of 50 to 60 instead of 100 to 118, such as was used in the work at Eustis, Fla., a very satisfactory pavement can be laid.

The engineers in their report estimated the cost of sand-clay surfacing at 19.8 cts. per square yard or about $1,045 per mile for a 9 ft. road. This cost was based on labor at $1.50 per day and teams at $4 per day, with an average haul on clay of 1 mile with no charges for the clay. The cost of the oil macadam was estimated at $1.02 per square yard.

The work in general calls for the improvement of old roads. Bids were asked on 19 of these highways, separate figures being required on each road. In the engineer's report the estimated cost for these 19 roads for the type of surfacing shown was as given in Table I.

In the first call for bids alternate proposals on all of these roads were asked on sand-clay, modified asphalt and oiled macadam. On the work for the Altoona to Crown Bluff Roads, alternate bids were asked in the above three clases and also on shell surfacing.

The road system for Lake County, Florida,

TABLE I

Name	Length, Ft.	Width Surfacing, Ft.	Kind of Surface	Est. Cost.
Tavares to Leesburg	54,745	15	Oil Macadam	$100,140
Leesburg City Limits to County Line	32,369	9	Oil Macadam	37,979
Leesburg to Lady Lake	60,527	9	Oil Macadam	67,728
Leesburg to Mascotte	116,651	9	Sand Clay	35,237
Mascotte to Bay Lake	41,375	9	Sand Clay	14,379
Mascotte to Groveland and Polk County	93,838	9	Sand Clay	32,037
Groveland to Double Run	62,088	9	Modified Asphalt	57,525
Wilson's Bridge to Groveland	43,181	9	Modified Asphalt	40,197
Evans Still	11,694	9	Modified Asphalt	11,005
Minneola to Orange County	31,800	9	Modified Asphalt	32,507
Tavares to Clermont	102,103	9	Modified Asphalt	96,880
Monteverde to West Apopha	48,315	9	Modified Asphalt	46,683
Tavares to Eustis	30,100	15	Modified Asphalt	42,805
Eustis to Orange Bend	69,815	9	Modified Asphalt	63,248
Mount Dora	28,790	9	Modified Asphalt	25,094
Mount Dora to Sorrento	74,633	9	Modified Asphalt	67,205
Eustis to Astor	138,798	9	Sand Clay	44,419
Altoona to Crows Bluff	92,163	9	Sand Clay	33,210
Umatilla to Negrotown	28,843	9	Sand Clay	8,957

will be constructed under the direction of the County Commissioners, of which A. L. Russell is Chairman and H. H. Duncan, Tavares, Fla., is Clerk. The J. B. McCrary Co., 1408 Third National Bank Bldg., Atlanta, Ga., is the engineer.

STATUS OF CALIFORNIA STATE HIGHWAY WORK.

Surveys Completed for 2,063 Miles of Road.

Work Completed or Under Contract 1.036 Miles.

The State Highway System of California calls for the construction of 3,000 miles of road. On Dec. 15, 1914, surveys had been finished for 2,062.84 miles of highway and the work completed or under contract on that date amount to 1,036.3 miles. Some 154 layouts had been finished, totaling 1,108.1 miles. The routes already established and the status of the work on them, according to the California Highway Bulletin, are as follows:

Route 1, along the Pacific Coast north of San Francisco Bay, through Marin, Sonoma, Mendocino, Humboldt and Del Norte Counties. Length as surveyed and with surveys ordered, 381.2 miles; completed or under contract, 111.6 miles.

Route 2, along the coast south from San Francisco to San Diego, through San Mateo, Santa Clara, San Benito, Monterey, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange and San Diego Counties. Length, exclusive of Los Angeles County highway, as surveyed, 464.6 miles; completed or under construction, 302.3 miles.

Route 3, through Sacramento Valley, from Sacramento to the California-Oregon boundary line, through Sacramento, Placer, Yuba, Sutter, Butte, Tehama, Shasta and Siskiyou Counties. Length as surveyed, 277.6 miles; completed or under construction, 158.5 miles.

Route 4, through the San Joaquin Valley, from Sacramento to Los Angeles, through Sacramento, San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kern and Los Angeles Counties. Length as surveyed, 270.8 miles; completed or under construction, 211.1 miles.

Route 5, from the San Joaquin Valley system to Santa Cruz via Oakland and San Jose. Length as surveyed, 92.2 miles; completed or under construction, 55.7 miles.

Route 6, from Sacramento across the Yolo by-pass to a connection with route 7 near Davis. Length as surveyed, 14.5 miles; under contract, 3.1 miles.

Route 7, from Tehama Junction to Benicia, connecting the county seats of Glenn, Colusa, Yolo and Solano Counties. Length as surveyed, 151.3 miles; under construction, 93.7 miles.

Route 8, from a connection with route 1 near Ignacio to a connection with route 7 either at Benicia or Cordelia via Napa, through Marin, Sonoma and Napa Counties. Length as surveyed, 26.2 miles; under construction, 4.5 miles.

Route 9, connecting San Bernardino with the main highway system, through Los Angeles and San Bernardino Counties. Length as surveyed, 31.8 miles; completed or under construction, 17.9 miles.

Route 10, connecting Hanford with the main route and runing to Visalia. Length as surveyed, 18.5 miles.

Route 11, connecting Placerville with the main route at Sacramento. Length as surveyed, 29.1 miles; completed or under construction, 18.7 miles.

Route 12, connecting El Centro with the main system at San Diego and running through Imperial and San Diego Counties. Length as far as surveys are completed, 102.5 miles; under construction, 21.4 miles.

Route 13, connecting Sonora with the main system in the San Joaquin Valley, through Stanislaus and Tuolumne Counties. Length as surveyed, 49.5 miles; under construction, 10.9 miles.

Route 14, in Contra Costa County. Length as surveyed, 20.8 miles; under construction, 10.6 miles.

Route 15, connecting Colusa with route 7 at Williams. Length, 8.5 miles.

Route 16, connecting Lakeport with route 1 at Hopland. Reconnaissance made.

Route 17, connecting Auburn with the main road in the Sacramento Valley. Length as surveyed, 15.6 miles.

Route 18, connecting Mariposa with the main system in the San Joaquin Valley at Merced. Surveys in progress. Approximate length, 33.9 miles.

Route 19, connecting Riverside with the main system at Los Angeles. Length as surveyed, 16.9 miles; completed or under construction, 16.3 miles.

Route 20, connecting Weaverville with the main system at Redding. Length as surveyed, 47.9 miles.

Route 21, from Richvale to Oroville in Butte County. Length as surveyed, 8.7 miles.

Proposed $15,000,000 Union Depot at St. Paul.

The new union depot project for St. Paul, Minn., has been advanced another step toward the construction stage. The plans, as agreed upon by the nine railroads forming the Union Depot Co., have been submitted to the City Council for its approval. As the undertaking contemplates changes in the river channel, the U. S. War Department also will have to approve the plans before actual work can be started. A considerable amount of legislation by the City Council regarding the changing or closing of streets and other concessions likewise will be necessary. The plan in general provides for a 3-story depot extending 315 ft. on Sibley St. and 220 ft. on Third St. The depot and terminal tracks will cover about 54 acres.

This project calls for a change in the Mississippi River channel by dredging on the west side and filling in to a width of about 300 ft. on the opposite bank to provide for public levee and terminal trackage. About 1¾ miles of channel is involved. According to the plans the track level in the Union depot will be raised 18 ft. This will cause grade changes through the entire terminal and in an area of about 200 acres. The first work undertaken will be the river channel changes. It is hoped to start this in the spring. The cost of the entire project will be about $15,000,000.

$3,000,000 Harbor of Refuge, Cape Lookout, N. C.

Bids were opened last week for the large government breakwater undertaking at Cape Lookout, N. C. This work is part of the project for the construction of a harbor of refuge that will have an area of 575 acres and a depth of 30 ft. or more. The estimated cost of the scheme as adopted by Congress is $3,526,000.

The main portion of the breakwater will extend seaward for a distance of 7,000 ft. It will have a top width of 20 ft. and a height above mean low water of 6½ ft. In addition there will be a 2,000 ft. shore connection of the following dimensions: Height above mean low water, 8 ft.; top width, 20 ft.; side slopes, 3 vertical on 5 horizontal. The main breakwater will have natural side slopes.

Three classes of stone will be used: Class A, consisting of stone weighing ½ lb. to 50 lbs. with at least 60 per cent in pieces weighing 5 to 10 lbs. each; Class B stone, weighing from 50 to 150 lbs. each, and Class C, quarry run stone. For the latter class operations at the quarry must be so conducted that at least 10 per cent of the output will be in pieces weighing 10 tons or over, 40 per cent in pieces weighing 7 tons or over and 70 per cent pieces of 2 tons or over. For the complete construction of the breakwater proper it is estimated that 78,700 tons of Class A and 1,143,000 tons of Class C stone will be required. The shore connection will require 3,000 tons Class A and 5,300 tons of Class B stone.

The bids received on Jan. 5 were submitted on two propositions: First on the work for which $1,260,000 is now available, and second on the entire work on the supposition that $3,170,000 would be available. In all 12 bids were submitted, the lowest being as follows: D. L. Taylor & Co., Medina, N. Y., $1,073,358 on the basis of $1,260,000 available, and $2,435,400 on the basis of $3,170,000 being available. The unit prices of the low bidders were as follows: (1) Standing for figures of D. S. Taylor & Co.; (2) H. P. Converse & Co., Boston, Mass.; (3) Roderick G. Ross, Jacksonville, Fla., and (4) Hardaway Contracting Co., Columbus, Ga.:

	(1)	(2)	(3)	(4)
Proposition No. 1, $1,260,000 available				
Class A, shore, 3,000 tons	$1.98	$2.38	$2.51	$2.85
Class B, shore, 5,300 tons	1.98	2.28	2.51	2.85
Class A, breakwater, 36,100 tons	1.98	2.38	2.51	2.80
Class C, breakwater, 497,700 tons	1.98	2.38	2.51	2.80
Propositioa No. 2, $3,170,000 available:				
Class A, shore, 3,000 tons	1.98	2.34	2.43	2.55
Class B, shore, 5,300 tons	1.98	2.24	2.49	2.55
Class A, breakwater, 78,700 tons	1.98	2.34	2.43	2.55
Class C, breakwater, 1,143,000 tons	1.98	2.24	2.43	2.25

Nine 600-Ft. Steel Towers for High-Power Radio Station.

Several unusually tall steel towers are to be erected for the high-power radio stations of the federal government. Bids are now being asked for the construction of nine of these towers, three to be erected at the U. S. Naval Reservation, Las Chollas Heights, San Diego, Cal.; three at the U. S. Naval Station, Pearl Harbor, Hawaii, and three at the U. S. Naval Station, Cavite, P. I.

Each tower will be approximately 600 ft. in height, of the self-supporting type, triangular in plan, the base of each leg forming the corner of a triangle 150 ft. on a side. Each tower leg will be supported on and anchored to a concrete foundation with insulating material between the base of the leg and the top of the concrete. Foundation and insulators will be furnished by the government. Based only on the general drawings the estimated total net weight of one 600-ft. tower is approximately 600,000 lbs.

The various portions of the work must be completed within the following periods from date of the contract: San Diego—Fabricated material delivered on site within 6 calendar months; tower completely erected within 11 calendar months. Pearl Harbor—Fabricated material delivered on site within 7 calendar months; tower completely erected within 12 calendar months. Cavite—Fabricated material delivered on site within 8 calendar months; tower completely erected within 13 calendar months.

Bids for the construction and erection of the towers will be received until 11 a. m., Feb. 27, by Bureau Yards and Docks, Navy Department, Washington, D. C. Bids will be on the nine towers and also on groups of three towers.

Railways Purchasing Equipment and Supplies.

One of the most encouraging developments of the past few days is the activity of the railroads in purchasing equipment and supplies. Large orders have been placed and many contracts are pending. The Pennsylvania R. R. came into the market for 170,000 tons of rails, nearly 40,000 tons more than the requirements in 1914. The Louisville & Nashville R. R. placed an order for 38,000 tons, the Pere Marquette for 8,000 tons and Ohio railroads for 15,000 tons. Other orders or negotiations for eastern railroads include 4,500 tons for the Boston & Albany, 3,000 tons for the New York, Ontario & Western, 40,000 tons for the Philadelphia & Reading, 25,000 tons for the Baltimore & Ohio, 10,000 tons for the Boston & Maine and 40,000 tons for the New York Central & Hudson River. Several western railroads also are in the market for large tonnages of rail.

The Baltimore & Ohio R. R. has placed orders for 2,000 freight cars, and also has taken options on an additional 2,000 freight cars. Announcement has been made that this company will expend $30,000,000 for new rolling stock, general equipment, replacement and extensions. A considerable amount of new equipment is to be supplied to the Chicago, St. Louis & New Orleans Ry. According to a statement filed by the Central Trust Co. of New York, the railway will be supplied with 1,000 gondola cars, 500 refrigerator cars, 5,000 box cars, 50 mikado type locomotives and 22 switch engines.

RAILWAY CONSTRUCTION IN UNITED STATES.

Statistics of Work Accomplished in 1915.

A disappointing but not unexpected record for railroad construction in the United States was made last year. According to statistics collected by the Railway Age Gazette the mileage of new lines completed in 1914 was the smallest in any year since 1895. The figures of our contemporary show that during the past 12 months only 1,532 miles of new first track, 566 miles of second track and 30 miles of third and fourth tracks were completed in this country. In 1913 a total of 3,071 miles of first track was built and placed in operation. In Canada the mileage of new first track and second track completed last year was 1,978 miles and 152 miles respectively. No new construction was reported from Mexico.

Comparative figures showing the status of work on Jan. 1 of this year and Jan. 1, 1914, are as follows:

	Jan. 1, 1915. Miles.	Jan. 1, 1914. Miles.
New first track under construction	1,015	1,522
New lines surveyed	1,229	1,511
Lines projected	2,031	1,296
Second track under construction	71	408
Second track projected	194	249

The largest amount of new line in 1914 was built in Florida, the total for this state being 220 miles. Other states with over 100 miles were California, Idaho and Washington. The Chicago, Burlington & Quincy R. R. built the longest continuous stretch of new line, this being the 61-mile extension from Casper, Wyo., to Orin Junction. The Charleston, Atlantic & Western R. R. constructed 57 miles of line from Andrews, S. C., to Charleston, S. C., and the Atlantic Coast Line completed a 50-mile extension from Dunnellon, Fla., to Wilcox. The greatest aggregate mileage completed by any one road was built by the Chicago, Milwaukee & St. Paul Ry., its total being 122 miles. The Southern Pacific Ry. built 92 miles.

Of the 566 miles of second track completed in 1914, 271 miles were built by four roads, the Chicago Milwaukee & St. Paul leading with 110 miles between Green Island, Ia., and Manila, Ia. The Atlantic Coast Line built 62 miles of second track in North Carolina: the Northern Pacific 55 miles in Washington and the Norfolk & Western 54 miles in Virginia. Approximately 64 per cent of the second track work was done in five states.

A summary of the new track built in 1914 in the various states is as follows:

United States—	No. Cos. building.	First track.	Second track.	Total miles.
Alabama	4	1.00	33.81	34.81
Arkansas	5	27.10	.50	27.60
California	9	103.91	18.94	122.85
Connecticut	1	......	2.10	2.10
Delaware	2	1.15	......	2.15[1]
Florida	7	220.46	......	220.46
Georgia	5	14.66	7.84	22.50
Idaho	3	117.22	12.89	130.11
Illinois	6	3.17	9.24	16.31[2]
Indiana	4	12.80	13.15	28.21
Iowa	4	26.16	110.00	136.16
Kansas	2	11.00	.49	11.49
Kentucky	4	31.57	16.68	48.25
Louisiana	3	7.79	......	7.79
Maine	2	.21	.61	.82
Maryland	2	......	12.14	12.14
Massachusetts	2	......	.13	2.98[3]
Michigan	4	18.81	......	18.81
Minnesota	2	8.42	......	8.42
Mississippi	2	19.15	......	19.15
Missouri	4	4.32	4.89	13.01[4]
Montana	2	48.13	2.00	50.13
Nebraska	1	.88	......	.88
Nevada	3	10.01	.70	10.71
New Jersey	2	.80	......	6.49[5]
New Mexico	2	29.47	......	29.47
New York	6	10.45	9.90	21.03[6]
North Carolina	5	34.00	71.61	105.61
North Dakota	4	63.24	4.33	67.57
Ohio	8	17.05	28.30	45.35
Oklahoma	1	4.00	5.00	9.00
Oregon	7	90.42	2.30	92.72
Pennsylvania	12	62.74	.97	69.53[7]
Rhode Island	1	......	......	1.32[8]
South Carolina	2	66.60	......	66.60
South Dakota	1	41.30	......	41.30
Tennessee	1	11.21	45.56	56.77
Texas	6	50.86	.80	51.66
Utah	1	41.95	......	41.95
Virginia	7	66.05	74.00	140.05
Washington	6	142.73	61.30	206.34[9]
West Virginia	4	19.80	5.99	26.00[10]
Wisconsin	3	29.78	9.41	39.19
Wyoming	1	61.43	......	61.43
Total	166	1,531.80	565.58	2,127.22
Canada	21	1,987.07	152.50	2,130.57

[1] Includes 1 mile of fourth or more track. [2] Includes 3.9 miles, third or fourth track. [3] Includes 2.85 miles, third and fourth track. [4] Includes 3.8 miles, third and fourth track. [5] Includes 5.69 miles, third and fourth track. [6] Includes 68 miles of third track. [7] Includes 5.82 miles, third and fourth track. [8] Third and fourth track. [9] Includes 2.31 miles, third track. [10] Includes 21 miles, fourth track.

$445,000 to Be Expended for Harbor Work in Ohio Cities.

Bids will be asked in the near future so that work may be started early in the season on Government improvements for the river and harbor district of Cleveland, O. Approximately $445,000 is available for dredging, breakwater construction and repairs in this district. This sum is apportioned as follows:

Toledo	$ 95,000
Cleveland	140,000
Conneaut	210,000

The work at Toledo harbor consists of dredging about 750,000 cu. yds. of mud and sand to complete the channel from Maumee Bay to the city to a depth of 23 ft. The existing depth varies from about 21 ft. in the center of the channel to 17 ft. at the sides. The dredged material may be deposited on the dumping ground in Maumee Bay, or may be placed behind bulkheads along the river where the contractor can make suitable arrangements with the owners of the water front.

At Cleveland harbor a section of the timber crib, east breakwater, about 1,500 ft. in length, is to be repaired by removing the timber above the lake surface and rebuilding the superstructure with stone in a manner similar to the rubble-mound breakwaters recently built in the Cleveland District. The work will require about 30,000 tons of stone.

The work at Conneaut harbor calls for the extension of the east breakwater about 900 ft. into the lake and the construction of a pierhead at the outer end. The structure will be rubble-mound and will require about 120,000 tons of stone.

Maj. P. S. Bond, Corps of Engineers, Cleveland, O., is District Engineer Officer.

Two Small Concrete Bridge Jobs in Illinois.

Two bridge contracts of interest to contractors engaging in small bridge undertakings are now being advertised for bids. Both projects are located in Winnebago County, Illinois, and both call for the construction of reinforced concrete bridges under the plans of the State Highway Commission. The main dimensions of the structures are as follows:

	Denny Bridge.	Slough Bridge.
Span, ft.	30	30
Roadway, ft.	18	20
Height over all, ft.	16	11½
Total concrete, cu. yds.	97.1	87.1
Reinforcing steel, lbs.	12,666	12,731
Distance to nearest railroad station, miles	3½	½
Estimated cost	$1,625	$1,525

The nearest railroad station to the Slough Bridge is Pecatonica, this being ½ mile from the work. The present bridge is wood, 10 ft. span, on store abutments. At low water flow the stream is dry; but at high water the stream is over the highway. The average depth of excavation is 6 ft. in clay and muck and will extend about 3 ft. below stream bed. Piles probably will be required. The work is to be completed on or before June 15, 1915.

The Denny Bridge is located about 3½ miles from Pecatonica, which is the nearest railroad station. It will replace a steel beam structure, 30 ft. span, on stone abutments. The low water flow is 1 ft. deep; high water flow, 7 ft. deep. Average depth of excavation is 13½ ft. in clay and loam and will extend about 5 ft. below stream bed to hard pan foundation. The work is to be completed on or before July 1, 1915. It is reported that gravel may be had for both bridges f. o. b. station at $1.15 to $1.25 per cubic yard. Bids for the construction of the Denny Bridge will be received by H. R. Schreider, Town Clerk, Seward Township, at Town Clerk's office, Pecatonica, until 2 p. m., Jan. 27. Bids on the Slough Bridge will be received by J. S. Tarbert, Town Clerk, Pecatonica, until 1:30 p. m., Jan. 27.

Levee and Sewer Construction at Augusta, Ga.

The River and Canal Commission of Augusta, Ga., is now calling for bids on another contract in connection with the flood protection scheme for the city. The work now being advertised calls for Section 4 of the levee, and requires 250,000 cu. yds. of earth fill and 30,000 cu. yds. of excavation. This will be scraper or wagon work. After this contract has been placed there will remain only one other section and this will be let probably in March or April. The Commission also is calling for bids for sewer construction for changing a portion of the drainage from the river to the drainage canal which has been constructed south of the city. This will involve the following:

960 lin. ft. of reinforced concrete box sewer, 7 ft. by 4½ ft.
420 lin. ft. of 48-in. brick sewer.
530 lin. ft. of 42-in, brick sewer.
760 lin. ft. of 36-in. brick sewer.
330 lin. ft. of 24-in. pipe sewer.

Bids for the levee work and sewer construction will be received by the River and Canal Commission, 747 Broad St., Augusta, until noon, Jan. 19. Nisbet Wingfield is Chief Engineer of the Commission.

According to a recent decision by the Idaho Public Utilities Commission, an auto-bus line is not a common carrier.

Central Heating, Light and Power Plant, Washington, D. C.

Plans and specifications are now approaching completion for a central heating, lighting and power plant, to be erected in Washington, D. C., under the direction of Supervising Architect's Office, Treasury Department. These plans and specifications will be ready for delivery on or after Jan. 15. Bids may be submitted for the entire work or for any one of the following sections: Power plant building complete, with steel stacks, boilers, generating apparatus, pumping equipment, condensers, coal and ash handling apparatus, steam and water piping, switching gear, tunnels, sub-station apparatus, etc. Prospective bidders should immediately submit applications for plans and specifications, stating the portions of the work upon which they desire to bid. If it appears that the applicant is in a position to bid on all of the work in any one of the sections of the project, or upon the entire work, the plans and specifications will be forwarded. No plans or specifications will be furnished sub-bidders or others not in a position to submit a bid on all of the work comprised in at least one section. The Department will be able to allow only about 15 days for the preparation of estimates. At the time plans and specifications are forwarded to bidders the date for the opening of bids will be stated, and this date will not be extended.

2,000,000 Cu. Yds. of Excavation and Levee Fill to Be Let.

Bids will be opened next week on a large earth moving contract for the Fabius River Drainage District of Marion and Lewis Counties, Missouri. The work calls for about 2,000,000 cu. yds. of ditch and channel excavation and levee fill. It provides for the construction of the Durgan's Creek, North Fabius River and South Fabius River diversion channels and levees, the South Fabius River cut-offs, the North Fabius River cut-off, Bonney levee, Mississippi River levee and interior drainage ditches. The work is divided into 10 sections as follows, all which may be awarded separately or to one or more contractors:

Section 1, Durgan's Creek diversion channel and levee covering 16,500 ft. of channel and levees, requiring 238,000 cu. yds. excavation, and the Mississippi River levee Sta. 43 to 85, requiring 45,400 cu. yds.

Section 2, Mississippi River levee, 31,540 lin. ft., 6-ft. crown, 5 to 1 side slopes 20-ft. berm, requiring 333,800 cu. yds. material for embankment and exploration trench.

Section 3, North and South Fabius River diversion levees, 19,260 lin. ft., 3-ft. crown, 4 to 1 slopes, 20-ft. berm, 271,200 cu. yds.

Section 4, North Fabius River diversion levees, 19,500 lin. ft., 3-ft. crown, 4 to 1 slopes, 20-ft. berm, 211,100 cu. yds.

Section 5, North Fabius diversion channel, 15,250 lin. ft., 30-ft. bottom width, 179,500 cu. yds. excavation, and South Fabius River cut-offs 1, 2 and 3, 8,480 lin. ft., 20-ft. bottom, 90,700 cu. yds.

Section 6, Laterals A (south of railroad), A-1, A-1-1, B and C, 66,300 lin. ft. in all, 10-ft. bottom, 10-ft. berm, 270,200 cu. yds.

Section 7, Laterals A (north of railroad), D, D-1 and D-2, 59,000 lin. ft. in all, 10-ft. bottom, 10-ft. berm, 307,000 cu. yds.

Section 8, North Fabius River cut-off, 960 lin. ft., 20-ft. bottom, 11,000 cu. yds.

Section 9, North Fabius River diversion, last levee, 540 lin. ft., 3-ft. crown, 2,600 cu. yds., Bonney levee, 6-ft. and 14-ft. crown, 2,600 lin. ft., 19,000 cu. yds.

Section 10, Mississippi River levee, 2,000 lin. ft., 6-ft. crown, 16,400 cu. yds.

Bids for the work for the Fabius River Drainage District will be received at the office of the Secretary, J. H. Best, Illinois State Bank, Quincy, Ill., until 9:30 a. m., Jan. 20. The Harman Engineering Co., Peoria, Ill., is the engineer.

PERSONALS

Mr. S. B. Robbins, member of the American Society of Civil Engineers, has opened an office in the new Ford building, Great Falls, Mont., as consulting engineer, specializing in irrigation, drainage and agricultural development.

Mr. G. W. Rice, who for the past seven years has been chief engineer of the Goose Lake Valley Irrigation Co. in the construction of their irrigation system near Lakeview, Ore., has resigned upon completion of the construction work.

Mr. Arthur G. McKee announces that Mr. Robert E. Baker and Mr. Donald D. Herr, his business associates during a number of years past, have joined him in the incorporation of his engineering and contracting business under the name of Arthur G. McKee & Co., contracting engineers, Cleveland, Ohio.

Mr. Chester M. Everett, who for the past eight years has been an employe of the firm of Hazen & Whipple, consulting engineers, 30 E. 42nd St., New York City, has been admitted to partnership in that firm. It is also announced that the firm name has been changed to Hazen, Whipple & Fuller. This change is made on the twentieth anniversary of the foundation of the business. The firm name was first Noyes & Hazen, and this continued for two years. After Mr. Noyes' death the business was conducted first under Mr. Hazen's name, and for the last eleven years under the name of Hazen & Whipple.

Mr. Edward D. Boyer, cement and concrete expert of the Atlas Portland Cement Co., delivered a lecture on Dec. 14 on "The Construction and Maintenance of Cement Concrete Pavements" before the graduate students in highway engineering at Columbia University. Other December lecturers and their subjects were as follows: Mr. William A. Howell, M. Am. Soc. C. E., engineer of streets and highways of Newark, N. J., on Dec. 16, illustrated lecture on "Specifications for Physical Properties of Paving Bricks and Stone Blocks." Mr. Nelson P. Lewis, M. Am. Soc. C. E., chief engineer Board of Estimate and Apportionment, New York City, Dec. 23, illustrated lecture on "Planning of Streets and Street Systems;" Mr. C. N. Forrest, Assoc. M. Am. Soc. C. E., chief chemist, Barber Asphalt Co., on Dec. 28, illustrated lecture on "Production of Bermudez and Trinidad Asphalts."

Mr. Claude E. Chappell has been appointed city manager for Jackson, Mich., by the new commission of that city which took office on Jan. 1. Mr. Chappell, who for the past eight months has been city manager of Big Rapids, Mich., was chosen from a field of twenty or more applicants, including several who have had actual experience with the new form of municipal government. A brief biographical sketch and a photograph of Mr. Chappell appeared in our issue of June 24, 1914, shortly after his acceptance of the position at Big Rapids. He has had wide experience in all lines of municipal engineering work, and during his tenure of office as city manager has added experience in financial supervision, fire and police department work and other non-engineering municipal matters. Jackson, a city of 38,000, is one of the largest cities to adopt the commission-manager system so far, and Mr. Chappell's work will be watched with interest.

Mr. George A. Warner has resigned as city engineer of York, Pa., to enter into business as consulting and contracting engineer, with office at 230 Carlisle Ave., York, Pa. He is prepared to handle all kinds of municipal work, farm surveys, etc., and will make a specialty of road construction and street paving. Mr. Warner was for seven years in private practice as a landscape architect, engaged in park, cemetery and private estate development, constructing roads, lakes, dams, sewers, etc. In 1902 he entered upon other lines and for a time was employed in railroad construction and location, mine development, furnace and mill construction, as engineer for the Alabama Steel & Wire Co. and for Edward Campbell of Ardmore, Pa. Later he did considerable county and borough work and was for two years engineer and superintendent of construction on water supply and municipal improvements. In 1907 he became engineer for the state highway department of Pennsylvania and resigned that position in 1911 to become city engineer of York, Pa.

Mr. George P. Du Bose has been appointed superintendent of the plant of the Holt Manufacturing Co. at Stockton, Cal. Mr. Du Bose has been with the company only a short while in charge of constructing exhibition machines for the two 1915 expositions, but his ability shown in that work and his record elsewhere made him a choice for the position. Since the retirement of Mr. George W. Haines from active work several years ago no general superintendent had been appointed, and the selection of Mr. Du Bose comes only after a very careful canvass of available men in various parts of the country. After the San Francisco fire Mr. Du Bose took an active part in the rebuilding of the city, acting as superintendent of construction for D. H. Burnham & Co. and the Thompson-Starrett Co. As general superintendent of bridge construction for the Western Pacific Railway he built most of the bridges in Nevada and upper California. He was also consulting engineer in the construction of the Chilkoot and Spring Garden tunnels in Feather River Canyon. He was engineer in charge of work on the Solano Irrigated Farms. In building a ditch for this company he took out 1,500,000 cu. yds. of dirt in 45 days. Previous to his construction work Mr. Du Bose had a variety of experience in modern shops.

OBITUARIES

James W. McCabe, railroad contractor of New York City, died suddenly Jan. 3.

J. H. Jennings, railroad contractor of Joplin, Mo., died in that city Dec. 28, aged 50. He had been in railroad building work for over thirty years.

Chauncey Ives, for many years chief engineer of the Cumberland Valley Railroad, died suddenly at Hood River, Ore., Jan. 5, aged 73. Mr. Ives was also formerly chief engineer of the Bay Ridge Improvement Co., Long Island.

Arthur R. Lester, grading contractor of Denver, Colo., died at his home in that city Dec. 27, aged 57. For many years he was associated with Peter McGurk of Denver. He went to Colorado thirty years ago from Mt. Sterling, Ill., and has been in the railroad contracting business there ever since.

CIVIL SERVICE NEWS

The State Civil Service Commission of Illinois announces an examination as follows:

Assistant Utilities Engineer.—Saturday, Feb. 6, 1915, at Anna, Chicago, Dunning, East St. Louis, Elgin, Jacksonville, Kankakee, Lincoln, Macomb, Mt. Vernon, Peoria, Pontiac, Springfield, Urbana and Watertown. Open to men over 21 years of age who are residents of Illinois. Salary, $90 a month, possible increase to $125.

Principal duties are to investigate cost records, check inventories of public utility properties, and investigate operating methods to determine fair value of such properties. Candidates should have the equivalent of two years of technical training in an engineering school of recognized standing; and should have experience in connection with the operation, design, or construction of public utility properties. Experience in the valuation of such properties is very desirable. Familiarity with the Illinois Public Utility Act is necessary. Applications must be on file at the office of the Commission in Springfield not later than 5 p. m., Saturday, January 30, 1915. The proper forms may be secured by addressing the State Civil Service Commission, Springfield, Illinois.

Junior Engineer, State Highway Commission.—Salary, $75 per month and expenses. Residence in Illinois not necessary. Minimum age, 21. Applications must be filed before Feb. 27. Examination held Mar. 6.

RAILWAYS

PROSPECTIVE WORK.

California:

San Diego, Cal.—State Railroad Commission has approved agreement of John D. and A. B. Spreckels to purchase $3,000,000 of stock of San Diego & Arizona Ry., and also plans for construction of Mexican link of the company.

Illinois:

Carbondale, Ill.—Election was held Jan. 12 to vote on franchise for line for Murphysboro & Southern Illinois Ry. Co., Murphysboro, to connect Carbondale and Murphysboro.

Minnesota:

St. Paul, Minn.—Plans for new union depot have been submitted to City Council by Union Depot Co., representing nine interested railroads. Improvement will cost $15,000,000 and will include 3-story building; ground area of depot and terminals will cover 54 acres; diversion of Mississippi River channel is included.

Missouri:

Kirksville, Mo.—Commercial Club is raising bonus of $20,000 for securing 2-mile spur of Big Creek R. R. to open up coal and clay fields west of the town.

North Carolina:

Andrews, N. C.—Hiawassee Valley R. R. is reported to be about to let contract for 14 miles of its proposed line. O. L. Anderson, Hayesville, N. C., is President.

Ohio:

Portsmouth, O.—Portsmouth Street Ry. & Light Co. is reported to have sold $500,000 bond issue and will begin construction soon on new line to Ironton. R. D. York, Portsmouth, is General Manager.

Oregon:

Pendleton, Ore.—Oregon-Washington Ry. & Navigation Co. may start work in spring on proposed freight terminal at Pilot Rock Junction near Pendleton.

Pennsylvania:

Chambersburg, Pa.—Charter will be secured soon for electric railway to connect McConnellsburg and Fort Louden. Line will be about 10 miles long, and preliminary surveys will be started soon. Edward J. Post, D. H. Patterson and Herbert A. Duffy are interested.

Virginia:

Winchester, Va.—Baltimore & Ohio R. R. is reported to be securing right of way in Berkeley and Jefferson Counties, West Virginia, for new cutoff from Cumbo to Harpers Ferry. It is stated that there are some prospects that work will be started this spring.

South Dakota:

Winner, S. Dak.—Chicago & Northwestern Ry. is reported planning to start work in spring for extension westward from Winner through Tripp County and into Mellette County.

Washington:

Seattle, Wash.—Citizens may vote at March election on purchasing Seattle, Reuton & Southern street car system for $1,500,000.

BIDS OPENED; CONTRACTS LET

Arizona:

Douglas, Ariz.—Bids are reported to have been taken for construction of the Mascott & Western R. R. This will be a 36-mile line connecting the Mascott Mine in the Dos Cabesas District with the El Paso & Southwestern R. R. near Kelton. Grading work will be light. C. P. Hennings is engineer in charge.

Minnesota:

International Falls, Minn.—Minnsota and Ontario Power Co., Minneapolis, is reported to be awarded contract for 25 miles extension of Minnesota, Dakota & Western Ry. from Littlefork to Craig.

South Carolina:

Charleston, S. C.—Smith & Kyle have started work on their contract for grading for 2-mile extension of Consolidated trolley car track to North Charleston.

Utah:

Ogden, Utah.—Phelan-Shirley Co., New Omaha National Bank Bldg., Omaha, Neb., has been awarded contract for 7 miles of double tracking between Ogden and Gateway Bridge for Oregon Short Line Ry. Subcontract for part of work has been let to Christensen Construction Co., Salt Lake City. Contract involves team work, steam shovel work and 250-ft. tunnel.

Wisconsin:

Oshkosh, Wis.—Wisconsin & Northern R. R. has awarded a contract clearing 10 miles of right of way at the Shawno end of its proposed 27 miles of new line between that place and Crandon. Contract for 10 miles of grading south from Crandon also has been let.

ROADS STREETS

BIDS ASKED.

Alabama:

Tuskegee, Ala.—Until Jan. 14, by E. M. Thompson, Mayor, for 10,000 ft. concrete curb and gutter.

Arizona:

Phoenix, Ariz.—Until 5 p. m., Jan. 18, by Earl H. Parker, Supt. of Streets, for paving with bitulithic the roadway of Madison St.

Indiana:

Rensselaer, Ind.—Until 2 p. m., Feb. 2, by Joseph B. Hammond, County Auditor, for 16,000 ft. of stone road in Carpenter Township, 5,300 ft. of stone road in Walker Township.

Fowler, Ind.—Until 1 p. m., Feb. 1, by Warren Waukey, County Auditor, for gravel road in Center Township. Estimated cost $16,040.

Brazil, Ind.—Until 10:30 a. m., Feb. 2, by Wm. O. Grasser, County Auditor, for stone road in Lewis Township.

Crawfordsville, Ind.—Until 10 a. m., Feb. 2, by B. B. Engle, County Auditor, for concrete road in Warner Township, gravel and stone road in Union Township, brick and concrete road in Franklin Township, stone road in Clark Township and concrete road in Union Township.

Tipton, Ind.—Until 10 a. m., Feb. 1, by Oscar Van Ness, County Auditor, for gravel road on boundary line between Prairie and Liberty Townships.

Valparaiso, Ind.—Until 2 p. m., Feb. 1, by C. A. Blachly, County Auditor, for gravel road contracts estimated to cost $17,230.

Maryland:

Baltimore, Md.—Until noon, Jan. 19, by State Roads Commission, Wm. L. Marcy, Secretary, for roads as follows: Dorchester County, Contract No. D-11, road from Linkwood to Mt. Holly, about 2.69 miles in length, concrete or macadam.

Baltimore, Md.—Until noon, Jan. 19, by State Roads Commission, Wm. L. Marcy, Secretary, for 1.5 miles of sheet asphalt paving for Hanover St. bridge and approaches.

New Jersey:

Camden, N. J.—Until 8 p. m., Jan. 18, by A. B. Sparks, Chairman, Committee on Streets, for repair of brick and cement sidewalks and paving new sidewalks for 1915.

New York:

New York, N. Y.—Until 11 a. m., Jan. 20, by L. H. Pounds, President Borough of Brooklyn, for 8 street improvement contracts. Largest calls for grading, curbing and laying sidewalks on E. 12th St. Contract includes 14,680 cu. yds. of fill, 2,840 lin. ft. steel bound concrete curb and 13,540 sq. ft. cement sidewalks.

New York, N. Y.—Until 11 a. m., Jan. 20, by L. H. Pounds, President Borough of Brooklyn, for 2,000 tons limestone or other suitable inorganic dust for municipal asphalt plant.

Ohio:

Ashtabula, O.—Until noon, Jan. 23, by Director Public Service, for about 16,000 sq. yds. of brick pavement.

Mt. Gilead, O.—Until 11 a. m., Jan. 29, by C. O. Higgins, County Auditor, for ¾ mile of road in Washington Township.

Marion, O.—Until noon, Jan. 16, by V. Perle Garfield, Clerk Board of County Commissioners, for regrading and resurfacing the Crissinger Pike road; estimated cost $6,081.

Texas:

Waco, Tex.—Until Feb. 8, by County Auditor, for iron culverts for road maintenance work during 1915.

Virginia:

Alexandria, Va.—Until Jan. 22, by Board of Awards, at office of Chief Clerk, Office of Public Roads, Washington, D. C., for experimental road on Mt. Vernon Ave. requiring about 29,000 cu. yds. excavation and 42,000 sq. yds. bituminous surfacing.

Washington:

Everett, Wash.—Until Jan. 25, by County Commissioners, for filling in trestle on Cavalero Road, requiring placing of 30,000 cu. yds. of earth.

Chehalis, Wash.—Until Feb. 6, by Lewis County Commissioners, for paving one mile of 18-ft. concrete road between Chehalis and Centralia; estimated cost, $15,500.

PROSPECTIVE WORK.

California:

Porterville, Cal.—It is proposed to cover the entire residence section within the city limits with concrete walks next spring.

Colorado:

Denver, Colo.—Board of Public Works has decided upon alley paving that will cost approximately $17,000. Work will be ordered finally Feb. 17.

Connecticut:

Hartford, Conn.—Street Board has decided to take preliminary steps towards widening Maple Ave. 10 ft. from Bond St. to the city line. Roscoe N. Clark is City Engineer.

Delaware:

Wilmington, Del.—Council favors plan to issue $350,000 in bonds for street improvements.

Georgia:

Macon, Ga.—Voters will be asked to pass upon the question of issuing $300,000 in bonds at a special election to be held March 4, for paving, sewers and hospital needs.

Illinois:

Naperville, Ill.—Proposition to pave 11 streets at an estimated cost of $104,000 has been postponed.

El Paso, Ill.—Village Board passed ordinance providing for $50,000 worth of brick pavement to be put down next summer.

Ottawa, Ill.—Local Improvement Board decided to extend the pavement on Jackson and Jefferson Sts., from Sanger St. to Armstrong St. City Engineer Geo. Farnsworth estimates the cost at $19,369.

Peoria, Ill.—Local Improvement Board passed resolution authorizing the opening of Locust St., Adams St. to Warner Ave.

Rockford, Ill.—Board of Local Improvements approved a petition for paving North Prospect with macadam. Estimated cost, $11,000.

Belleville, Ill.—A bill is before Council providing for the paving of Rock road at a cost estimated over $100,000.

Indiana:

Indianapolis, Ind.—Board of Public Works postponed until March 1 hearings on resolutions for paving Pennsylvania St., Maryland to Georgia Sts., and from Virginia Ave. to Maryland St.; Pearl St., Pennsylvania to Illinois Sts., and Court St., Illinois St. to Capitol Ave.

Indianapolis, Ind.—Board of Park Commissioners adopted resolution to include the acquisition of land and construction of a boulevard along the stream from Madison Ave. to Garfield Park. It was estimated the cost will be $60,000.

Indianapolis, Ind.—Board of Park Commissioners adopted resolution for the acquisition of land and construction of a boulevard along both sides of Pleasant Run from Raymond to Beecher Sts. The estimated cost is $87,500, of which $31,000 is for construction work.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

Volume XLIII. CHICAGO, ILL., JANUARY 20, 1915. Number 3.

A Call for Adequate Support of the U. S. Coast and Geodetic Survey.

The great importance of the work which has been done and is being done by the Coast and Geodetic Survey of the United States is known to engineers. Very few engineers, however, have knowledge of the handicaps under which this work has been and is being carried on. The assertion that the Survey is inadequately provided with housing accommodations, with vessels, with apparatus and with funds only partially indicates the facts. The housing accommodations are not only inadequate and uneconomical, but are unsafe and unsanitary. These statements are from reports of the building officials of the District of Columbia and of the Federal Public Health Service. The vessels provided for coast survey work are in no single instance thoroughly modern in accommodations and equipment and in three instances are practically unseaworthy. So lacking in all requisites for wholesome living is one of these vessels that in his last report Secretary of Commerce Redfield says: "I protest in the name of ordinary decency, against being obliged to continue such a vessel in service." This is not an isolated example. All through the forty pages of his report on the Survey the Secretary is citing examples of obsolete, uneconomical, unsafe and crude apparatus, equipment and methods compelled by lack of funds. In comment on the service as a whole it is pointed out that it is the oldest scientific service of the Government; that it has invented and made instruments of precision of the highest value; that its geodetic and coast survey work has been a model in speed, accuracy and economy; that it operates under conditions which "put the nation to the blush." Engineers have an opportunity here to perform a needed service. They can, through their organizations, take concerted action which will compel consideration of the Survey's requirements. They should justify their doctrines by taking action.

Exposition Structures, with Particular Reference to the Tower of Jewels.

The great expositions of the past have all required the construction of large and carefully planned buildings and other structures of special interest. After the close of these expositions most of the buildings have been wrecked, the sites have been cleared, and there is left to us only a memory of the principal features presented. Even though the structures were generally of a temporary character, they did, however, possess engineering features of considerable interest; in fact the necessity of accomplishing something definite at a minimum expenditure often required the highest type of engineering skill and ingenuity. It is to be regretted that our engineering literature does not contain specific and complete data on these structures for the general use of engineers in the practice of their profession. The advisability of keeping permanent records concerning engineering work was not appreciated by those in charge of former expositions, and few data are now available. The engineering department of the Panama-Pacific International Exposition is to be commended for the attitude it has taken in making public the engineering features of the structures built by it. Not only has information been made readily available to engineering publications, but the various engineers in charge of the design and erection of certain structures have prepared articles describing and illustrating in detail the essential features of their work. These engineers are serving the engineering profession in a substantial way and are establishing a precedent which should be followed by those in charge of succeeding expositions. By making public the information in advance of the opening date they have also been able to do efficient advertising work and thus make their services of increased value to their employers.

In previous issues of Engineering and Contracting we have published articles on various projects connected with this exposition. In the "Buildings" section of this issue there appears an article on the design and construction of the 435-ft. steel framed "Tower of Jewels," which possesses many interesting features, and which was built at a cost of about $420,000. The details of the steelwork are fully described and illustrated, while the main architectural features are also set forth. The design and erection features of the timber work are described, but no illustrations for this part of the work are shown, as they will be given in a later issue.

The steelwork consists principally of six main frames, parallel in plan, which are designed as two-hinged arches, and which form a monumental archway—the main entrance to the exposition grounds. The ends of each arch are connected by steel ties and rest on segmental, spherical cast-steel bases. By means of these specially designed and carefully fabricated bases the loads are equalized on the reinforced concrete footings and pile foundations. The magnitude of the structure, the care with which each part of it has been analyzed, and the completeness of the published data make the article one of special value to structural engineers, as many of the principles are also applicable to other types of steel structures.

Short College Courses in Highway Engineering or Annual Meetings of State Associations of Highway Engineers: Which is the Better Plan?

Within the past few weeks announcements have been made by a number of prominent engineering schools that short courses in highway engineering from one to eight weeks in length would be offered. Announcements have also been made of various state meetings of road foremen and engineers for the purpose of discussing methods of construction and the interchange of ideas, these meetings lasting from a few days to several weeks. Apparently the object of both is to increase the efficiency of men engaged in road construction work. The motive is undoubtedly good; which is the better plan?

The object of thorough engineering schools is to train men in the fundamentals of engineering, of the associations to increase the efficiency of men already employed in highway work. To what extent is this object attained by short college courses? If such a course is taken by an engineer already expert in other branches of engineering does he need the elementary training in fundamental principles of engineering that are the same for all branches, and does he receive practical information that would be of service in constructing roads? For instance, would a railroad engineer after taking a short course in highway engineering be competent to inspect the laying of a brick pavement or supervise the operation of a road maintenance crew. Can details and methods be learned from lectures or should they be absorbed on the actual work?

On the other hand, does a short course in highway engineering train a road superintendent, experienced in the details of road construction, in the economics of engineering and instill in him the engineering viewpoint, or the faculty to weigh and judge matters pertaining to engineering designs, that it has been held by many requires years of broadening study to achieve? At such a short course does a man obtain a clear grasp of the subject or does he merely acquire the patter of the art and a multitude of ideas that previous training has not prepared him properly to digest?

It must not be inferred that these short courses are absolutely lacking in value. They give men a certain superficial familiarity with road work that enables them to undertake the construction of roads and obtain actual experience in the work from the contractor, or by a series of experiments while the work is in progress that will aid them in digesting the rather large dose of ideas given in the short course.

Graduate courses in road engineering given to graduate or experienced engineers that deal exclusively with the theory of road construction are timely and have a well defined place in our engineering schools. Also trade schools that teach the details of a subject have a growing field. But the average short course covers neither field thoroughly, it is neither "meat nor flesh." Radical modification of these courses is necessary if they deserve to be continued.

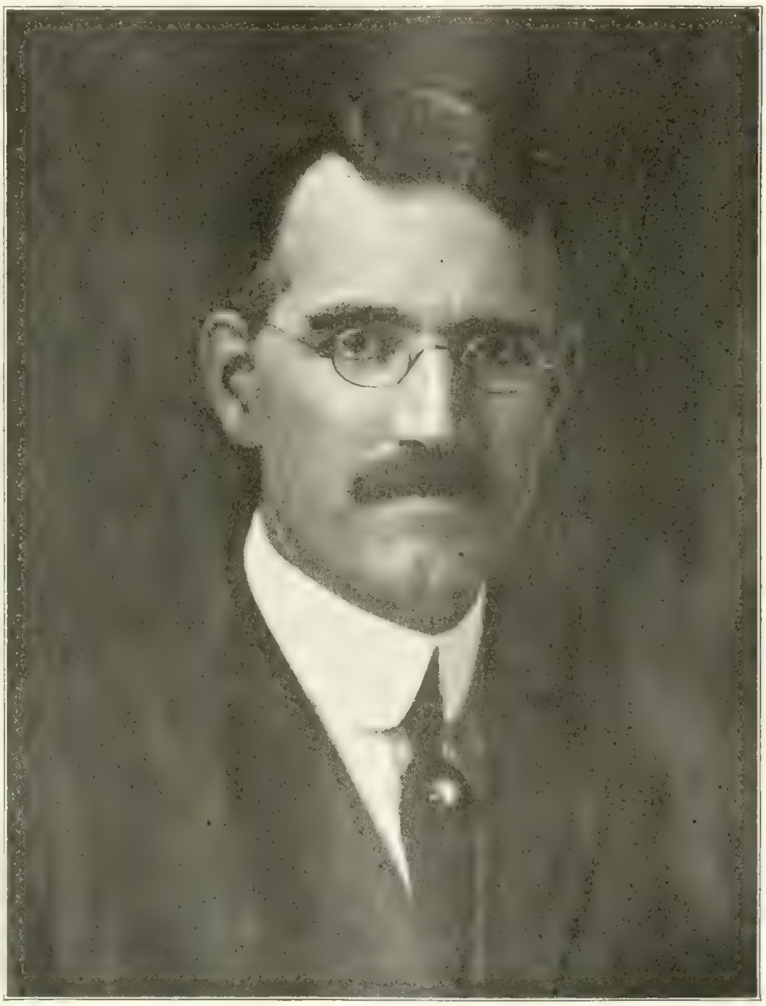
Meetings of state associations of road engineers and foremen, or the road school as it is called in Wisconsin, have for their object the interchange of ideas and the development of "esprit de corps" among state employes. At one such meeting the following subjects were discussed: accounting details, the improvement of main highways and radiating roads, the use of asphaltic oil on gravel roads, securing right of way, and helpful lines of study for engineers. At another meeting various types of road machinery are studied in detail and other subjects of a similar practical nature discussed. Attendance is required of employes but others may attend should they so desire. These meetings are similar in nature to the annual schools of study required of teachers and are a distinct aid in securing efficiency.

An important problem of road construction and maintenance is the securing of competent inspectors and foremen with initiative and a knowledge of details, in short, trade school men. A large number of engineers is not needed for any construction work and competent and well trained men are available. The training of an engineer in the work of a foreman is unsatisfactory, since as soon as trained he leaves the work to follow his profession. Similarly, the engineering patter acquired by the average foreman or inspector comes not from the reasoning mind but from the memory.

Meetings and schools supervised by state highway departments that have for their end the increasing of the efficiency of employes deserve the utmost encouragement. Results obtained have been excellent and the principles upon which they are based are sound. The undertaking of trade school work by engineering schools, however, is fraught with grave danger to the school, to the standards of the engineering profession, and to the man who attends such a course and perhaps receives false ideas as to its effectiveness in aiding him to secure the training desired.

WILLIAM B. JACKSON, President of the Western Society of Engineers.

William B. Jackson, member of the firm of D. C. and William B. Jackson, consulting engineers of Chicago, was elected president of the Western Society of Engineers at the annual meeting held in Chicago, January 13-14, 1915. Mr. Jackson has long been actively identified with the Electrical Section of the society, and when the members decided that it was time that a president be elected from that section, the choice fell on him.



Wm B. Jackson,

Mr. Jackson was born in Kennett Square, Pa., in 1870. His father, Josiah Jackson, was a professor of mathematics at the Pennsylvania State College, and the son received his technical training at that institution. He took the mechanical engineering course, graduating with the degree of B. S. in 1890. Five years later he received his degree in mechanical engineering in recognition of certain field work and a thesis.

After graduation Mr. Jackson began a varied career by taking a position in a bank in Colorado Springs. In 1893 he had charge of the Pennsylvania Mining exhibit at the World's Fair in Chicago, and at the close of the fair he installed that exhibit at the Pennsylvania State College. He also spent some time at that institution in studying electrical engineering. Later in 1894 he became inspector for the United Electric Light & Power Co. of New York City, and then for a time was connected with the Stanley Electric Manufacturing Co., in the shops and testing department, becoming later engineer in charge of specifications. In 1895 he was transferred to Chicago as engineer for the Northwest, having charge of all plant installation and engineering work in that district for the company.

It was while holding this position that Mr. Jackson undertook the completion and starting up of the Lowell-Grand Rapids Power Transmission system in Michigan, which was the first high tension electric tranmission system to be started east of the Rocky Mountains. In 1896 he became manager and chief engineer of the Lowell Water & Light Co. and the Peninsula Light, Power & Heating Co. of Grand Rapids. He developed an improved method of charging for light and power wherein a uniform basic charge is made per unit of translating devices operated by the consumer, to which is added an equitable charge for each unit of power actually used. This system of charging has been widely adopted as a just one for both consumer and company.

Mr. Jackson also devised means for working upon the live circuits of the high tension transmission line replacing the line insulators while the line was in service.

In 1897 he re-entered the service of the Stanley Electric Manufacturing Co., having charge of the installation and testing of the two-phase alternating current generator sets at the West New Brighton plant of the New York & Staten Island Electric Co. He later became superintendent and chief engineer of that system.

In 1899 he became general superintendent and chief engineer of the Colorado Electric Power Co., and while holding that position he perfected several other valuable devises now in use.

He again joined the Stanley Electric Manufacturing Co. in 1901 as traveling engineer, his work including the inspection of and reporting on all lighting and power projects in which the company was interested.

During this time he designed the 20,000 hp. hydro-electric station of the York, Haven Water & Power Co. on the Susquehanna river, and also carried out work of this kind in Austria and Hungary.

With his brother, Dugald C. Jackson of Madison, Wis., Mr. Jackson in 1902 opened the consulting engineering office which has become well known under the firm name of D. C. and William B. Jackson. The firm was first established in Madison, but removed to Chicago in 1907, and is now located in the Harris Trust building on Monroe street. A second office was later established in Boston.

The firm has been engaged on the design and supervision of construction of many important electrical projects, in valuation and rating examinations, in the laying out and carrying out of improvements of the physical and operating features of electrical properties and other lines of civil and electrical engineering work. Mr. Jackson's experience has included pioneer work in the manufacture of polyphase electrical apparatus, and the installation and operation of central stations and electrical transmissions.. Mr. Jackson is also a director of the Cutler Hammer Mfg. Co. of Milwaukee.

Mr. Jackson has always been actively interested in the work of the engineering societies. He is a member of the American Institute of Electrical Engineers, being also a member of the board of managers of that society. He is a member of the council of the American Society of Mechanical Engineers, and a member of the American Society of Civil Engineers, the American Gas Institute, the National Electric light Association, the American Electric Railway Association, the Engineers' Club of Chicago, the Engineers' Club of Boston, the Association of Commerce and the Union League Club, of Chicago, the City Club, the Press Club, the Mid-Day Club and Flossmoor Country Club, all of Chicago, and the Association of Commerce of Milwaukee.

Mr. Jackson makes his chief headquarters at the Chicago office of the firm, his residence being in Winnetka, Ill.

BUILDINGS

Design and Construction of the 435-Ft. Steel Framed Tower of Jewels at the Panama-Pacific International Exposition.

Contributed by Frank S. M. Harris, Assistant Structural Engineer, Panama-Pacific International Exposition.

(In this article the design and erection of the steel frame of the tower are fully described and illustrated. The design and erection features of the timber framing are also described, but no details are shown. As the timber details are exceptional they will be given in a later issue.—Editors.)

The main entrance tower at the Panama-Pacific International Exposition occupies a commanding position at the head of the "Court of Honor." Rising to a height of 435 ft., it overtops the surrounding domes and arches by 250 ft. or more, thereby fulfilling its function as the dominant feature of the architectural scheme.

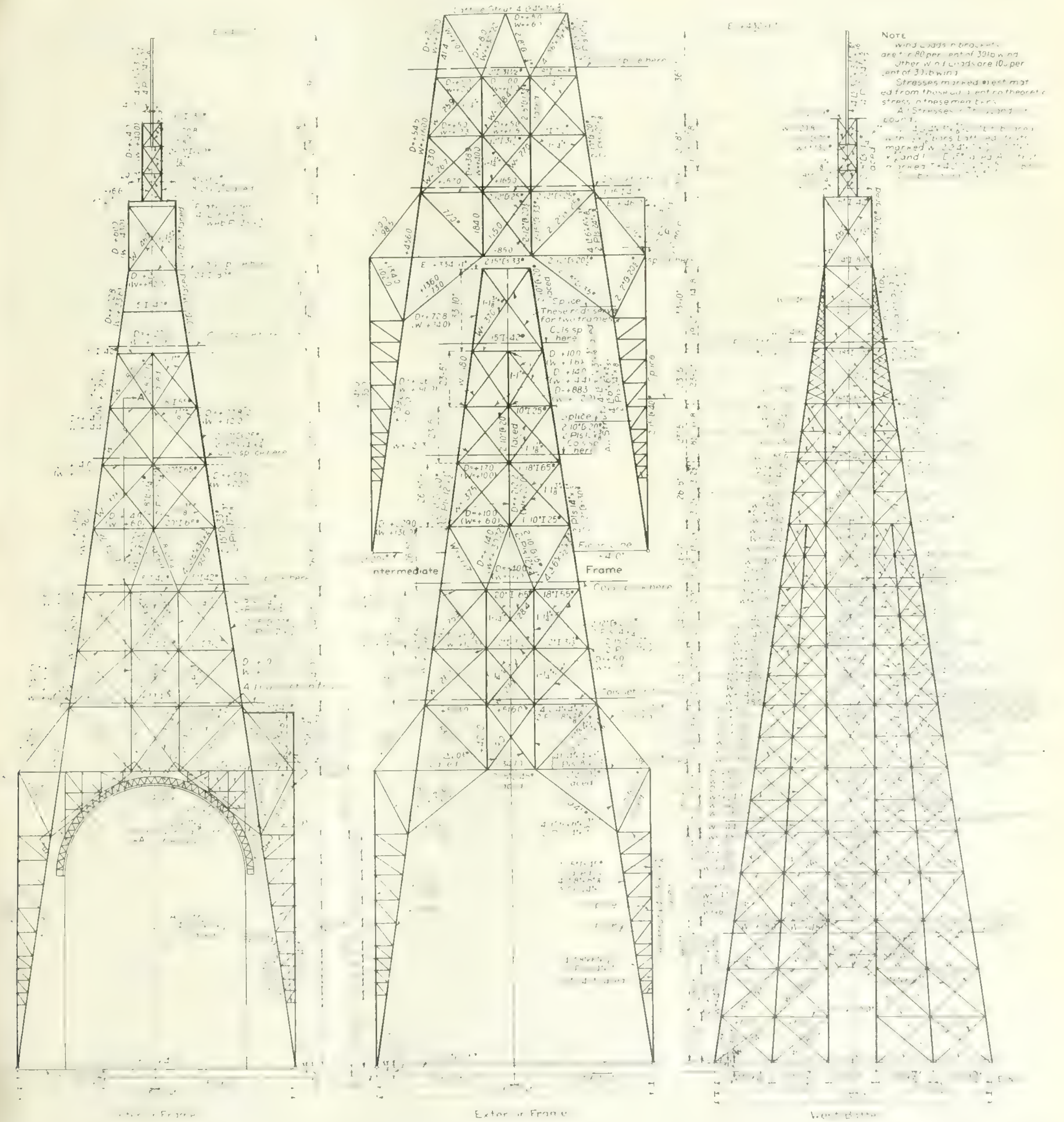


Fig. 1. Stress Sheet Showing Exterior, Intermediate, Interior and West Batter Steel Frames of Tower of Jewels, Panama-Pacific International Exposition, San Francisco, Cal.—Also see Fig. 2.

To an elevation of 152 ft. above the ground the walls of the tower rise vertically, forming a huge cube, 120 ft. square in plan; this cube being pierced in a north-and-south direction by a barrel arch, the soffit of which is 119 ft. above the court. Above the top of the cube the structure consists mainly of a series of cylindrical portions of variable and rapidly decreasing diameter, composed of balustrades, colonnades, and heavy belt courses. The outstanding ornament upon these upper decks is elaborate. The structure gains its name, "The Tower of Jewels," by the studding of its exterior with thousand of cut-glass jewels which, in the bright sun or under the searchlight beams at night, are expected to present a brilliant and dazzling spectacle.

Flanking the tower proper, to the east and west, and extending the whole width of the "Court of Honor," are colonnades surrounding rectangular courts which contain the "Fountains of Youth."

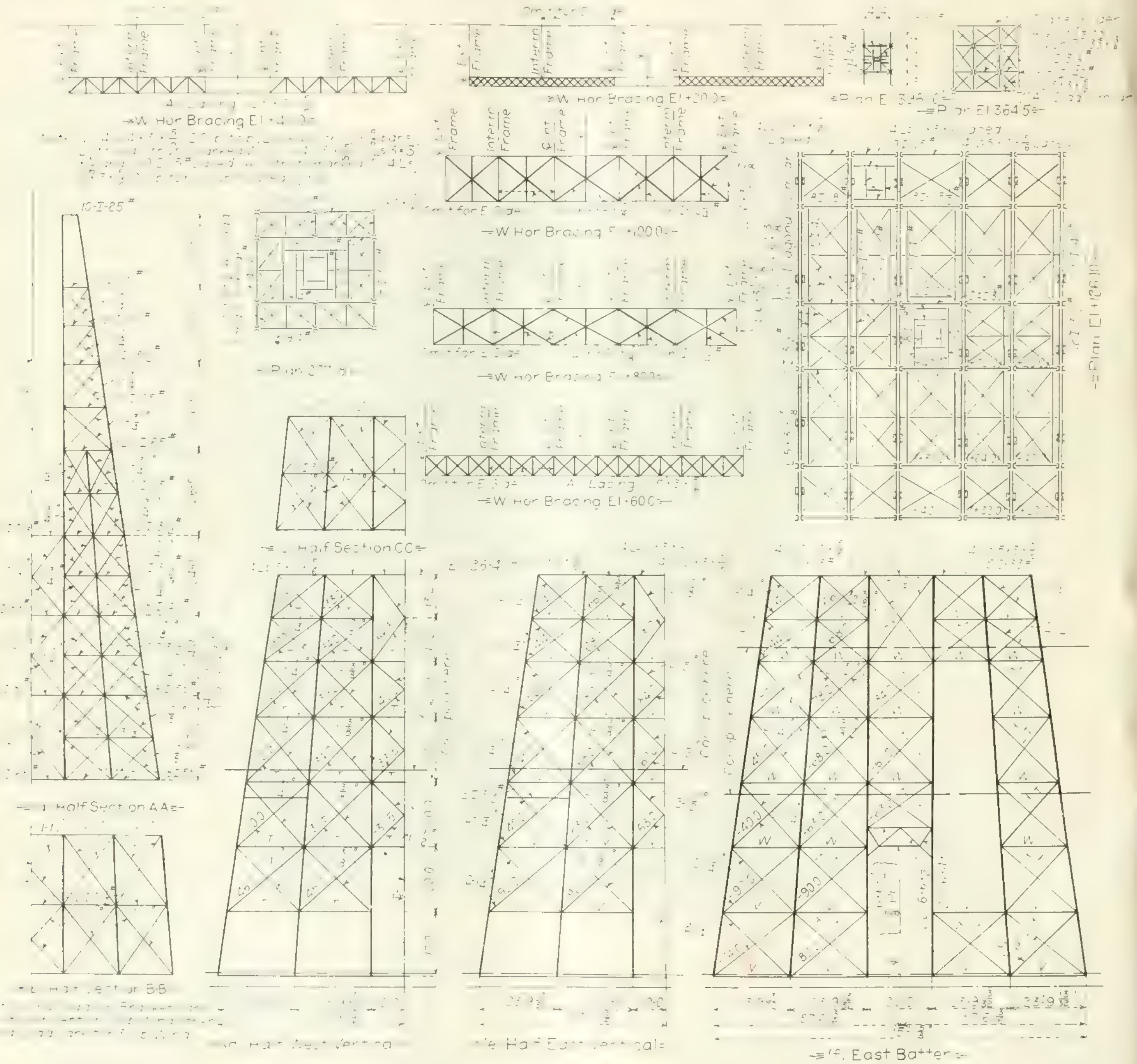


Fig. 2. Stress Sheet Showing Various Steel Frames and Bracing of Tower of Jewels—Also see Fig. 1.

The main frame of the tower is of steel (see Figs. 1 and 2) supporting an exterior shell of timber, plaster, and staff. The great rectangular box, below elevation 152 ft., as well as the flanking colonnades are self-supporting timber structures, but slightly tied back to the steel frame. The coffered ceiling of the barrel vault is suspended from the steel arches. Above the rectangular section the successive decks are carried on timber brackets, resting in seats provided on the steel frame and secured to it by rods and clip angles. Upon these decks are framed the walls and outstanding ornaments of the tier above.

THE STEEL FRAME.

The steel structure consists mainly of six frames (see Fig. 1) parallel to each other in plan, two of them vertical, the other four battered. The two vertical frames, designated as the "interior frames," rise to an elevation of 364 ft., being spaced 20 ft. center to center, throughout. The two "exterior frames" are battered so as to meet the vertical interior frames at elevation 335 ft. The "intermediate frames" also batter, at half the rate of the exterior frames, and if produced they would also intersect the interior frames at elevation 335 ft. The intermediate frames, however, are discontinued at elevation 227 ft., to simplify the construction. Above elevation 335 ft. all columns are vertical.

Below elevation 152 ft. the six frames are constructed as two-hinged arches, with elastic ties, their feet resting on twelve cast steel spherical bases, which are in turn supported upon reinforced concrete slab footings, capping pile clusters.

Cross-bracing is introduced between the six frames, both in the planes of the main batter posts and in the planes of the lower vertical members of the main arches, from elevation 126 ft. to the ground. Bracing is further provided in the planes of the kneebraces and in the hip members of the arches. These diagonal tension members take the form of square upset rods, except in the immediate vicinity of the portals on the east and west axis, and adjacent to the elevator shaft in the northeast quadrant, where stiff diagonals composed of four angles and lacing are employed to take either the tension or compression that may come upon them, due to the discontinuity of the tension diagonals.

Horizontal bracing is placed at 20-ft. intervals, vertically, in the lower legs of the frame, and at approximately 25-ft. vertical intervals, immediately below the floors, throughout the upper reaches of the frame.

DEAD LOADS.

The exterior walls consist only of staff and plaster on metal lath, spiked to the studding and furring timber. With the exception of a loose plank floor at elevation 152 ft., intended to protect the main plaster arch from injury by falling objects, there are no complete floors in the building, the several decks extending only a few feet inside the exterior walls.

Inasmuch as spectators are not to be permitted within the tower, even these floor systems were considerably lightened in the design. A live load of 50 lbs. per square foot was taken to insure stiffness, but this load was not carried into the column investigations. There are no interior partitions. The staff was taken at 25 lbs. per square foot, including the timber backing sticks but excluding the main studding of the walls. Plaster on metal lath was taken at 20 lbs. per square foot.

The dead loading was, therefore, quite definitely known, and, with the estimated weight of the steel itself, could be combined with the wind loads, as described later, and carried to the next level below.

WIND LOADS.

As a wind load of 30 lbs. per square foot of vertical projection was assumed upon all exterior surfaces the pressure which is to be expected is that from a wind velocity of 100 miles per hour, by the accepted formulas. This high velocity was chosen in view of the isolated position of the tower, as regards other high structures, and the unobstructed sweep of winds from the Pacific Ocean. Full reduction for cylindrical surface, by the application of a two-thirds factor was not made, it being thought that the outstanding ornament would form pockets which would retain the wind sufficiently to offset considerably the effect of the cylindrical surface in reducing pressure. A compromise was therefore made in the use of an eight-tenths factor, making the wind load, as used, 24 lbs. per square foot of vertical projection.

Wind concentrations were then determined for the several levels, the wind between panel points on the steel frame being carried equally to the floors above and below by the wall studding. The wind loads thus concentrated at the floor levels were distributed among the several frames as follows:

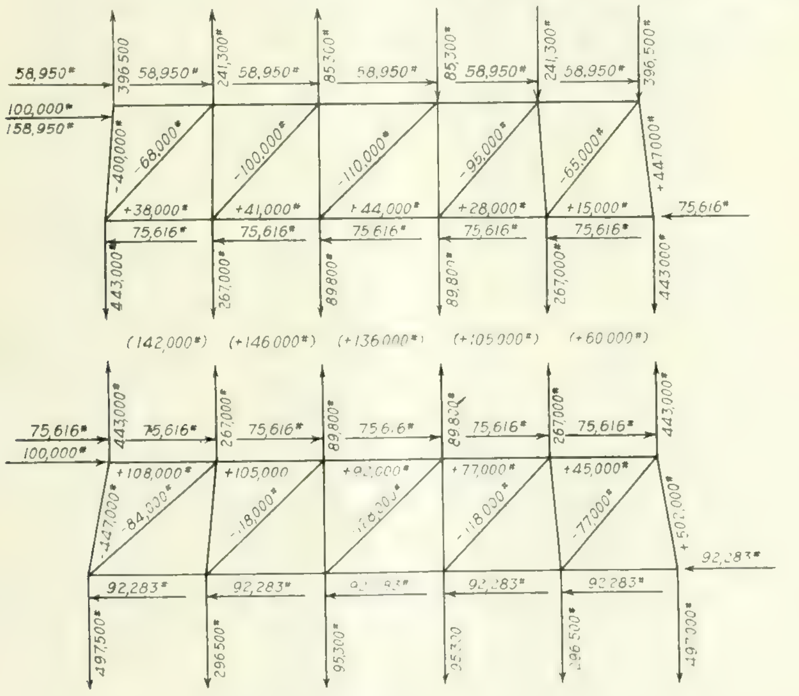


Fig. 3. Two Adjacent Transverse Bays of Tower of Jewels, and Their Stresses, Illustrating Method of Analysis Used.

(1) Wind parallel to the main frames, i. e., in an east-and-west direction, was assumed to be distributed equally between as many frames as were active at that elevation, two, four or six, as the case may have been. (See Figs. 1 and 2.)

(2) Wind perpendicular to the main frames, i. e.; in a north-and-south direction, was assumed to be carried equally by the two main transverse frames, in the planes of the batter posts. This is seen to be a reasonable assumption when the distributing action of the extensive horizontal bracing systems is considered. The stiff timber floors are very effective also in distributing the wind loads.

While it is true that other vertical transverse frames act between certain levels, the main transverse frames in the planes of the batter posts offer the only direct and continuous means of transmitting these stresses to the foundations. The partial and local effects of the interior transverse frames, in the upper portions of the tower and the exterior transverse frames in the planes of the vertical columns below elevation 150 ft., were, therefore, taken as additional factors of safety, and were neglected in the analysis.

Having the panel point concentrations for the main frames, in accordance with the above assumptions, a graphical stress diagram of the usual form was carried through. Where too many concurrent members resulted in graphical indetermination about a panel point, auxiliary members were introduced. Having completed the analysis of the above device the auxiliary members were later resolved into the actual members of the frame by considering the large panel with its auxiliary diagonal as an independent figure. The stresses about each individual panel point were then closed graphically as a check upon the resolution and summation of the partial quantities.

Below elevation 152 ft. the main frames were considered to act as two-hinged arches, carrying the vertical and horizontal loads from the structure above as concentrations on their upper chords at the points of the column connections. About the east-and-west axis of the tower the stresses and, therefore, the frames are symmetrical, requiring three types of frame, two in each type, designated respectively as the "exterior," the "intermediate" and the "interior."

For the compelte analysis of stress in each of these types of frames, three cases of loading were investigated, as follows:

Case I. Dead loads alone.

Case II. Dead loads plus loads from wind parallel to the main frames, i. e., east and west winds.

Case III. Dead loads plus loads from wind perpendicular to the main frames, i. e., north and south winds.

In the adaptation of these three cases to the analysis of an elastic arch it is necessary to depart from the usual method of procedure by which the stresses resulting from the dead loads are selectively combined with those resulting from live or wind loading, for maxima and minima. Since the theory of least work assumes that the stress in any particular member is dependent upon the stress existing simultaneously in all of the other members of the frame, it is evident that the total load at each panel point resulting from whatever cause, dead, live or wind, must be put upon the frame as a unit, and the analysis carried through for that combination of loading.

The application of the three cases to the frame in question resulted in the following:

Case I. Vertical dead loads alone.

Case II. Vertical dead loads as for the preceding case plus vertical wind concentrations of either tension or compression, and horizontal wind concentrations on the upper chord of the arch at the bases of the columns to the total horizontal wind shear from above.

Case III. Vertical concentrations alone, composed of the dead loads plus or minus the uplift or down thrust from the overturning moment of the wind on the frame above.

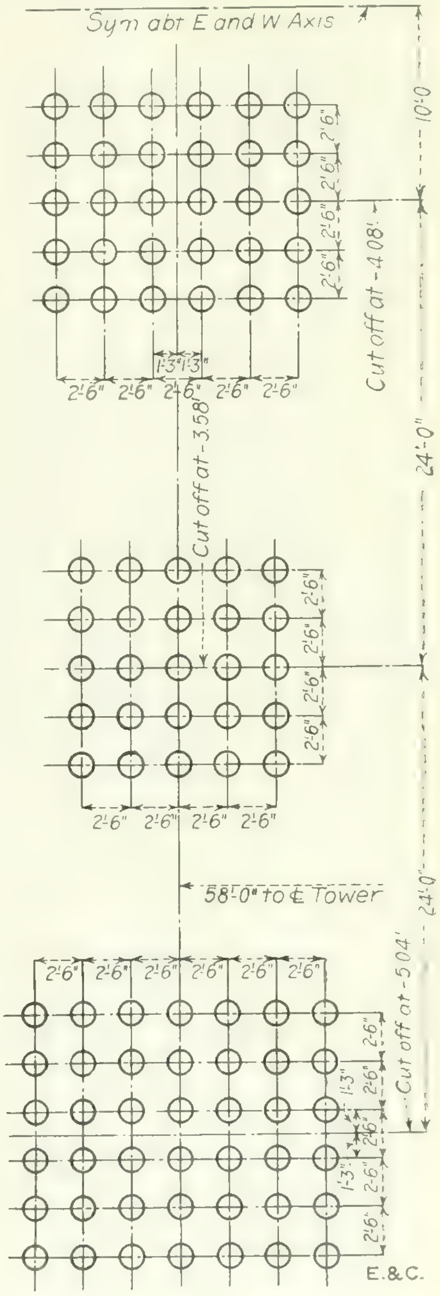


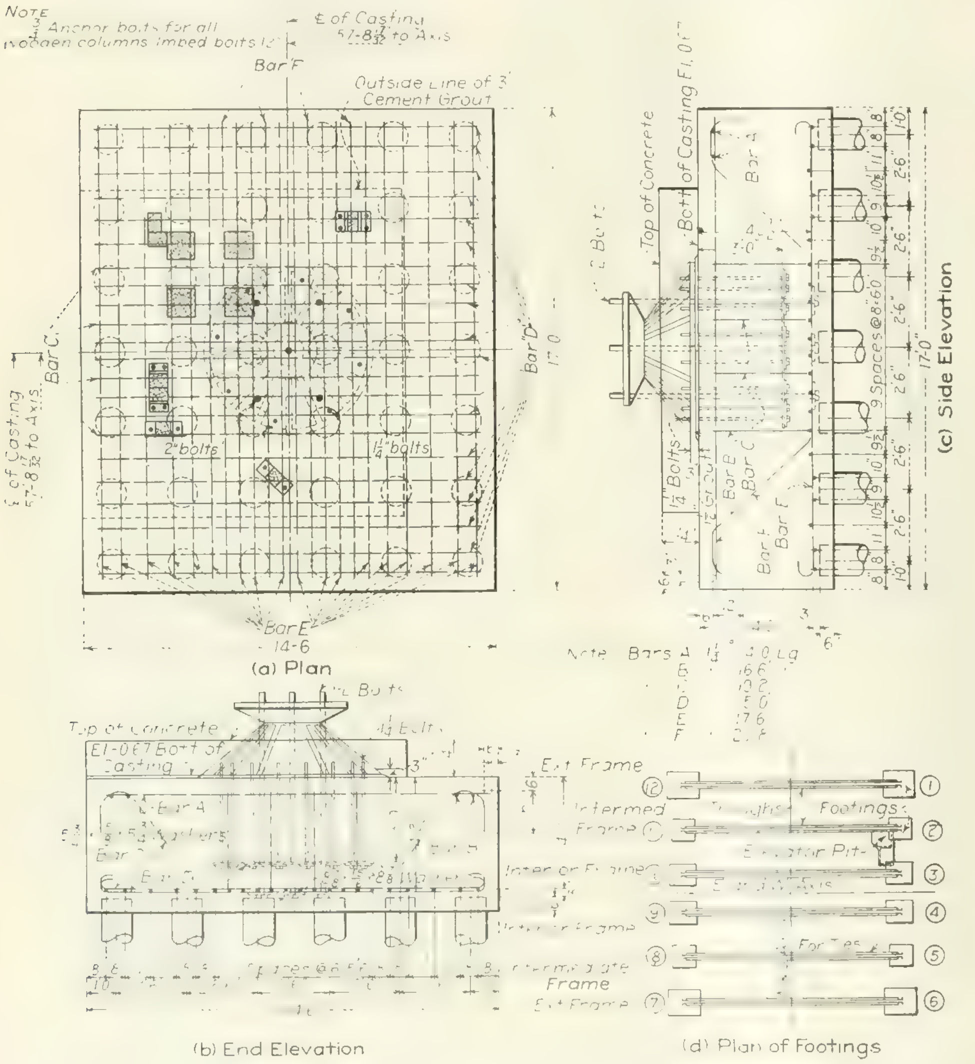
Fig. 4. Quarter Plan of Piling for Footings of Main Steel Frames of Tower of Jewels.

No wind was assumed on the steel frame below elevation 152 ft., as the timber structure, which is self supporting protects the steel frame from the horizontal wind loads.

Having determined the loads upon any frame the distribution of stress was accomplished by the application of the principles of least work to the two-hinged arch. In this analysis Prof. Ketchum's graphical and analytical method, as outlined in his "Steel Mill Buildings," was followed very closely. Pins were assumed at the bottom of the legs and an elastic tie supplied between them.

The maximum stress in each member under the three cases of loading was determined, and the absolute maximum of the three taken as the design stress. Inasmuch as the gross section of the member enters into the least work analysis, it will be seen that the gross area of the member as determined under one case of loading enters into the analysis of the other two, revising the distribution of stress under those cases. A revision of section, to suit one case, therefore, required an investigation of the stress distribution in the other two cases as well. With a little experience as to the effect of such changes, it was possible to determine by inspection whether further analysis was necessary. The analysis of a frame under each of the three preceding cases was therefore advanced to a fair closure separately and then all carried to a complete closure, more or less simultaneously.

The checking of the computations was painstaking. The interrelation of the successive stress sheets in the analysis of the two-hinged arches was, in itself, a satisfactory check against all but compensating errors, and even these would scarcely re-occur in the third diagram. Wind and dead load concentrations on the frames were recomputed and checked by two parties independently. Nearly all graphic moment and stress diagrams were checked by analytic computations, and vice versa.



(a) Plan

(b) End Elevation

(c) Side Elevation

(d) Plan of Footings

Fig. 5. Plan of Footings and Details of Typical Footing for Exterior Frames of Tower of Jewels.

TEMPERATURE STRESSES IN TWO-HINGED ARCHES.

In the matter of temperature stresses it is evident that the enclosing of the steel frame within the timber and plastered walls, and the burying of the tie members under the pavement of the court, materially reduce the temperature range to which the steel arches are subjected. For the two-hinged arch within an elastic tie temperature stresses arise only from a difference in temperature between the tie and the arch proper. A difference of 40° F. if distributed equally above and below the closing temperature, causes a change in length in the tie member of only 3/16 in. This is equivalent to the effect of an axial force of 56,300 lbs., which is only 30 per cent of the total stress in the tie member. It was therefore thought justifiable to neglect further consideration of the temperature stresses, particularly in view of their rare occurrence in this magnitude, and also since there is a considerable factor of safety in the tie members offered by the lateral resistance of the foundation piers to spreading.

As a further precaution, in the event that for any reason the frames below elevation 152 should not act as two-hinged arches, the stresses were investigated, considering that portion of the arch between elevations 126 and 152 to act as a simply supported truss resting upon the lower legs of the arch. This assumption, as is to be expected, greatly increased the stresses in the upper and lower chords at the center of the span. While this condition of stress could never obtain in full degree it was thought advisable to limit the intensity of stress in the several members under these assumptions to 30,000 lbs. per square inch. To satisfy this requirement it was found necessary to increase slightly the section of two of the chord members. Though there was considerable question as regards just which members would compose the truss, under those assumptions, the investigation gave additional assurance in the strength of the frame to meet all conditions of load upon it, and served to show the very considerable saving of weight of metal effected by designing the lower frames to act as two-hinged arches.

Following the assumptions of the foregoing paragraph the legs, themselves, were investigated for stiffness in column action, under the reactions of the simply supported truss. A radius of gyration was taken, at one-third the height from the ground, while the length was taken as the distance from the knee-brace to the ground, unsupported in a direction parallel to the plane of the frame. These were found ample by the most conservative formulas.

TRANSVERSE FRAMES.

The transverse frames were found more difficult of analysis, the concurrence of the members rendering the panel points indeterminate to the second degree. The following method was evolved:

(1) The panel point concentrations at the several levels were first computed, and a graphical moment diagram constructed, considering the entire structure as a cantilever fixed at the base.

(2) Knowing the bending moment at the various horizontal sections from the moment diagram, it was assumed that the columns would take vertical reactions due to overturning moments in proportion to their distances out from the center or neutral axis of the frame. These vertical tensions and compressions were then computed for the several columns at each horizontal section.

(3) The total horizontal shear, at the several levels, was distributed at the bases of the columns equally, inasmuch as these columns take this shear, not in proportion to their stiffness in bending, but receive it as a result of the truss action of the diagonals coming in at their feet. When it is recalled that the various sections are so thoroughly braced horizontally it is reasonable to assume this uniform distribution of shear at least for the panel next below that in which the wind increment is received into the frame.

(4) Having the horizontal and vertical loading, as above, it was possible to take one of the transverse bays out of the frame and analyze it as a unit, stressed under the above mentioned loads. For the upper and lower chords of these transverse bays, which serve in common in two adjacent frames, the algebraic sum of these stresses was taken.

Putting the stresses thus obtained back into the frame as a whole it was found possible to close the stresses about each of the otherwise indeterminate panel points. As in the case of the analysis of the main frames, mentioned before, auxiliary members were introduced where necessary to simplify the analysis, and resolution was later made to obtain the stresses in the actual framing. As a typical case two adjacent transverse bays and their stresses are shown in Fig. 3.

DIAGONAL WIND STRESSES.

There still remained to be investigated the stresses resulting from a wind striking the tower at an angle of 45° with the axis. It was reasonable to suppose that this might give a conditon of maximum stress in the four corner columns, acting, as they do, simultaneously, in the main and the transverse frames. For this purpose it was again assumed that the columns took vertical wind stresses in proportion to their distances out from the neutral axis of the tower. Section moduli were therefore computed for the different horizontal sections that were to be investigated, about an axis perpendicular to the wind, i. e., at an angle of 45° with the axis of the tower.

Combining the vertical wind stresses, so computed, with the dead loads in the columns it was found that the load under 45° wind was in every case from 5 to 25 per cent lower than the maximum load under wind parallel to the frames.

(After working out the structural analysis along the foregoing lines, Prof. Charles D. Wing, of Leland Stanford Jr. University, was retained in a consulting capacity to ascertain particularly whether the application of the methods of least work to the analysis of so massive a frame was justifiable, as well to settle the matters of temperature stresses and the stiffening of the upper chords of the two-hinged arches for simple truss action. In these particulars he concurred fully with the methods adopted.)

WORKING STRESSES IN STEEL FRAME.

The working stresses used in the design may be briefly summarized as follows:

(1) For truss and column members the axial dead load was taken at 16,000 lbs. per square inch for tension and $16{,}000 - 70 \frac{l}{r}$ for compression. Where axial wind loads were combined with dead loads an eighth-tenths factor was introduced into the former before combining with the dead load, which was in effect working the steel at 20,000 lbs. per square inch under the wind load.

(2) Horizontal members of floor systems under combined direct stress and bending were so designed that the extreme fiber stress in bending plus the intensity of axial stress, uniformly distributed over the cross-section, should not exceed 16,000 lbs. per square inch.

(3) Wind loads in diagonal tension rods were taken at 80 per cent of the stresses resulting from a 30-lb. wind load and were designed at 20,000 lbs. per square inch. This was thought justifiable in view of the considerable stiffness of the frame itself, and the improbability that the whole frame would be loaded with a 30-lb. wind pressure at any one time. The partial transverse frames mentioned before, which were neglected in the analysis, further operate to reduce the intensity of the wind stresses in these rods.

(4) To guard against any weakness due to faulty end connections between rods and gusset plates the pins and clip angles were designed on a basis of 20,000 lbs. per square inch, thus giving them 20 per cent additional strength over the main section of the rods coming upon them. To insure the snug fitting of the rods against the pins, so that no slack would be present to be taken up before they would be thrown into action, an initial tension stress of 5,000 lbs. was added to each rod, in addition to its computed load.

For the structural details, the following unit loads were used:

	Lbs. per sq. in.
Shop rivets in single shear	11,000
Shop rivets in bearing	22,000
Field rivets in single shear	8,800
Field rivets in bearing	17,600
Turned bolts in single shear	8,800
Turned bolts in bearing	17,600
Ordinary bolts in single shear	7,000
Ordinary bolts in bearing	14,000

Turned bolts were used in vertical splices in columns, ordinary bolts being used in all other positions.

TIMBER FRAMING.

The main cube of the tower below elevation 152, and the colonnades to the east and west of the tower proper are self-supporting timber structures.

Along the east and west walls of the cube a series of two-post columns extend from the foundations to elevation 152 ft. These are tied together by bracing trusses which, in addition to their stiffening function, support the studding for the exterior plaster walls. The north and south elevations of the cube are framed with four-post columns also tied together with bracing trusses. Above the main arch the walls and the floor at elevation 152 are carried on heavy timber trusses of 64-ft. span. These trusses are placed in pairs, one above the other, and are so tied together as to form a thoroughly stiff portal across the arch way. From these trusses circular furring arches of timber were suspended for the support of the arch ceiling.

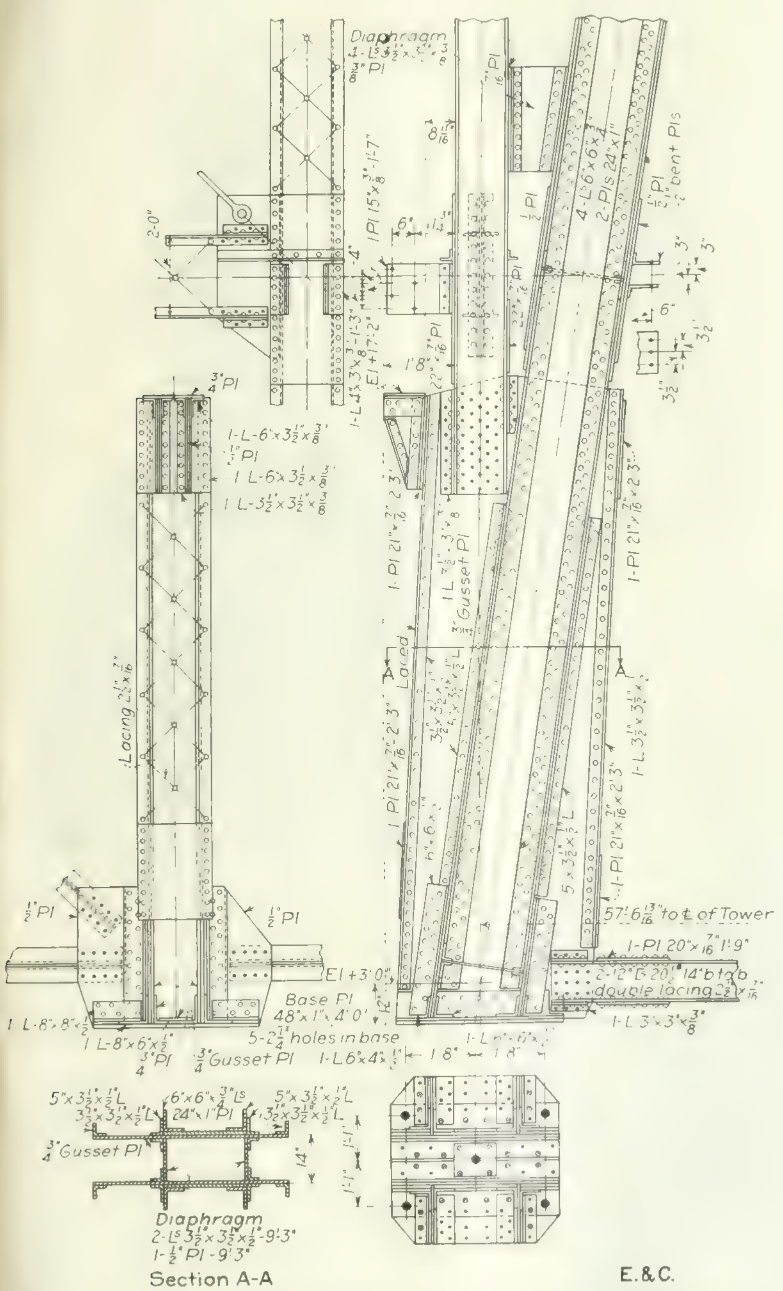


Fig. 6. Details of Lower Portion of an Interior Frame of Tower of Jewels—Note Base and Manner of Reinforcing the Frame.

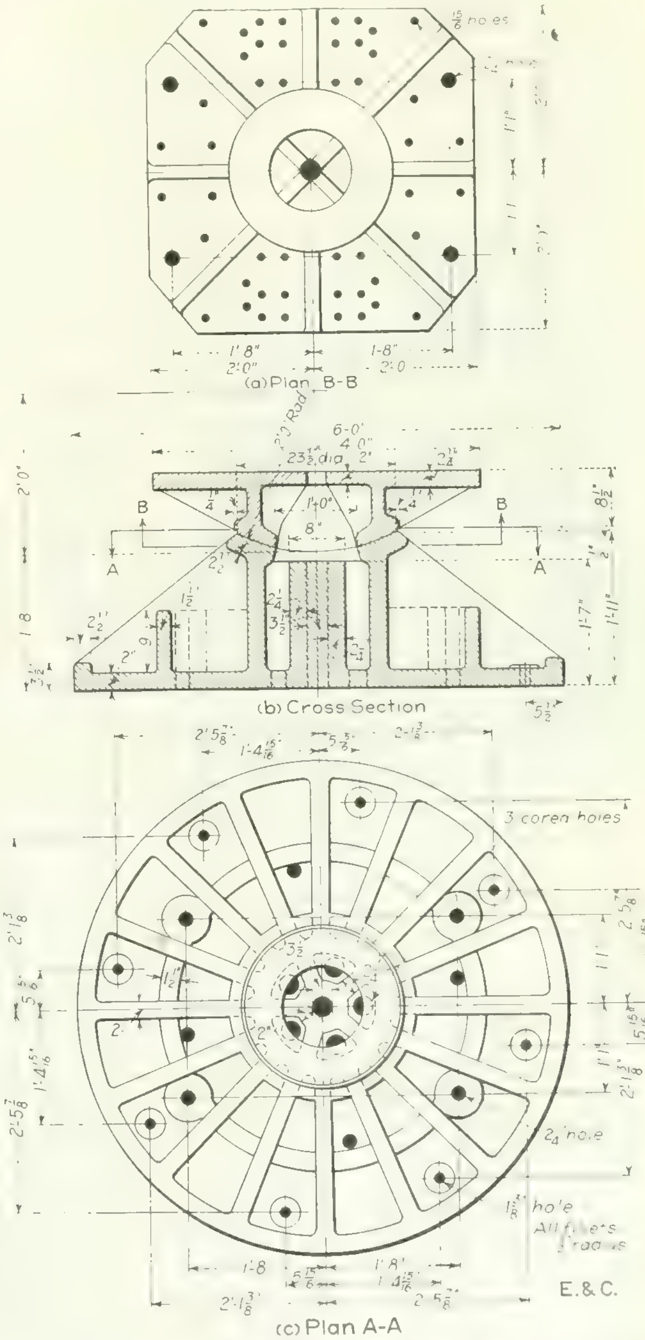


Fig. 7. Details of Cast Steel Bases for Exterior and Interior Frames of Tower of Jewels—Note Segmental Spherical Bearing.

The colonnades are also self-supporting timber structures, the tops of the colonnade columns being built into horizontal trusses, which in turn are carried into the steel frame at the interior or tower end and into a large four-post abutment tower at the outboard end.

The timber framing above elevation 152 ft., although comparatively light, was considerably complicated by the batter of the steel frame, and by the diagonal bracing rods. The circular plan of the decks necessitated the scarfing of many of the large sticks.

In the timber design the following working values were used:

	Lbs per sq in
Tension with grain	1,200
Compression, end bearing	1,600
Compression, cross grain	350
Bending, extreme fiber	1,500
Shearing with grain	150
Modulus of elasticity, dead load	1,000,000
Modulus of elasticity, live load	1,500,000
Columns under $l/d = 15$, $P =$	1,200
Columns over $l/d = 15$, $P =$	$1{,}600 - \frac{l}{60d}$

FOUNDATIONS

Considerable attention was given to the foundations, in view of the unknown stresses to which the two-hinged arches would be subjected if serious unequal settlements were to take place.

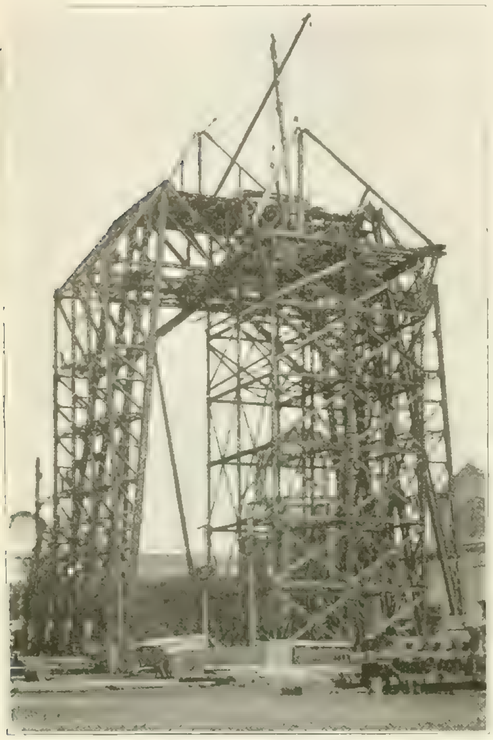


Fig. 8. View of Two-Hinged Steel Arches of Tower of Jewels, and Wooden Traveler Used in Their Erection.

Ten test borings were put down at symmetrically disposed points over the area of the tower. These resulted in the finding of a yellow hardpan at elevations ranging from —35 ft. to —47 ft., the ground surface being at +4 ft. Immediately overlying the hardpan was a softer layer of sand and clay from 12 to 15 ft. thick. Superimposed upon this were successive strata of a wet blue clay and sand, and a loose yellow sand, each from 10 to 12 ft. in depth.

In driving the piles it was found practically impossible to secure a penetration of more than 10 to 12 ft. without serious brooming and splitting, the worst feature of which was the uncertainty as to whether or not the damage was serious, as telescoping was frequent. Moreover, this depth was considered insufficient to offer security against the horizontal wind shears. Arrangements were made for the simultaneous driving and jetting of the piles, a thoroughly satisfactory solution of the difficulty, although even with the jet the penetration per blow under the 5-ton hammer was frequently less than 1 in. after the first 10 ft. of driving.

After this first bringing up the piles drove slowly and uniformly until the hardpan was reached, in which they were practically brought to refusal. Although designed for a 20-ton load these piles as driven would hardly be expected to settle under a load of twice this amount.

The specifications called for yellow pine, or red Douglas fir (Oregon pine) piles, unpealed, with a butt diameter of 14 ins. clear of the bark, after cut-off, and a minimum diameter at the tip of 8 ins for piles not exceeding 50 ft. in length and of 7 ins. for lengths exceeding 50 ft. In all, about 600 piles were driven, which at an average length of 45 ft. gave 27,000 lin. ft. of driving.

The piles are in clusters under the feet of the twelve main columns, the number of piles in the groups ranging from 25 to 42, as shown in Fig. 4. This drawing is a quarter plan of the footings for the main steel tower. These footings are arranged in two rows of six footings each, the rows being spaced 119 ft. on centers. The two interior footings are spaced 20 ft. on centers; the distance between the interior and intermediate footings is 24 ft. on centers, and that between the intermediate and exterior footings also 24 ft. on centers. The arrangement, spacing, and cut-off of the piles are shown in the drawing.

The piles in each footing are capped with a block of concrete, rectangular in plan to suit the arrangement of the piles. Figure 5 shows the details of a typical exterior footing. The reinforcement consists of a mesh of 1-in. and 1¼-in. square bars, with particular attention given to the placing of the bars to take care of the excessive diagonal tension to which such thick slabs are subjected. Punching shear from the column bases had also to be investigated. In general, the analysis used follows that outlined in Bulletin No. 67 of the University of Illinois Engineering Experiment Station. See ENGINEERING AND CONTRACTING of July 30, 1913.)

The intermediate footings are 12 ft. square and 3 ft. 3½ ins. high, to the base of the steel castings, and, as shown in Fig. 4, are each supported on 25 piles. The interior footings are 12 ft. wide, 14 ft. 6 ins. long and 3 ft. 9½ ins. high, and are each supported on 30 piles.

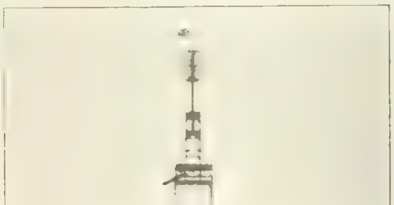


Fig. 9. South Elevation of Steel Frame of Tower of Jewels.

In addition to the main rectangular blocks considerable concrete was poured subsequently in and about the cast steel bases for the support of timber columns. A well-graded 1:6 mixture was used for the piers. Six concrete troughs were placed for the support of the steel tie members between the pins of the main arches. These troughs were for the dual purpose of heat insulation and protection from bending under settlement of the roadway, the ties being placed as close to the surface as practicable. After the steel erection was complete these troughs were filled with a 1:8 concrete.

With the exception of the large timber columns of the tower proper all timber framing in the colonnades and in the small courts is carried on spread footings, with sand boxes introduced where necessary to provide anchorage against overturning wind moments.

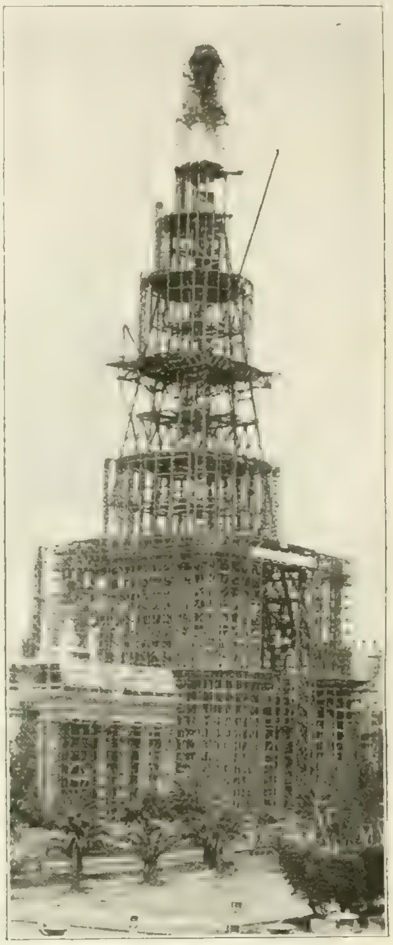


Fig. 10. View Showing Timber Framing in Place—Tower of Jewels.

CAST STEEL BASES.

For the feet of the two-hinged arches it was thought that some provision should be made to guard against indeterminate bending in the legs, such as might result from unequal settlement of the foundations, from unsymmetrical wind or temperature loads, or from other such cases. A uniform distribution of the load was of course desired between the cast steel base and the concrete of the footing. All of these ends were accomplished by the use of a segmental spherical bearing. Such a bearing also greatly facilitated the closing of the arches during erection.

These bases are of cast steel, circular in plan, and 6 ft. in diameter. A concave spherical bearing, turned to a radius of 3 ft., was supported, concave upward, upon 16 radial ribs. Into this socket there was placed the convex bearing shown which is bolted to the structural steel of the leg. Figure 6 shows details of the lower section of one of the interior frames, and indicates the manner of reinforcing this member and of connecting it to the steel base. Anchor bolts, 2½ ins. in diameter, embedded in the concrete of the piers, extend up through the upper and lower sections of the cast steel base and through the structural steel of the main member, thereby insuring against any tendency of the ball portion of the bearing to leave its seat, as would be likely under excessive wind pressure or earthquake impact. Figure 7 shows details of one of the cast steel bases used for the exterior and interior frames. The castings used for the intermediate frames are similar, but have bases 5 ft. in diameter.

The specifications covering the manufacture of the cast steel were explicit, as regards chemical composition and mechanical properties. It was required that the percentage of phosphorus and sulphur be not over 0.05 per cent each, and drillings for analysis were taken from the test ingot. Mechanically, the requirements were as follows:

Tensile strength, lbs. per sq. in.	[illegible]
Yield point (drop of the beam), lbs. per sq. in.	31,500
Elongation in 2 ins., per cent	18
Reduction in area, per cent	30

The form of the test specimens and the methods of testing were in conformity with the recent recommendations of the American Society for Testing Materials.

As regards the finishing of the bases the specifications were unusually rigid, it being provided that, after turning and grinding together to a true fit, no point on the spherical surface should be out more than 0.04 in. from a turned test ring, 18 ins. in diameter, when placed to bear at three points at least 90° apart on the arc. As actually finished these requirements were satisfactorily met, the majority of the castings refusing even the 0.025-in. feeler.

STEEL ERECTION.

For the erection of the two-hinged arches the steel contractor constructed a timber traveler 50 ft. square in plan and of sufficient height, with blocking, to reach the lower chord of the arches. The traveler was erected in position for the setting of the two interior arches, the bottom of it resting upon steel rollers which traveled upon a timber track, shod with ¼-in. plates. The lower timbers of the traveler were protected by short lengths of 12-in. channel, placed with flanges up. A view of this traveler and of the two-hinged steel arches is shown in Fig. 8.

The upper deck of the traveler projected over the face of the framework about 2 ft., thus permitting the erection of the steel arch immediately against the side of the timber work. This overhang prevented interference during the setting of the knee-braces. Upon the upper deck of the traveler a 20-ton stiff-leg derrick was so placed as to pick up the material directly from the receiving and sorting yard located to the south and west of the tower site.

The twelve first-tier columns, which are about 50 ft. in height, were first set around the entire building, and were guyed back to dead-man, with sufficient of the horizontal struts in place to steady them laterally. The second-tier columns, on the four central frames were then placed, after which the two interior frames were carried to completion. By manipulation of the guys and the anchor bolts through the spherical bearings it was a simple matter to bring the trusses to closure at the center. Before removing the traveler from under the erected portion the trusses were so thoroughly pinned and bolted that no deflection was detected before riveting, which was begun as soon as it was assured that the next adjacent frame was closing properly.

Having completed the two interior frames, the south intermediate and the south exterior frames were completed in order, after which the traveler was taken through the tower to the north intermediate and north exterior frames. The filling in of the small steelwork, including the rods, was carried on by two other gangs, simultaneously with the main erection.

Above the arches the stiff-leg was discarded for a guyed derrick, which was raised to the successive decks, thereby reaching all points, by the simple shifting of the guys. No particular difficulty was experienced until the section above elevation 300 ft. was reached, where outriggers were required for the guys. Above elevation 364 ft. a single gin-pole was left for the setting work, all pieces having been sent up to elevation 400 ft. before the removal of the guy derrick. Figure 9 shows the south elevation of the steel frame of the tower.

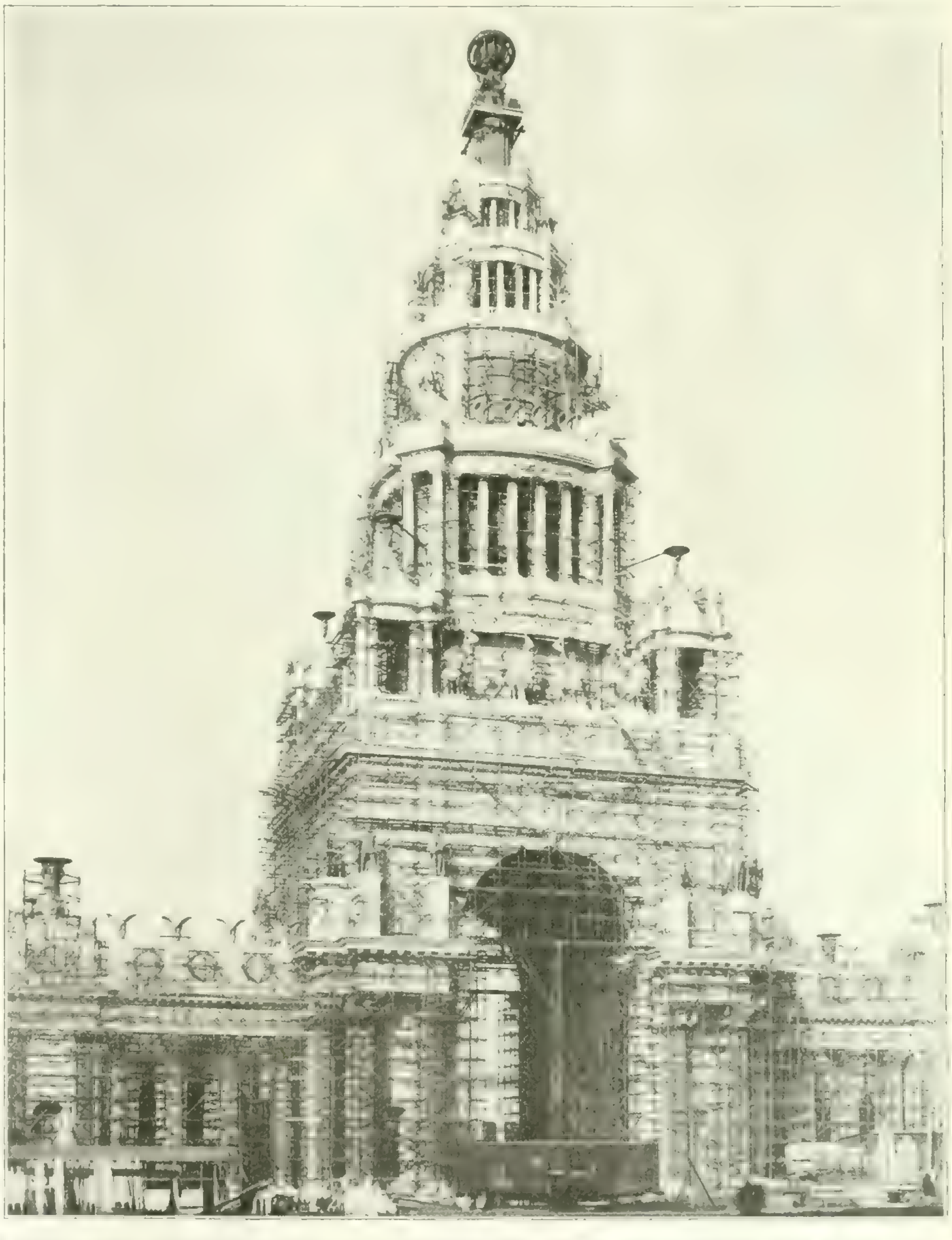


Fig. 11. View Showing Tower of Jewels Practically Completed—Note Elaborate Ornamentation.

The total steel contract amounted to 1,460 tons, and it was detailed, fabricated, and erected in 220 days. Only a small amount of the steel could be obtained on the Pacific Coast, which required the ordering and delivery of the major portion of the large sections from the East. The upset rods, clevises and turnbuckles were a further source of delay.

TIMBER ERECTION.

By reason of the fact that the completion of the steel contract had preference over the timber construction all of the general contract work, which was carried on simultaneously with the steel erection, had to be so performed as not to interfere with the steel contract. This resulted in the flat framing of a large percentage of the lower columns and trusses, far in advance of the time for the erection of the members in place. The tower site was at times severely conjested, the framed material being piled high, in the inverse order of its erection.

When the steel erection had progressed sufficiently so as not to be interfered with by the timber, this framed material was rapidly swung up into place, either by raising shears or by a tackle hooked directly into the steel frame, where convenient. The heaviest single hoist of timber work was the large four-post trussed column at the corners of the main tower frame. These columns were 5 x 7 ft. in plan, 150 ft. in length, and contained 16,800 ft. B. M., which, together with the iron fittings, weighed approximately 35 tons. These columns were, as were all other large parts, framed with their feet in approximate position, so that in raising only hold-back lines were necessary to guide them into position. Practically all timber construction below elevation 152 ft. was erected in this manner.

Above that level a "Chicago" boom was used, its foot being set at elevation 300 ft., and its topping lift at elevation 364 ft. This, with its 70-ft. boom, was very efficient in setting the major portion of the upper construction. Of the 1,500,000 ft. B. M. used in the construction of the tower, two-thirds were below elevation 152 ft. Of the third above, the greater portion was in the form of floor material and wall studding, which required but little framing out of place. There were few heavy pieces, therefore, to be moved with this rig.

As a result of the procedure of the steel contractor it was possible practically to complete the timber framing of the east colonnades and the basins of the east court while the corresponding area to the west of the tower was being utilized as a storage yard for the steel. When finally this was available the general contractor carried on the framing of that portion simultaneously with the construction of the upper portions of the tower proper. Three parts of the work, entirely independent of each other, were therefore worked upon and brought to completion at the same time. Figure 10 shows the tower with the timber framing in place.

FIRE PROTECTION MEASURES.

In view of the eminent risk from fire in a structure of so inflammable a construction it was decided early that spectators should be excluded from the building. For this reason no attempt was made toward fireproofing either the elevator shaft or the stairways.

Other fire protection consists of high-pressure monitor standpipes and cornice sprinkler systems, under a maximum static head of 320 lbs. per square inch. The monitors are required to deliver smooth solid streams of 1,500 gals. per minute through a 2-in. tip. A test pressure of 400 lbs. per square inch is to be maintained for a period of 15 minutes without excessive leakage. Sprinkler nozzles are installed at all cornices, and are so set as to throw either fan shaped or continuous arc jets. These results in a possible complete water curtain over the entire outer surface of the building.

The outstanding portions of the tower are isolated from the adjoining buildings on each side by continuous fire walls of reinforced concrete 60 ft. high, which form parapet walls above the level of the adjoining roofs.

The timber work, in general, may be characterized as slow burning mill construction, as few timbers of less than 8-in. exposed dimensions were permitted. Six-inch faces were used only where absolutely necessary. These remarks do not apply to small furring lumber which are entirely closed in plaster and staff, as the fire-resisting properties of the latter are ample.

COST DATA.

The total cost of this structure is approximately $420,000, divided as follows:

Driving piles	$ 6,600
Furnishing and erecting steel	137,400
General construction	216,000
Models	18,200
Lumber, 1,500,000 ft. B. M.	22,700
Decorative painting	4,000
Additional electric wiring not in general contract	2,000
Additional plumbing and piping not in general contract	1,500
Paving	500
Additional incidental requirements	11,100
Total	$420,000

The following data apply to the unit costs of the steel frame and of the entire structure. In compiling these data the cubic contents of the structure, for determining the unit cost of the steel frame, were taken to be that of the main structure exclusive of the two side colonnades. Further computations were made to include the cubic contents of the colonnades in order to arrive at the unit cost of the entire structure. Computations were made on a basis of excluding the cubic contents of all sculptured features.

The volume of the tower is 3,440,300 cu. ft., and it contains 1,403 tons of structural steel, or 0.816 lbs. per cubic foot. Its cost in place was 4 cts. per cubic foot.

The entire architectural feature contained 3,907,500 cu. ft., and cost 10.67 cts. per cubic foot of enclosed contents.

PERSONNEL AND GENERAL REMARKS.

The plans were prepared by the Division of Works of the Exposition Company, of which H. D. H. Connick is director and A. H. Markwart, assistant director. The structural work and the substructure were designed by the writer and others, under the immediate supervision of H. D. Dewell, chief structural engineer of the Division of Works. The architectural design was by Thomas Hastings, of New York.

The steel contractors were Dyer Bros., of San Francisco, while the general contract, including all except the steel frame, was executed by the Commary-Peterson Co., Inc., also of San Francisco.

The first design of the structural part of the tower was made by J. D. Galloway, consulting engineer, of San Francisco, the writer acting as his principal assistant. At that time the program of conditions was more ambitious. It provided for a continuous fireproof wall between the main tower and the adjacent parts, for four elevators in the lower portion, and for three fire-resisting ceilings at elevations 154, 255 and 336 ft. respectively, as a means of localizing, temporarily, a conflagration. Furthermore, the several decks were completely floored, and were designed for a total load of 150 lbs. per square foot, the intention at that time being to use the tower for observation purposes. Steel framing was used in other parts, such as in the four corner pylons of the first main deck. On taking preliminary prices and making estimates from the completed plans it was found that the cost of this design exceeded the appropriations, and that the program of requirements must be revised—those structural as well as those architectural. The changes were so numerous, and the necessity of reducing the cost so apparent, that a new design was made, as noted above.

Figure 11 is a view of the tower practically completed showing the architectural treatment and its general effect.

The contract time for the general contract, which included the foundations, the timber construction, the ornamental staff and plaster, and the high-pressure and electrical installations was originally 200 days, 120 days of which were guaranteed to be after the completion of the steel contract. The overlapping of the two contracts, however, operated to extend the total time on the general contract to approximately 270 days.

WATER WORKS

Experiences of a City of 6,000 Population With Water Waste, Famines, Meters and Rates.

In the sale of water it seldom happens that a municipality changes over completely from flat rates to a meter system of charging within a comparatively short period of time. Cities and towns usually start by metering the water services of their largest consumers and, gratified with the results effected, proceed gradually to meter other connections until only a few are left. These unmetered few are generally the connections of the public buildings, and they are a constant source of trouble if the buildings are not regularly inspected.

The present article records the experience of St. Albans, Vt., a city of 6,300 population, with water waste, water famines, water meters and water rates. St. Albans is the center of a farming community, has one or two factories and the offices and shops of the Central Vermont Railway. The public water supply is municipally owned and is managed by the Superintendent of Water and the City Council. There are three reservoirs supplying the city through a gravity system, with a combined water shed of 1,581 acres and a capacity of 363,000,000 gals. The third of these, with 200 acres of watershed and 128,000,000 gals. capacity, was built in 1913. The information here given is from an article by C. J. Renner of New Rochelle, N. Y., in a recent issue of The American City.

TWO WATER FAMINES.

The water situation in St. Albans first attracted serious attention in August, 1908, when the supply on hand began to decrease rapidly. The park fountain was turned off, plumbing was inspected, and all other means possible were taken to reduce the consumption. In spite of all efforts, however, by November the supply was exhausted. Meanwhile a two-mile line of 6-in. pipe had been laid over the ground to Lake Champlain, where a pumping station was installed. By this means the consumers were kept partially supplied until water again flowed from the reservoirs.

In 1911, owing to the wasting of water and the extremely dry season, a water famine was again precipitated, making it necessary to use the reserve plant previously mentioned. It was with difficulty that the plant could keep up pressure, though it was supplying only a portion of the city and furnishing 600,000 gals. per day. This state of affairs lasted 64 days.

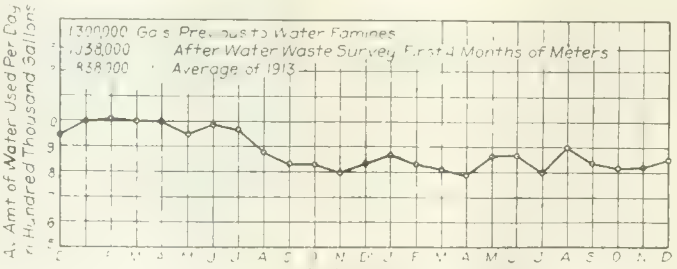


Fig. 1. Average Daily Water Consumption at St. Albans, Vt., During 1912-13.

It is needless to say that the water taken from Lake Champlain was in no respect equal to the water in the regular supply, which was generally found to be wholesome and pure.

The direct financial costs of the two water famines were as follows:

10,750 ft. 6-in. pipe, in place	$ 5,817.56
Pump and pump station, in place	1,810.04
Pumping, coal, etc.	4,795.17
Interest, at 5 per cent, on cost of plant, five years	1,908.40
Total	$14,337.17

The plant has now been disconnected and dismantled. The lead in the pipe joints nearly compensated for labor of disjoining. After dismantling, the value to the city was, approximately:

10,750 ft. 6-in. pipe, at 40 cts. per foot	$4,300.00
One pump	500.00
Total	$4,800.00

This leaves a net loss of $9,537.17 gone forever that might have been avoided by the timely installation of meters or by additional water supply.

PRELIMINARY REMEDIES.

In 1909, after the first water troubles, the spillway of one reservoir was raised, but on account of more or less rainy weather with accompanying full reservoirs, no further action was taken.

In 1910, Mr. D. F. McCarthy, then Superintendent of Water, maintained a rigid inspection of fixtures and reported that inspection alone could not prevent the large waste of water caused by the use of direct flushing closets and by the running of faucets in cold weather. Flat rates made conditions such that but few cared.

The increasing waste led to making measurements at the sewer outlets. From the results of these it was estimated that 6,000 people connected with the sewers were using 900,000 gals. per day, or 150 gals. per capita, for domestic purposes only. It was plain that the situation was causing anxiety to the superintendent, for he constantly advocated and recommended the installation of meters.

It should be remembered that there are always some people in every community who will oppose anything which they think will adversely affect their individual interests, and others who on general principles dislike anything which restrains them. For instance, the first class would rather see the water wasting every day, so long as it is free, than pay a plumber to fix the leak; and the second class would be very careful of the water in many instances, but do not care to have a meter forcing them to this end. Opposition to meters is felt all the time, from these people and from persons who deliberately waste water, feeling that the city is rich and can stand it, and also from the conservatives, who think that installing meters is an unnecessary expense and at best only an experiment.

The opposition in St. Albans held the matter of meter installation in check until the city was brought to face a second water famine in 1911. This convinced all, for the time being at least, that something must be done. A city meeting was called at once, and it was promptly voted to install a meter system along with other measures of relief. Mayor Greene's efforts were largely responsible for the success of the plans.

A 14-in. Venturi meter was purchased and installed so as to register the entire city. In the latter part of November it showed a consumption of 1,000,000 gals. per day. Continued rigid inspection and a water waste survey reduced this to 800,000 gals. per day, but it crept up again in December.

During the first four months of 1912 the domestic and other meters were installed. The work was done economically, because there were several handy men in the water department and plumbers were needed only occasionally. Persons who maintained private meters for their own use were rebated $8.40 upon surrender of same to the city, whether in good or poor condition.

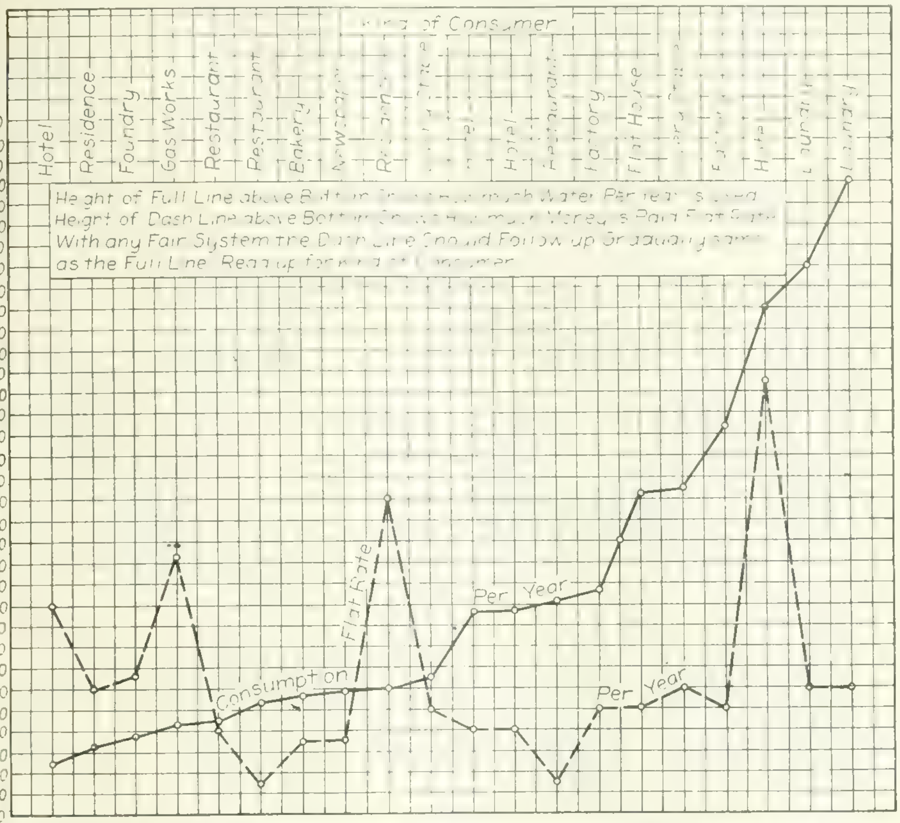


Fig. 2. Consumption and Amounts Paid by Special Rates in St. Albans by Different Classes of Consumers Under Flat-Rate System.

The cost of installing meters was as follows:

One Venturi meter, in place	$ 686.74
1,295 domestic meters, in place	13,356.18
Total	$14,042.92

which amount is less than the cost of the two water famines as already given.

RESULTS OF METERING.

The net results of metering the city may be seen in Fig. 1 in which the average consumption in gallons per day for each month is given.

The chart shows a drop in consumption due to meters of 200,000 gals. per day. In five months this amounts to 30,600,000 gals. To this quantity we may add 40,100,000 gals., which is the saving for the same period of time, due to rigid inspection and water waste surveys. The total, 70,700,000 gals. is far in excess of what was needed to avert either water famine. Practically all the saving was in the domestic consumption, the commercial interests contributing only a small amount. Previous to a famine it took five months for the reservoirs to go dry.

RATE MAKING.

Up to the time of the meter installation, the rates for water were as follows:

Dwelling houses, stores and offices occupied by five persons or less	$[illegible]
Each additional person	1.00
One bath tub	3.00
One water closet	3.00
Each wash basin	[illegible]
Each private laundry	[illegible]
Each sprinkling hose	3.00
Each carriage horse	[illegible]
Extra water closet or bath tub	[illegible]

Each commercial rate fixed by special agreement.

Payment due in advance, semi-annually.

As may be seen, persons with houses having modern improvements were taxed the most by this schedule, though they were not always the largest users. A family of six people dwelling in a house where one faucet was installed would obviously use more water than a family of two living among a few improvements. It did not follow that the family of two could any better afford to pay the higher water rent, and they certainly should not have been expected to do so.

The item relating to commercial rates is particularly interesting. This matter was analyzed and a curve of the results was drawn which showed some amazing facts. Men in the same line of business were paying all out of proportion to the amounts of water used. This curve is here reproduced as Fig. 2.

Comparing the hotels in the chart, Fig. 2, it is seen that one man using 25,000 cu. ft. per year paid $100, while his neighbor who used four times as much paid only $40. Differences like this were the result of knowing nothing definite concerning how much water really was used, the rates being based on the judgment of the City Council when applications were made. With fair rates for all, however, the dashed line showing amounts paid should ascend smoothly in the same manner as the consumption line, and not zigzag all over.

With the coming of the meters came the necessity to devise a system of rates which would be satisfactory to all. To this end meter schedules and rules of other cities were consulted, but there were always objections. It was impossible to satisfy everybody. One thing finally agreed upon was that there should be a yearly charge of $6 per year to each consumer, with 3,000 cu. ft. of water allowed, whether used or not. Pressure was and is being brought to bear to have this allowance increased and the price lowered.

The water plant being publicly owned, there was no reason to make the rates higher than was necessary to meet expenses. Under the old flat rates the revenue each year amounted to approximately $16,860, which was sufficient. It was planned to make the new rates aggregate the same amount.

What was wanted was a schedule so made that, as the consumption of any user increased, the rate per 100 cu. ft. would diminish, though the amount of the water bill would always increase. By this arrangement the large consumer would get his water at a cheaper rate, but his water tax would be larger than that of a small consumer.

In St. Albans, where the commercial interests are the backbone of the community, and where evacuation by any one of them would be serious, provision had to be made to give them especially cheap rates. The new rates are given below for classes 1 and 2, those of class 3 not being for publication.

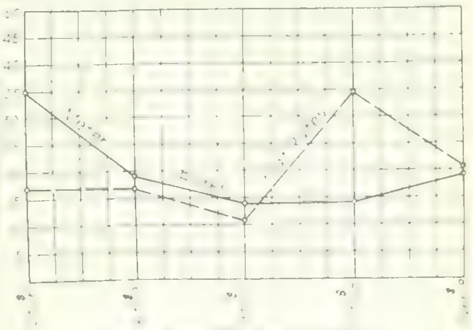


Fig. 3. Percentage of Consumers Paying Various Yearly Amounts Before and After Meter Installation at St. Albans, Vt.

ST. ALBANS WATER RATES.

Class 1.—Domestic users: Houses, blocks, stores. Where water must be supplied for living purposes.

Class 2.—Industries dependent on city for their existence; those that employ labor, but draw [illegible] by virtue of the city's existence, such as laundries, restaurants, garages, hotels, gas companies, newspapers, etc.

Class 3.—Industries necessary for the welfare (existence) of the city; those that employ labor, but do not secure the money to pay for same from city, such as the railroad, manufactories and wholesale distributors of St. Albans products to the outside world.

The City Council reserves the right to specify the class of any consumer.

Minimum cu. ft. per year.	Minimum flat rate per year.	Equivalent rate per 100 cu. ft.	Rate for additional 100 cu. ft.
Class 1 Domestic.			
3,000	$ 6.00	$0.20	$0.20
6,000	12.00	.20	.20
12,000	24.00	.20	.20
18,000	36.00	.20	.18
24,000	46.80	.19½	.17
48,000	87.60	.18¼	.16
96,000	164.40	.17 1/10	.15½
192,000	313.20	.16¼	.15
384,000	601.20	.15⅝	.14
768,000	1,138.80	.14¾	.13
1,536,000	2,137.20	.14	.12
Class 2 -Local Industries			
3,000	$ 6.00	$0.20	$0.13
6,000	9.90	.16½	.12
12,000	17.10	.14¼	.10
24,000	29.10	.12½	.08
48,000	48.30	.10	.07
96,000	81.90	.08½	.06
192,000	139.50	.07¼	.05
384,000	235.50	.06	.04
768,000	389.10	.05	.03½
1,536,000	657.80	.04¼	.03½

These rates and quantities plot smooth curves.

RESULTS OF METER RATES

The results in revenue obtained under this schedule for the first year of the new system are tabulated thus:

First quarter	$ 5,907.88
Second quarter	3,498.69
Third quarter	4,353.71
Fourth quarter	4,631.78
Total for year	$18,392.06

This includes all classes of consumers. The railroad was still paying by flat rate, though metered and using 290,000 gals. daily average. The low figure for the second quarter was due to credits allowed to consumers when their meter rates amounted to less than the old flat rates, which they had already paid in advance. That the great majority of the people benefited is clearly shown by Fig. 3 in which the per cent of connections and revenue furnished before and after meter installations is given. There were about 1,275 meters in all.

A study of the curves shows that 45 per cent of the connections yielded $12 per year or less by the old rates. After meters were installed the number paying $12 or less rose to 68 per cent. The result is still more striking with minimum rate consumers who paid $6.

The expenses of maintaining the meter system meant no extra man in the water department and eight weeks' work by the other men. The summary of the whole matter is that meters are indispensable where the economical management of a water-works is concerned. They prevent water famines and unnecessary waste, and also give us the only fair basis for governing the sale of water. While maintenance charges are an extra expense, this expense is small when compared with the benefits resulting.

The Laboratory Control of Small Water Supplies.

In Illinois the State Water Survey has been promoting the establishment of laboratories for the chemical and bacteriological control of the water supplies wherever such control is needed. During the last few years a number of water works in the state have established such laboratories. Sometimes it has been difficult to show the various water works operators, whether in the employ of companies or municipalities, the value of water analyses made either by themselves or by the state laboratory. Many of the operators, however, are easily persuaded to install laboratories, and those who have installed them have been delighted with the results. The present article, which is from a paper by Dr. Edward Bartow, director of the Illinois State Water Survey, in the December number of the Journal of the American Water Works Association, discusses the laboratory control of small water supplies.

The owners of large water supplies can employ their own experts and can establish the necessary laboratories for control. They will, of course, have a bacteriological laboratory that will contain all that is needed to make bacteriological investigations. They will have a sanitary-chemical laboratory containing the equipment necessary for sanitary-chemical analyses. They may even have a laboratory for the determination of the mineral content of the water; for such determinations are often necessary when waters of varying composition from a river or from a combination of several sources have to be treated. One suggestion with regard to such laboratories is, do not make the rooms too large. A compact arrangement increases efficiency.

In Illinois there are very few plants exceeding 5,000,000 gals. daily capacity. We recommend simple laboratories that are suitable for such small plants, where the operator hesitates to undertake extra work that will require extra help. We must also, necessarily, advocate only the simple and necessary tests. The simplicity of the outfit required is illustrated by one of the smallest laboratories in the state of Illinois, or even in the United States. This is a laboratory for the control of the iron-removal plant of the Champaign and Urbana Water Co. The water treated is from deep wells and contains no bacteria. The chemical constituents are constant, therefore the test for iron is the only one required. The necessary apparatus consists of a few collecting bottles, bottles for re-agents, a burette and some pipettes. These are installed on a simple laboratory table in one corner of the pump house.

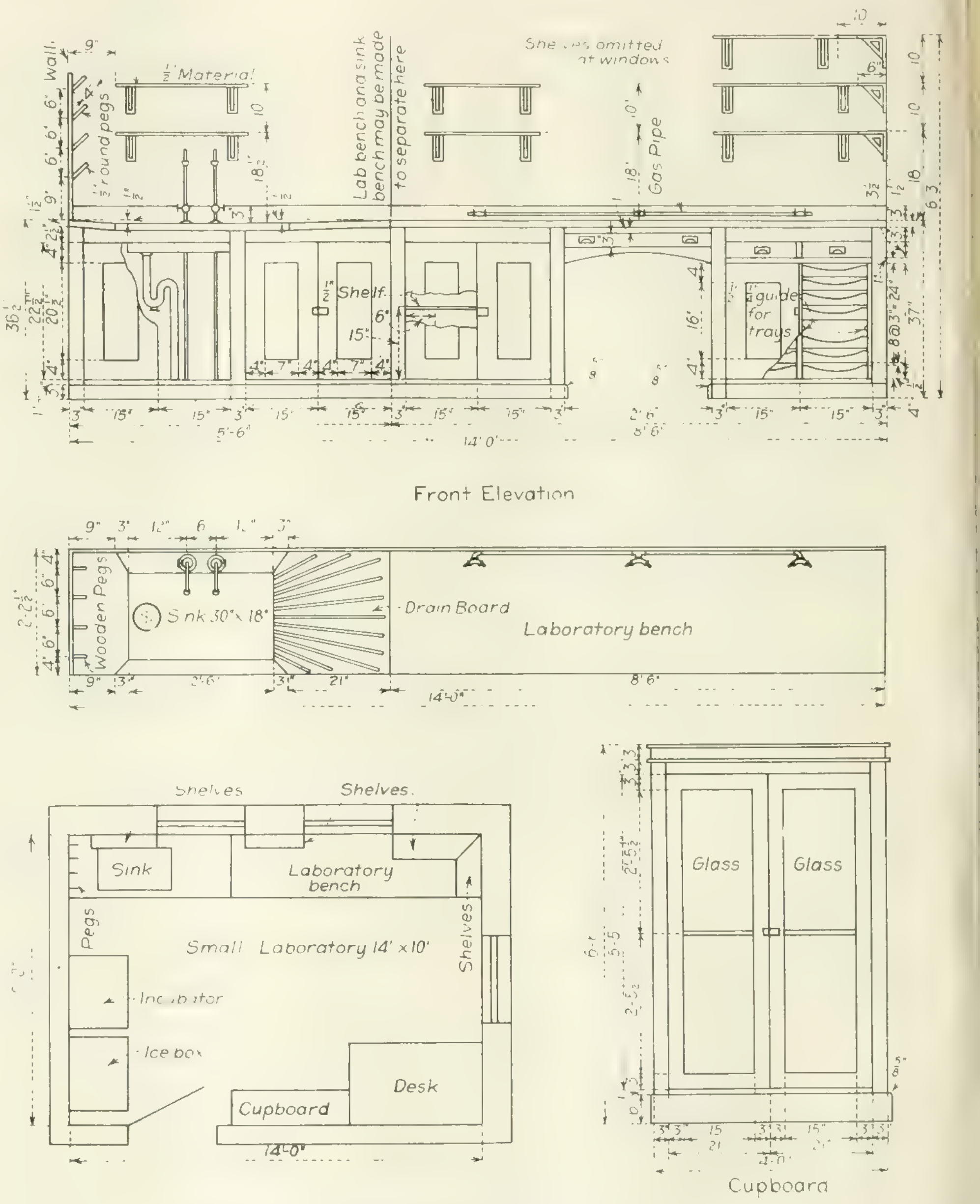


Fig. 1. Plan of Small Laboratory, Showing Detail of Table, for Laboratory Control of Small Water Supply.

For the control of filter plants using river water a more extensive outfit is needed. Tests for number of bacteri , gas-forming bacteria, turbidity, color and alkalinity must be made. Several laboratories of this type have been established and have given satisfaction.

It often seems difficult to find space for the laboratory, but the difficulty can be overcome. At Pontiac, which has one of the old-style plants, the laboratory has been constructed in one corner of the filter house and partly over one of the filters. It is 9 by 14 ft. in size, and contains sufficient apparatus for the satisfactory control of this small plant.

More elaborate structures may be erected. The Danville Water Co. recently constructed, adjacent to the plant, a building for an office and laboratory that adds considerably to the attractiveness of the plant. Charts are prepared each month by Mr. H. M. Ely of the Danville Water Co. to show the results obtained by this laboratory. The chart for March, 1913, for example, shows some of the results which impressed upon the minds of the operators the necessity for complete and continuous control. The amount of bleaching powder was indicated by the available chlorine, which was discontinued on the 20th of the month and was not used for the following six days. During this period the number of bacteria, as clearly indicated by the chart, increased very largely, dropping as soon as the use of the bleaching powder was resumed. Positive tests for the gas formers were also evident during this period, and ceased immediately on the resumption of the use of the bleaching powder.

In order to assist operators in establishing laboratories a list of the necessary apparatus and chemicals has been prepared. (See University of Illinois Bulletin, Water Survey Series No. 8.) The list is so arranged that an operator can choose what is needed for a small laboratory, or for a more extensive laboratory.

A diagrammatic plan showing the fixtures needed in a small laboratory, Fig. 1, has been of value to those who have established laboratories. The table can be easily constructed, and the detailed plan has been used as the basis for several laboratory tables now in use in the state. If a larger outfit is desired the table can be doubled, Fig. 2. For example, two units may be placed back to back in the center of the room, and the remainder of the furniture distributed around the sides of the room.

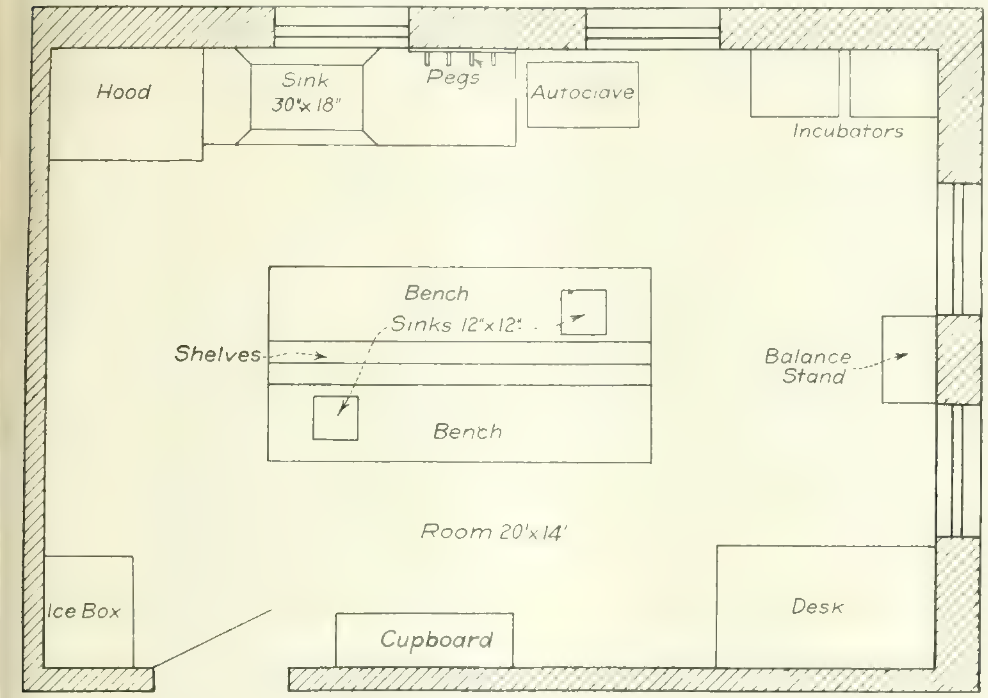


Fig. 2. Plan Showing an Arrangement of Furniture in a Small Water Works Laboratory.

The suggestions which have been briefly described have been accepted by several of the water works operators, and we think we can safely say that those who have established laboratories and given them a thorough trial would be unwilling to dispense with them.

The Use of Brass in Water Works Construction With Special Reference to Experience on the Catskill Aqueduct.

For about 40 years several kinds of forgeable copper alloys of high tensile strength, known as bronzes and brasses, have enjoyed a wide use in water works construction. These alloys have been adopted, of course, for their resistance to corrosion in the presence of water or moisture in the air. Only a few months ago a paper was read before the New England Water Works Association by a practical water works superintendent who strongly urged the advisability of using more brass in the construction of water gate valves. Since then some of the limitations of brass in water works construction have been pointed out by Mr. Alfred D. Flinn, Deputy Chief Engineer of the New York Board of Water Supply, in a paper before the Municipal Engineers of the City of New York. Mr. Flinn's observations were made in connection with his work on the Catskill aqueduct and while they clearly indicate the importance of careful inspection of water works brass goods they do not at all signify that brass is becoming structurally or economically obsolescent in water systems. The following matter is based on Mr. Flinn's paper:

Claims of brass or bronze makers backed up by tests and experience led the engineers of the Catskill aqueduct, after careful investigation, to adopt some of these copper-zinc alloys for extensive use where their noncorrodibility and other good qualities claimed for them made them especially suitable. It is safe to say that on no other single engineering enterprise have such large quantities ever been used, the total being nearly 3,000,000 lbs. More than 2,000,000 lbs. of this was in the form of castings ranging from a fraction of a pound to 22,000 lbs. each. Forgings constituting a large proportion of the remainder, varied from small bolts to sluice gate stems about 6 ins. in diameter and 31 ft. long, weighing 3,200 lbs. each. The balance was made up of plates, rods and shapes. Manganese bronze constituting a very large proportion of the total, "naval brass," including Tobin bronze, was used in large amounts and various common brasses and special compositions made up the relatively small remaining quantity.

It was not in the large castings, however, that trouble was experienced, but in the smaller objects, such as bolts, ladder rungs and pipes. These numerous and various brass articles had been made by a number of manufacturers scattered through New England, New York, Pennsylvania and New Jersey. The experience of the Catskill aqueduct with these brass articles may be summarized as follows:

Large numbers of brass bolts have been found cracked and broken in their packing boxes after storage through a winter, but having never been stressed; others never exposed to low temperatures and never stressed have been found in similar condition. These bolts ranged from ½ in. to 2¼ ins. in diameter. Similarly, flat bars, rolled plates and long rods supporting only their own weight have been found cracked or severed after a lapse of a few or many months. Flanged ¼-in. plates riveted together, after careful inspection being in apparently good condition, were found some months later to have incipient and well developed cracks, with many rivets cracked or yielding to relatively light blows from a hand hammer. Many upset rivet heads have come off. Hundreds of bolts have broken under tension after short or long intervals. The failures have been so numerous and important as to have caused the gravest apprehension and led to the substituting of steel for brass in many cases, in spite of the recognized disadvantage of steel as to corrosion which the engineers had sought earnestly to avoid.

No brand or make of brass or bronze has wholly escaped. Manganese bronze, naval bronze (including a well-known bronze, and its imitation), and Muntz metal, from *all* the manufacturers who have furnished any considerable quantity, *all* have failed. Hitherto castings and large forgings have been exempt, or at least failures in them have not been discovered, except in a few cast bolts and nuts.

When studying the extent and cost of these failures, it was found that other users also have had trouble of one kind or another, knowledge of which has come to hand within relatively recent time. At just what date or when in the state of development of brass manufacture these troubles began, or how extensive they have been, has not yet been learned. Possibly they might have been considered occasional or accidental but for the large use of these alloys on the Catskill aqueduct under supervision which led to a detection of these defects.

The discovery of these failures in the fall of 1913 was all the more disappointing because the specifications had been drawn carefully in the light of information which is in hand and practically all the metal accepted had been subjected to careful inspection, including the standard physical tests and chemical analyses. Much of the metal accepted had shown physical qualities in generous excess of the specified requirements, and it is quite unthinkable that the manufacturers were not honestly endeavoring to fulfill the specifications and furnish satisfactory materials.

Among the physical characteristics required were that manganese bronze should have a tensile strength of not less than 65,000 lbs. per square inch, an elastic limit of not less than 45 per cent of the ultimate tensile strength and an elongation of not less than 25 per cent. That rods for brass rivets should have a tensile strength of not less than 55,000 lbs. per square inch, an elastic limit of not less than 30,000 lbs., and an elongation not less than 20 per cent. It is known that in brasses the elastic limit or yield point is not well defined and, judging from some experiments recently performed, must under prolonged stress be regarded as the ultimate strength. It was known that apparently sound brass pipes and some kinds of brass wire would occasionally crack without evident reason; but leading manufacturers of brass pipe have discovered how to modify the details of manufacture so as to overcome these troubles in a large measure, and little trouble has been experienced with pipes furnished by reputable manufacturers in recent years. There is, therefore, small excuse for supplying other than dependable brass pipe nowadays.

Experiments carried on by Inspector Jonson of the Catskill aqueduct laboratory demonstrated that improperly cold-worked rods were in a state of initial stress, and that these stresses were frequently of important magnitude, so that in many cases a small or moderate increment of stress, like temperature change or load, would produce failure. By placing round rods in a lathe and removing their exterior surface, accurate measurements showed that the length of the rod gradually increased, demonstrating that the interior metal had been under compression and the exterior surface in tension. Conversely, on boring a good-sized core from the inside of rods, the rods shortened, again demonstrating the same condition. From the amount of expansion or contraction in length it was possible to calculate with close approximation the stresses and strains in the material.

Martens and Heyn, the eminent German physicists, have developed a method for determining the tendency of brass to crack by applying a solution of mercury salt to the surface of a brass rod under initial stress. Cracks would be developed almost instantaneously or in a few minutes in some specimens, while in others the cracks would not become apparent for a number of days. This mercury test has been used by the Board of Water Supply and, while useful, has not proved infallible, some rods which gave negative results under this test subsequently cracking. Moreover it would be manifestly impracticable to apply this accelerated test to the whole surface of every rod of a large shipment, and a more practical test is desired by which one can make sure that brass rods or other articles being purchased or already in place are permanently free from the tendency to crack.

After the discovery of the extensive cracking referred to, it was decided to use plain extruded or hot-rolled rods wherever practicable and to anneal all material which had to be drawn or rolled whole. Unfortunately, the method of manufacture did not avoid further trouble of this kind. Plain extruded, hot-forged and annealed brass rods supposedly free from initial stress have also failed in disturbingly large quantities.

Some experiences and observations indicate that corrosion has much to do with the cracking of brass under some circumstances. Apparently certain kinds of corrosion greatly reduce the cohesion of the affected part of the material, thus destroying the ductility so that cracks develop as soon as the deformation extends to or beyond the yield point. If this conclusion be true, it should be possible to produce season cracking in bars free from appreciable initial stress by stressing them by means of an external force and then corroding the surface. Experiments made in the laboratory of the Board of Water Supply demonstrated that such results were obtained, both strong ammonia and mercury salt solution being used as corroding agents. Tests made indicate that brass, especially when subjected to a tensile strength approaching the yielding point, is liable to inter-granular oxidation which may penetrate indefinitely along certain planes of weakness. This opinion is confirmed by the appearance of breaks which indicate that the metal is not torn apart, as in a tensile test, but parts gradually along the boundaries of the grain which are supposed to be groups of very small and intimately mixed copper, zinc and tin crystals.

QUERIES IN CONCLUSION.

For designing and constructing engineers the following questions should be satisfactorily answered if they are to continue the use of these brasses or bronzes for important purposes:

Can a brass or bronze of high tensile strength be reliably produced which can be used safely for important permanent structures in such parts as bolts and other rolled, drawn, extruded or forged shapes?

What should be the specifications for such brasses or bronzes?

What inspection methods and tests should be used?

By what tests can the tendency to subsequent failure be detected at any time after manufacture?

What working stresses may be used safely for these various alloys?

Will these brasses, or bronzes, deteriorate by reason of constantly applied or frequently repeated stress; that is, will they fail from fatigue?

ROADS AND STREETS

Analysis of Concrete Curb Construction for Suburban Improvements Near New York City.

Contributed by Allen C. Haskell, 15 Williams St., New York.

The Construction Service Company was engaged recently, in the capacity of efficiency engineers, upon the initial development, for residential building purposes, of a large tract of land not far from New York City.

When they undertook their duties work had already been started and was progressing as best it could under the system of management then in vogue. The mission of the efficiency engineers was to reduce unit costs by properly organizing and scientifically standardizing the various tasks. Their first step in this direction was to make time studies of the grading work, transporting of materials, trench work, pipe laying, concrete curb work, etc.

Observations extending over a period of almost one month were made upon the laying of concrete curb, and represent the performance after the work had been organized. The process was divided into the following parts: *Trenching, Placing Forms, Removing Forms, Mixing and Handling Concrete, Mixing and Handling Fine Stuff, Finishing, Cleaning and Scrubbing,* and *Backfilling.* Daily reports, like the one shown, Fig. 1, were made out for each gang by the cost keeper, who had been properly instructed, and these were checked by the field observations of the Construction Service Company's inspector. The writer can personally vouch for the accuracy of the reports from which the data below are computed, both as to the division of man hours spent upon each operation and as to quantities of materials used and measurements of work accomplished. The costs given are naturally correct for the period of observation only, and, as mentioned above, the observations upon which they are based were made after the work had been organized, and therefore the average cost of all curb work, including the period of organization, etc., is somewhat higher than that shown, but the data and costs of the performance after organization, as presented, are considered to be more of a criterion than would be the case were the period of organization included.

There were two gangs engaged in the actual curb work. Each averaged about 17 men in number, and as far as was feasible the same men in each gang performed the same work day after day so that they became proficient in executing their individual duties. A separate gang dug all trenching for the two curb gangs, thus not only becoming adept but also being able to keep trench open in front of the curb gangs in proportion to the latters' rate of working, and thereby enabling them to lay curb without interruption.

The curb was of the cross-section shown in Fig. 2. It was laid in 6-ft. lengths, with metal section plates. The coarse stuff was poured into the form to within 10 ins. of the top, then a strip of thin board was placed longitudinally in a section 1 in. back from the face. Behind this the coarse stuff was poured and rammed, and in front of it the fine stuff, to within 1 in. of the top. The thin strip of wood was then removed and the top facing of fine stuff put in. After finishing, as soon as the mixture had set sufficiently the front forms were removed and the curb was scrubbed. Steel brushes were used for this purpose where the material had set hard enough to require them, but usually the final scrubbing was done with a common stiff-bristle brush. A small hose furnished running water where connections were possible, Fig. 4, but at other points it was necessary to use water in pails. This latter method was less satisfactory, as

CURB AND SIDEWALK WORK.
CONSTRUCTION SERVICE COMPANY.

JOB....... *Curbs*
LOCATION....*Road "X"*....

WORK ORDER No. *150*
DATE......*Aug. 24, 1913*.....
WEATHER.......*Clear*.......

Work Order	No. Men	Work	Reg. Hours	Reg. Rate	Extra Hours	Extra Rate	Total Hours	Total Amount	Work Done	Unit Costs
										Cu. ft.
....	*1*	Foreman	*10*	*37½*			*10*	*$3 75*		*1.7*
.....	*1*	Waterboy	*10*	*10*			*10*	*1.00*		*0.5*
.. .	.....	Trenching......	...				...		Sta..	
.. ..	*4*	Placing and removing forms	*20*	*17½*	*10* *10*	*25* *35*	*40*	*9.60*	Sta. *108′*	*9.0*
. ..	*1*	....	*3*	*17½*		..	*3*	*0.52*	*114′*	*0.4*
.....	*7*	Mixing and handling concrete.	.... *50*	 *17½*	*10* *10*	*18½* *20*	*70*	*12.60*	Sta........ *214′-4″*	*5.9*
....	*2*	Mixing and placing fine stuff ..	*10*	*17½*	*10*	*20*	*20*	*3.75*	Sta. *214′-4″*	*1.7*
. ..	*2*	Finishing	*5* *10*	*35* *40*		...	*15*	*5.75*	*214′-4″*	*2.6*
.....	*3*	Cleaning	*10*	*17½*	*5*	*35*	*15*	*3.50*	.... *214′-4″*	*1.6*
	.. .	Distrib. material								
. .	*1*	Backfilling......	*3*	*17½*			*3*	*0.53*	*114′*	*0.4*
..	.....	Cement								*6.8*
.	....	Sand.								*1.3*
...	....	Gravel								*7.0*
..	.....	Pebbles					......			*0.5*

No. Men in Gang, *17.* *Cost per ft. curb exclusive of trenching* .... *cu. ft.* *39.4*

Cement: *48* Bags.
Gravel: *8* Yards.
Water: .. Cu. ft.
Curb Width *5* Inches
Kind of Finish *1 1½ : 1½*
Material on Hand in charge of Foreman at 6 P. M

Sand: *3.8* Yds.
Fine Gravel: *0.69* Yds.
Thickness: *24* Ins.
Concrete: *1 : 2½ : 6*

Forms set included 1 corner.
A. B. Smith, Timekeeper.
C. D. Jones, Foreman.

Fig. 1. Specimen Daily Cost Report for One Gang.

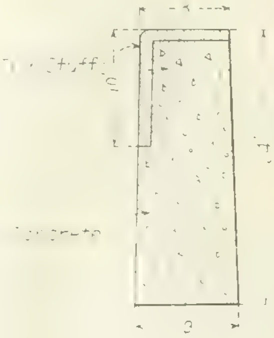


Fig. 2. Cross Section of Curb.

the water soon became dirty from too constant re-use and the curb showed the effects by presenting, when dry, a surface coated over with a thin film of sediment. After the scrubbing was completed the back forms were removed and earth backfilled along the curb to the desired depth.

OPERATIONS IN DETAIL.

Trenching.—The trenching gang averaged about seven men in addition to the foreman and water boy. The digging was in a mixture of sand and clay, enough of the latter being present to require the almost constant use of

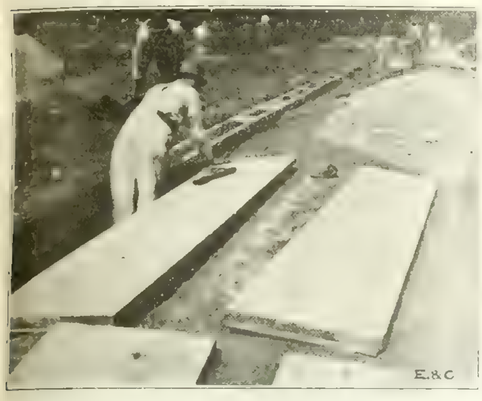


Fig. 3. Showing Evenness of Trench, Also Forms.

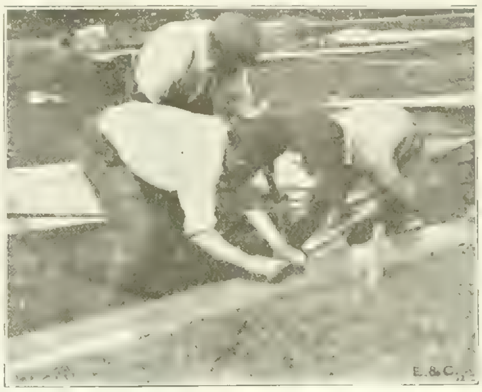


Fig. 4. Scrubbing Curb and Washing With Running Water.

Fig. 5. Showing Mixing Platform and Sand and Gravel Measure.

TABLE I.—PERFORMANCE IN MAN-HOURS BASED ON 38 SEPARATE TIME STUDIES.

Foreman.	Water boy	Trenching.			Placing forms.			Removing forms.			Mixing and handling concrete.				Mixing and placing fine stuff.				Finishing.				Scrubbing.			Backfilling.			No. men in gang.
		Man-Hrs.	Amt.	Amt. M.-H.	Man-Hrs.	Amt.	Amt. M.-H.	Man-Hrs.	Amt.	Amt. M.-H.	Man-Hrs.	Amt.		Amt. M.-H.	Man-Hrs.	Amt.		Amt. M.-H.	Man-Hrs.	Amt.		Amt. M.-H.	Man-Hrs.	Amt.	Amt. M.-H.	Man-Hrs.	Amt.	Amt. M.-H.	
10	10	...	....	....	40	160′	4.0	20	216′	10.8	30	105′	5″	3.5	10	105′	5″	10.5	15	105′	5″	7.0	15	105′	7.0	20	216′	10.8	16
10	10	...	....	....	40	120′	3.0	8	186′	23.3	28	74′	5″	2.7	8	74′	5″	9.3	20	74′	5″	3.7	6	74′	12.4	..	....	....	12
10	10	114	72′ 500′	0.63 4.4	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	13
10	10	40	200′	5.0	..	....	....	25	228′	9.1	40	186′	1″	4.7	10	186′	1″	18.6	20	186′	1″	9.3	10	186′	18.6	15	228′	15.2	20
10	10	...	....	....	40	108′	2.7	3	114′	38.0	70	214′	4″	3.1	20	214′	4″	10.7	15	214′	4″	14.3	15	214′	14.3	3	114′	38.0	17
2	2	24	18′ 120′	0.75 5.0	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	6
10	10	...	....	....	46	216′	5.4	11	132′	9.4	54	225′	11″	4.2	12	225′	11″	18.8	30	225′	11″	7.5	18	226′	12.6	14	250′	17.9	19
10	10	...	....	...	38	236′	6.2	12	154′	12.8	63	119′	9″	1.9	18	119′	9″	6.7	18	119′	9″	6.7	7	120′	17.1	12	154′	12.8	17
10	10	..	....	....	27	68′	2.5	10	144′	14.4	63	157′	1″	2.5	18	157′	1″	8.7	16	157′	1″	9.8	16	157′	9.8	5	144′	28.8	16
10	10	...	....	....	40	264′	6.6	25	132′	5.3	35	144′	5″	4.1	10	144′	5″	14.5	20	144′	5″	7.2	5	144′	28.9	..	....	....	16
5	5	40	33′ 292′	0.83 7.3	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	8
8	9	22	75′	3.4	22	76′	3.5	10	72′	7.2	36	144′	0″	4.0	14	144′	0″	10.3	10	144′	0″	14.4	15	144′	9.6	..	....	....	16
10	10	48	132′	2.8	10	160′	4.0	18	60′	3.3	23	132′	9″	5.8	8	132′	9″	16.2	20	132′	9″	6.6	16	133′	8.3	..	....	....	18
10	10	100	75′ 585′	0.73 5.9	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	10
10	10	94	60′ 460′	0.64 4.9	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	11
9	10	...	....	...	6	24′	4.0	30	228′	7.6	27	114′	0″	4.2	10	114′	0″	11.4	18	114′	0″	6.3	10	114′	11.4	20	228′	11.4	15
10	10	100	90′ 640′	0.90 6.4	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	10
10	10	50	210′	4.2	20	168′	8.4	28	246′	8.8	19	96′	0″	5.1	5	96′	0″	19.2	17	96′	0″	5.6	8	96′	12.0	27	246′	9.1	18
10	10	100	62′ 485′	0.62 4.9	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	10
10	10	...	....	....	20	204′	10.2	15	216′	14.4	60	228′	3″	3.8	25	228′	3″	9.1	22	228′	3″	10.4	11	228′	20.3	..	....	....	15
10	10	...	....	...	20	236′	11.8	15	168′	11.2	49	246′	7″	5.0	21	246′	7″	11.7	21	246′	7″	11.7	24	247′	10.3	10	168′	16.8	16
10	10	...	....	....	19	180′	9.5	12	190′	15.8	32	168′	7″	5.3	12	168′	7″	14.1	30	168′	7″	5.6	18	169′	9.4	..	....	....	18
11	10	...	....	..	20	156′	7.8	6	204′	34.0	65	217′	8″	3.3	30	217′	8″	7.3	22	217′	8″	9.9	10	218′	21.8	4	204′	51.0	16
10	10	88	40′ 203′	0.45 2.3	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	9
10	10	60	62′ 488′	1.03 8.1	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	6
10	10	...	.	.	20	212′	10.6	20	252′	12.6	10	174′	7″	4.4	10	174′	7″	17.5	25	174′	7″	7.0	20	175′	8.7	20	252′	12.6	18
10	10	. .	.	.	20	240′	12.0	15	228′	15.2	30	203′	10″	6.8	10	203′	10″	20.4	10	203′	10″	20.4	20	204′	10.2	..	....	....	16
12	10	...	....	...	20	168′	8.4	16	120′	7.5	56	252′	8″	4.5	24	252′	8″	10.5	30	252′	8″	8.4	31	253′	8.1	10	120′	12.0	18
11	10	. .	....	.	20	216′	10.8	10	214′	21.4	50	232′	0″	4.6	35	232′	0″	6.6	22	232′	0″	10.6	16	232′	14.5	..	....	....	16
10	10	46	40.5′ 217′	0.88 4.7	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	5
10	10	...	..	....	20	204′	10.2	18	200′	11.1	28	120′	0″	4.3	18	120′	0″	6.7	20	120′	0″	6.0	24	120′	5.0	14	200′	14.3	16
12	10	...	....	..	20	156′	7.8	10	152′	15.2	52	214′	0″	4.1	18	214′	0″	11.9	19	214′	0″	11.3	27	214′	7.9	..	....	....	14
10	10	30	13′ 101′	0.43 3.4	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	3
10	9	61	82′ 583′	1.34 9.6	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	9
10	9	...	....	....	18	120′	6.7	29	168′	5.8	30	192′	7″	6.4	19	192′	7″	10.1	20	192′	7″	9.6	4	193′	48.1	17	100′	5.9	15
10	9	...	....	....	23	210′	9.1	25	84′	3.4	40	200′	8″	5.0	20	200′	8″	10.0	18	200′	8″	11.1	15	201′	13.4	12	84′	7.0	17
10	10	...	....	...	20	264′	13.2	12	192′	16.0	18	83′	0″	4.6	12	83′	0″	6.9	10	83′	0″	8.3	8	83′	10.4	8	190′	23.8	13
10	10	...	....	....	20	528′	26.4	10	180′	18.0	35	168′	0″	4.8	10	168′	0″	16.8	20	168′	0″	8.4	20	168′	8.4	15	150′	10.0	15
10	10	128	467′	3.6	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	14
10	10	80	345′	4.3	..	....	....	..	....	....	..	....	..	...	..	....	..	....	..	....	..	....	..	....	....	..	....	....	8
10	10	...	....	....	23	60′	2.6	15	172′	11.5	40	192′	0″	4.8	20	192′	0″	9.6	20	192′	0″	9.6	15	192′	12.8	..	....	....	15
10	10	45	100′	2.2	20	144′	7.2	19	180′	9.5	30	180′	0″	6.0	10	180′	0″	19.0	14	180′	0″	12.9	11	180′	16.4	6	180′	30.0	16
10	10	40	110′	2.8	41	276′	6.7	20	90′	4.5	30	172′	0″	5.7	10	172′	0″	17.2	20	172′	0″	8.6	16	172′	17.2	10	180′	18.0	20
10	10	60	150′	2.5	16	120′	7.5	4	96′	24.0	30	156′	0″	5.2	10	156′	0″	15.6	20	156′	0″	7.8	10	156′	15.6	6	100′	16.7	20
					Plac. & Remov.																								
10	10	85	300′	3.5	30	348′	11.6	..	....	...	25	120′	0″	4.8	10	120′	0″	12.0	20	120′	0″	6.0		....	....	..	..	...	20
10	10	40	150′	3.8	73	180′	2.5	..	....	...	32	156′	0″	4.9	12	156′	0″	13.0	20	156′	0″	7.8	12	156′	13.0	..	...	..	21
10	9	34	150′	4.4	29	120′	4.1	..	....	...	30	120′	0″	4.0	12	120′	0″	10.0	20	120′	0″	6.0	..	....	....	..	....	....	21
10	9	36	100′	2.8	18	220′	12.2	..	..	....	30	96′	0″	3.2	13	96′	0″	7.4	15	96′	0″	6.4	9	96′	10.7	..	...	....	20
10	9	36	100′	2.8	28	150′	5.4	..	....	....	35	162′	0″	4.6	14	162′	0″	11.6	19	162′	0″	8.5	8	162′	9.0	..	...	....	18
10	10	17	17′ ..	.88 ...	32	100′	3.1	..	. .	...	40	120′	0″	3.0	12	120′	0″	10.0	20	120′	0″	6.0	15	120′	8.0	.	. ..	....	15
11	10	60	200′	3.3	4	144′	36.0	.	....	.	40	144′	0″	3.6	22	144′	0″	6.5	24	144′	0″	6.0	22	144′	6.5	.	. ..	...	18
11	10	30	20′ 120′	.67 4.0	16	144′	9.0	..	....	....	45	168′	0″	3.7	25	168′	0″	6.7	22	168′	0″	7.6	14	168′	12.0			. .	16
10	10	130	85′	.65	10	156′	15.6		.	..	.	...	..	...		.				. .		.			.	..	.	. ..	17
11	10	92	40′ 434′	.43 4.7	..	. ..				...	32	84′	0″	2.6	16	84′	0″	5.7	12	84′	0″	7.0					. .	.	17
12	10	155	60′ 300′	.39 1.9	8	50′	6.3	..	....	....	..	....	..	...		.		.		.		.					...	...	21
10	10	122	78′ 300′	.64 2.5	28	192′	6.9	.		....	..	....	..	...						. ..		....	.	....			....	...	21
Min.	..	17	75′	1.9	6	24′	2.5	3	60′	3.3	18	74′	0″	1.9	5	74′	0″	6.5	10	74′	0″	3.7	4	74′	5.0	3	84′	5.9	8 12
Av.	...	68	278′	4.1	25	183′	7.2	16	167′	10.6	39	161′	0″	4.2	15	161′	0″	10.6	19	161′	0″	8.3	15	166′	11.4	12	175′	14.1	11 17
Max.	..	155	640′	9.6	41	528′	26.4	30	252′	38.0	70	253′	0″	6.8	35	253′	0″	20.4	30	253′	0″	20.4	30	253′	48.1	27	252′	51.0	21 21

Note.—The average number of feet of forms placed and forms removed does not agree with the average number of feet of curb laid for the **reason that the averages of the former were not taken over the same period as the latter.**

Under "No. men in gang" the upper figures at min., av. and max. are for trench gangs, the lower ones are for the concrete gangs picks. There were many boulders and it was frequently necessary to blast. In many instances the land had not yet been graded to the level of the top of the curb, and it was necessary to make the trench somewhat deeper than the 24 ins. required for the curb. The cuts over all the work averaged about seven lineal feet of trench to a cubic yard. The work was carried on with few delays and the trench when finished presented a fine appearance, Fig. 3, being even and straight.

Forms.—Wooden forms were used and were made up of three 12-ft. by 8-in. by 1½-in. spruce boards cleated together, Fig. 3, thus making each completed form section 12 ft. by 24 ins. by 1½ ins. in size. These were used upon the straightaway portions. One-half inch cypress, cut and curved to suit conditions, was used at the corners, because it did not split easily. The form sections were kept at the proper distance apart by 8-in. strips of wood set in at frequent intervals, and were held together tightly against these strips by metal screw clamps. This arrangement is clearly shown in Figs. 4 and 8.

In each curb gang there was a carpenter and helper placing forms. The carpenter constructed the forms, made the gauge pieces inserted at intervals to maintain the required distance between sections, placed the forms in their proper positions in the trench, gauged, braced and aligned them. The helper saw to it that the requisite materials were on hand so that the carpenter need not spend more valuable time in searching for lumber, nails, etc. He assisted in the heavier handling, filled in behind the forms when they were properly set in the trench, and acted as general handy man for the carpenter. When necessary the services of another helper were incorporated. An average of about 25 man-hours per day was spent on this work—full time for carpenter and helper and 5 man-hours of extra help.

The number of men per gang who removed forms depended upon the progress of the concrete workers, but ordinarily one man devoted his entire time to this part of the work and was assisted as necessity arose by others to the extent of 6 man-hours per day—a total of 16 man-hours. The average amount of curb laid per day was a little over 161 ft., and each man, therefore, removed an average of about 10 ft. per hour. This includes not only the actual removal of the forms from the trench, but also cleaning them and putting them in condition to be used again, carrying them to the next point where they were to be used, and there so arranging them with their gauge pieces and metal braces as to facilitate their handling.

Concrete.—At first a 1:2:5, but later a 1:2½:6, mixture of concrete was used. It was mixed on a wooden platform in batches consisting of 6 bags of cement, 12 cu. ft. of sand and 30 cu. ft. of coarse stuff. For the fine stuff a 1:1½:1½ mixture was used and mixed in batches consisting of 3 bags of cement, 18 shovelfuls of sand and 18 shovelfuls of gravel.

An average of about 54 man-hours per day per gang was spent in handling and mixing concrete, including fine stuff. Usually about seven men were engaged in mixing coarse stuff and two in mixing fine stuff for a total of 6 hours during the day. For the balance of the time they assisted in removing forms, in scrubbing the curb, in backfilling or in screening, as their services were required. For the most part the cement, sand and gravel had been distributed previously at such points along the curb trenches and in such quantities that the average haul from materials to mixing platform was a minimum. The mixing platform was moved to keep pace with the progress of the work and occupied the middle of the street, so that both curbs could be laid simultaneously with the least shifting of apparatus.

Measures for the sand and gravel of the type shown in Fig. 5 and of such size as to give the proper proportions for each batch were used. The 4-ft. by 3-ft. by 1-ft. measure was first placed upon the platform, the sand poured in from wheelbarrows, the measure lifted and the sand spread about. Then the 4-ft. by 3-ft. by 2½-ft. gravel measure was placed thereon, filled and raised. The gravel was cratered out on the top and the cement poured in. The required water was added and the batch mixed.

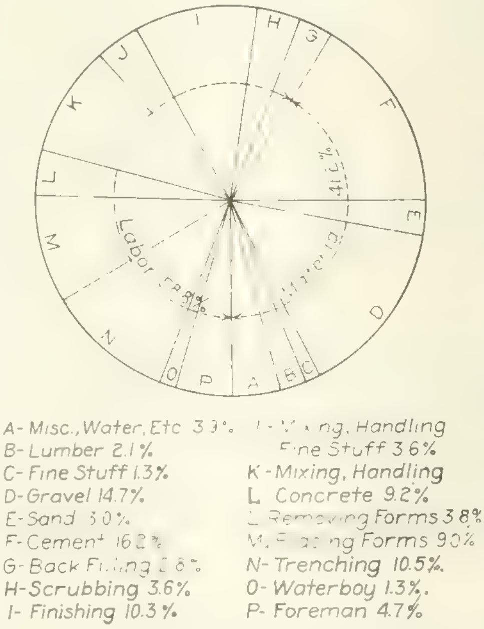


Fig. 8. Diagram Showing the Percentages of the Various Items of Labor and Material to the Total Cost Per Linear Foot of Curb.

The coarse gravel was screened and the resulting fine stuff put into cement bags, Fig. 6, in the proper amounts for a batch, so that when it was neecsary to make a mix the time required to shovel the gravel was saved. It was also much easier to distribute in this form and it prevented waste.

Finishing.—In each gang there were two finishers whose whole time was devoted to this work. Great care was taken that the curb should present an even, uniform appearance, and at each joint the edges were carefully beveled and finished. And in this connection it may be well to mention here that great care was exercised in every branch of the work to have it of the best possible quality.

Scrubbing.—From one to three men scrubbed the curb, and this operation required about 15 man-hours per day. Figure 4 gives a clear idea of how the work was conducted, the methods being described above.

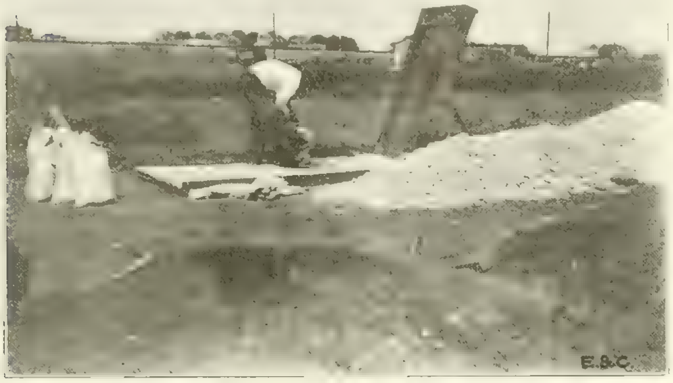


Fig. 6. Screening Gravel and Putting Fine Stuff Into Bags.

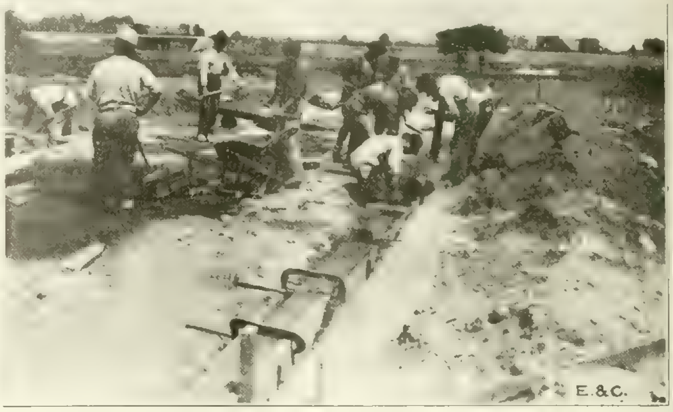


Fig. 7. Handling Concrete From Mixing Board to Forms.

Backfilling.—After the outside forms were removed the earth was backfilled and this work required, on the average, 12 man-hours per day.

Foreman and Water Boy.—It will be observed that time for foreman and water boy has not been included above. This averages 10 hours per day for each and may be divided among the various operations in proportion to the time spent on each, thus:

	Average man-hours spent on each class of work.	Per cent of total.	Foreman's and water boy's time, man-hours.
Placing forms	25	17.7	1.8
Removing forms	16	11.4	1.1
Mixing and handling concrete	39	27.7	2.8
Mixing and handling fine stuff	15	10.6	1.1
Finishing	19	13.5	1.3
Scrubbing	15	10.6	1.1
Backfilling	12	8.5	0.8
Total	141	100.0	10.0

COSTS.

The costs of labor and materials on the work were as follows:

Item		
Material—		
Cement, per bbl.		$1.29
Sand, per cu. yd.		0.75
Gravel, per cu. yd.		1.90
Fine stuff, per cu. yd.		1.75
Labor—		
Foremen, per 10-hr. day		3.75
Water boy, per 10-hr. day		1.00
Common labor, per hour	$0.17½, $0.18½.	0.20
Carpenters, per hour		0.35
Carpenters' helpers, per hour		0.25
Finishers, per hour		0.35
Scrubbers, per hour		0.35

Table I is a record of performance, showing the amount of work done per man-hour in the various divisions outlined above. Of the three columns under each division the first represents the number of man-hours spent, the second the total amount of work performed and the third the amount of work per man-hour.

An average of 161 lin. ft. of finished curb was laid per working day. The amount of concrete required for this was about 230 cu. ft., of which 210 cu. ft. were coarse stuff and 20 cu. ft. fine stuff; while 5.4 cu. ft. of coarse stuff were mixed and placed per man-hour and 1.3 cu. ft. of fine stuff.

Table II is a summary of costs and performance, giving the minimum, average and maximum for each item. The percentage of each to the total cost is given, and also a diagram, Fig. 9, which conveys a little more clearly than the table the relative weight of each item of labor and material in contributing to the final cost.

TABLE II.—SUMMARY OF COSTS AND PERFORMANCE BASED ON 38 TIME STUDIES.

	Cost in cts. per lin ft. Min.	Av.	Max.	Pct. of av. to total.	Amount done per man hour, ft. Min.	Av.	Max.
Labor							
Foreman	1.1	2.2	3.9	4.7	..	..	..
Water boy	0.4	0.6	1.3	1.3	..	..	..
Trenching	2.2	4.9	9.4	10.5	1.9	4.1	9.6
Placing forms	1.0	4.2	10.4	9.0	2.5	7.2	26.4
Removing forms	0.5	1.8	5.2	3.8	3.3	10.6	38.0
					2.0	4.6	7.3
Concrete	2.6	4.3	9.5	9.2	1.9	4.2	6.8
					1.2	2.1	5.4
Fine stuff	0.9	1.7	2.9	3.6	6.5	10.6	20.4
Finishing	1.8	4.8	10.7	10.3	3.7	8.3	20.4
Scrubbing	0.4	1.7	3.4	3.6	5.0	11.4	18.1
Backfilling	0.3	1.3	2.0	2.8	5.9	14.1	51.0
Materials							
Cement	6.2	7.6	8.9	16.2			
Sand	1.2	1.4	1.5	3.0			
Gravel	6.0	6.9	7.7	14.7			
Fine stuff	0.4	0.6	0.7	1.3			
Forms (lumber)	1.0	1.0	1.0	2.1			
Miscel. (water, waste, etc.)	1.5	1.8	2.0	3.9			
Total	27.5	46.8	80.5	100.0			
Summary of above items:							
Foreman and water boy	1.5	2.8	5.2	6.0			
Trenching and backfilling	2.5	6.2	11.4	13.8			
Forms	1.5	6.0	15.6	12.8			
Concrete	5.7	12.5	26.5	26.2			
Materials	16.3	19.3	21.8	41.2			
Total	27.5	46.8	80.5	100.0			

NOTE.—These costs do not include superintendence or overhead charges of any kind.

Cost of Trenching Through Brick Pavement for Laying Lighting Conduit and Cutting Holes in a Concrete Sidewalk.

To the Editors: I am enclosing herewith, some cost data on brick steel work that may be of interest to some of the readers of Engineering and Contracting. I greatly appreciate many articles of a similar nature that I get from that magazine.

The following costs of work accomplished in Kankakee, Ill., include the operation of tearing up a cement grouted brick pavement, trenching the sand cushion to provide a space for laying wire conduit between ornamental street lights and relaying and grouting the brick. The trench followed the street curb as closely as practicable, crossing two street intersections and two street car lines.

	Total cost.	Cost per lin. ft. of trench.
Labor:		
Tearing up and cleaning brick	$21.37	$0.019
Relaying and grouting brick	27.95	.025
Hauling material	4.00	.004
	$53.32	
Material:		
Cushion sand, 2 cu. yds.	$ 3.00	
Cement, 4 bbls	6.00	
New brick, 300	4.00	......
Insurance, cleaning up, lights and other incidentals	5.00	
	$18.00	$0.016
Total cost of labor and material	$71.32	$0.064

Conditions:
Width of trench, 18 ins.
Length of trench, 1,130 ft.

The following are the costs of cutting 16 holes through a concrete sidewalk down to the concrete pavement being a distance of about 16 ins., filling the holes with concrete and setting 4 bolts in each hole to fit in the bases of ornamental lighting posts:

	Total cost.	Cost per hole.
Labor:		
Cutting holes, 25 hrs. at 50 cts.	$12.50	$0.78
Concreting holes	5.00	.31
Material:		
Wood templates to hold bolts in place, 12 in all	3.00	.19
Concrete, 2 cu. yds. at $3.60	7.20	.45
Insurance, red lights, cleaning up, etc.	1.12	.07
Total cost of labor and material	$28.82	$1.80

Conditions:
Size of holes, 18 ins. by 18 ins.
Number of holes, 16.
Depth of holes, 16 ins.
Labor, per hour, 25 cts.

Yours truly,
FRANK L. SHIDLER.
General Contractor.

Kankakee, Ill.
January 7, 1915.

Method of Constructing Gravel Coated Earth Roads in Polk County, Minnesota.

To the Editors: The method of applying a thin coat of gravel to earth roads that has been successfully used in Polk County, Minn., is as follows:

In the first place it is necessary to have a well-drained and well-crowned dirt road for a foundation. The road should be well packed or one that has been traveled for several years, and should be at least 20 ft. wide on top, and should have a crown from 6 ins. to 1 ft.

The next step is to haul gravel and place it along the center of the road using about 1 cu. yd. to every 10 ft., or length of wagon box. This amounts to about 530 cu. yds. per mile.

The gravel is then spread with a blade machine, with shovels, or left to spread itself and be beaten in by traffic. It becomes a smooth, hard, well beaten road in 2 or 3 months. This coat is left on the road from 3 to 6 years or till clay begins to show on the surface and the road becomes rough, then a second coat is put on in the same manner as the first coat. This coat also becomes smooth and hard after a few months travel. The second coat should last a great deal longer than the first coat.

All methods for graveling roads that I have seen described recommend earth shoulders to hold the gravel in place. In the above method earth shoulders are not necessary. They only increase the cost of construction and prevent the top of the road from draining off properly.

Most of our gravel is hauled in the winter after the ground freezes since teams can be got in abundance at that time of the year and at a lower price than at other seasons. In the winter the price per cubic yard per mile for hauling will range from 12½ to 20 cts. Gravel generally costs from 10 to 15 cts. per cubic yard in the pit in this county.

Maintenance is much cheaper on gravel roads than on earth roads. Much less dragging is required. A few yards of gravel is required per mile for a few years to fill in soft spots that develop in the road.

A soil survey of the U. S. Department of Agriculture classifies the soil area that is being graveled in this manner as black silty clay. This soil bears up well under heavy loads but is very sticky in wet weather and if roads are not graveled the clay will stick to the wheels of wagons making hauling heavy in wet weather and roads rough in dry weather. For these reasons a thin coat of gravel is sufficient to make the road hard and smooth.

Yours truly,
S. STEENERSON, District Engineer,
State Highway Commission.

Crookston, Minn., Jan. 9, 1915.

[The method of improving earth roads outlined in the above letter has been used for many years in sections of the country where soil conditions are as stated above. For roads that bear a light traffic during the seasons of the year where the earth is saturated with water it has proved an economical and satisfactory method of road improvement. While this superficial coating of gravel cannot be termed a gravel road it represents a successful type of road improvement that might possibly be called a gravel coated earth road.—Editors.]

CONSTRUCTION PLANT

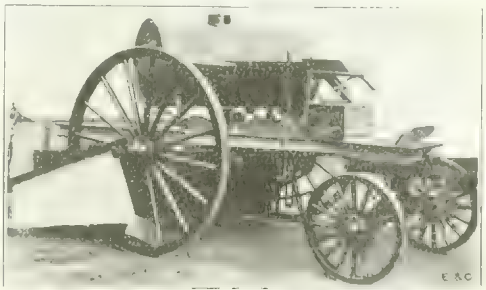
MACHINES DEVICES MATERIALS

The Studebaker Combined Sprinkler and Sweeper.

The combination street sprinkler and sweeper illustrated consists of a complete sweeping apparatus, upon the frame of which is mounted an iron watering tank, providing a means of spraying water directly in front of the broom when the sweeper is in operation.

A steel A frame is mounted upon four Sarven patent wheels and is covered with a tight deck. The broom is operated by three simple gears beneath the platform. The broom may be adjusted by means of a turnbuckle to any desired angle and an adjustment in suspension provides for the shortening of fiber due to wear. Iron shields at the sides prevent the dust from flying when the sweeper is in operation. Operation of the broom is controlled from the driver's seat.

The sprinkling attachment consists of a 175-gal. galvanized tank from which the water is discharged through the bottom by means of a perforated pipe that is parallel to and just in front of the broom. The lever at the side of the driver's seat opens and closes the valves for the discharge of water. The valves are constructed so that more or less water may be delivered, according to the needs for dust-laying purposes.



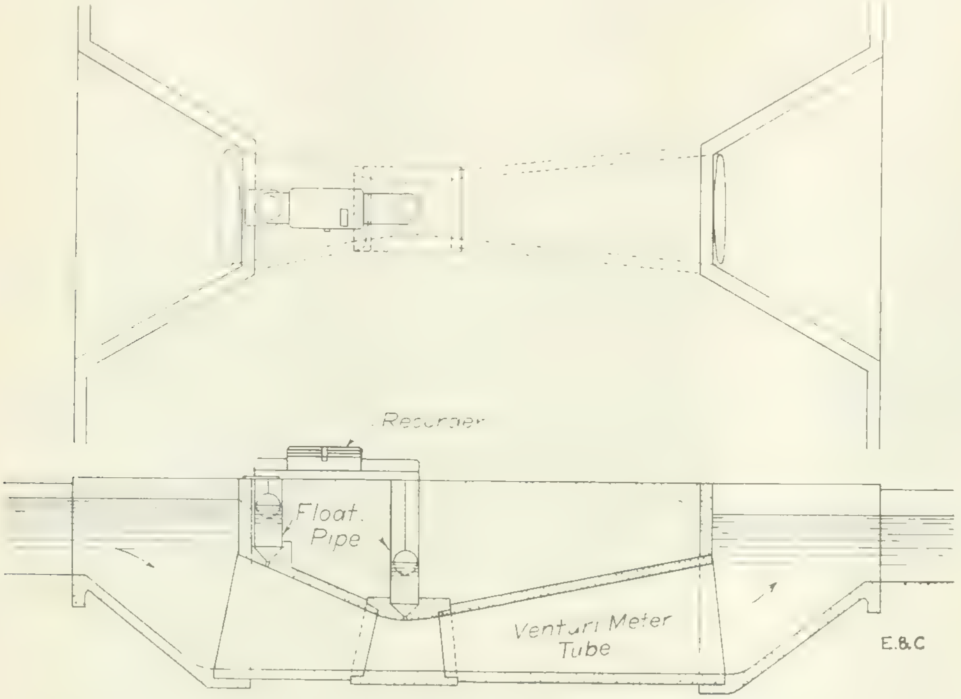
The Studebaker Combined Sprinkler and Sweeper.

The apparatus is manufactured by the Studebaker Corporation, South Bend, Ind. The following cities are among those using this sweeper at the present time: Salem, W. Va.; West Newton, Pa.; Moultrie, Ga.; Winston-Salem, N. C.; Jacksonville, Fla.; El Paso, Tex.; Kingman, Ind.; Portage, Wis.; Peru, Ind., and Van Buren, Ind.

Special Venturi Meter for Irrigation Water Measurement.

(Contributed.)

The illustration shows the Venturi meter outfit developed for measuring water in irrigation and as installed on a number of irrigation works in California. Briefly described, the Venturi meter consists of two parts, the meter tube through which the water flows, and the instrument which shows the rates at which it flows. The meter tube consists of a peculiarly shaped pipe having both ends conical, of different tapers, and joined by a small section of straight pipe. The meter tube is set directly in the ditch or the pipe line. To the inlet section and to the throat or constricted sections are connected vertical pipes in which the water levels assume different positions depending on the head in the meter tube and the rate of flow through it. The level of water in the inlet pipe is the same as that in the ditch in which the meter tube is placed. If no water were flowing through the ditch—that is, if the meter tube were placed in a stagnant trench—the columns of water in both tubes would be at the same height. When a flow takes place through the ditch, however, the columns of water at the inlet of the meter tube remains at the same level as the water in the ditch, but the height of the water column at the throat is less because at this point, as previously mentioned, the water gains in speed and suffers a temporary diminution of head. After the water has passed the throat section its velocity becomes less and it regains practically all of the head which it had at entrance, so that the water in the canal beyond the meter tube is at practically the same level as the water at the entrance of the meter tube. It will be noted that the outline of the meter tube consists of straight lines and smooth curves. These proportions are the result of a quarter of a century of study and experience in determining that contour of the interior which gives maximum accuracy with minimum friction loss. The meter tubes are constructed of cast iron (with galvanized iron cone pieces) concrete, or wood staves, whichever material is most suitable for the local conditions and most easily transported.

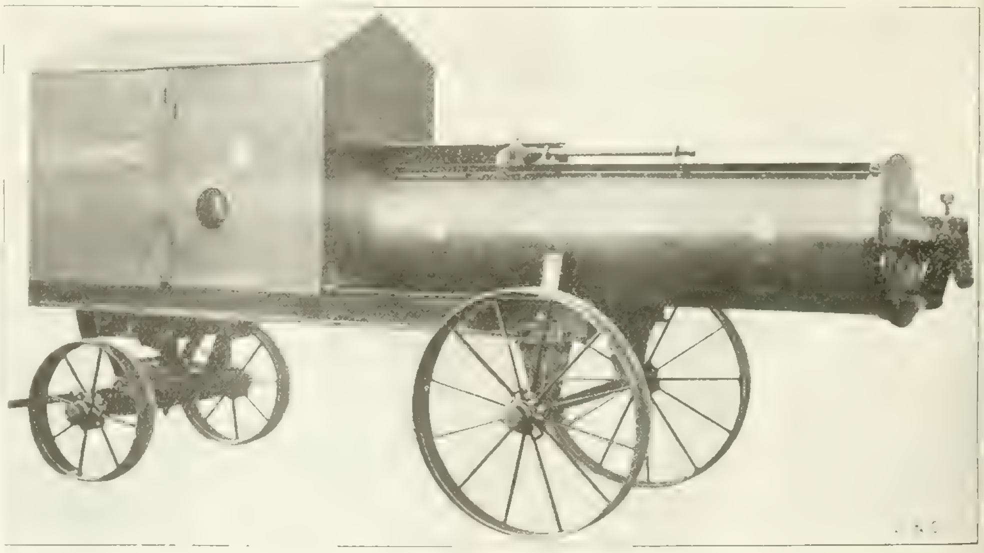


Venturi Meter Outfit for Measuring Water for Irrigation.

On the surface of the water in each vertical tube or pipe rests a spherical float. This float is of convenient size to permit a vertical movement without binding in the float pipe and without undue freedom of movement in a horizontal direction. These two floats transmit their movements to the recorder—placed immediately above—by means of special float cable designed for this particular purpose. The recorder receives the two movements and automatically interprets them into rates of flow. The chart plainly shows the rates of flow at the moment of observation and also provides an accurate record of all variations in the rate of flow. Most of the interior parts are of bronze and aluminum and the workmanship employed is of high grade. The recorder is protected from the weather, dust, insects, and unauthorized persons by a rugged cast iron case which is fastened with a padlock. It would be extremely difficult for anyone to tamper with the instrument and impossible to do so without leaving a trace. In the top of the hinged cover is a peep-hole protected by glass, enabling the rate of flow to be observed at any time, together with a portion of a chart record.

The chart is 12 ins. in diameter and is usually graduated for one week's run. Each chart is correctly graduated in second feet, or other desired units for the size of meter with which it is to be used. It is revolved by clockwork and a line is traced upon it by the pencil of the recorder, which moves in response to the variations of the water levels in the float tubes, which in turn are dependent upon the velocity of flow through the meter tube. The curve so described shows every irregularity in the rate of discharge through the meter tube and the time at which it occurred. The total flows for a period of one week, or less, may be obtained by following the curve on the chart with a special planimeter.

The charts may form a basis for the study of water waste, and also provide the irrigation manager, superintendent or ditch-rider with indisputable evidence of hourly performance and the time of starting and stopping. The charts supply the man receiving the water not only the above information, but also give him an absolute record of how much water is applied to any particular tract he may select, regardless of its size. He simply remembers the time he turned the water on and shut it off. It also serves as a most decided check on the efficiency of his irrigators, this latter being an important item.

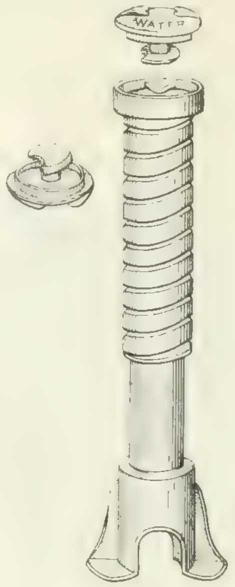


The Eureka Mortar and Plaster Mixer.

The Venturi irrigation meter is made by Builders Iron Foundry, Providence, R. I.

A Machine Mortar and Plaster Mixer.

The machine illustrated will mix cement mortar or plaster and can be used for concrete mixing in small quantities. As in the line of concrete mixers of the same make the mixing is done by a rotating shaft set with detachable blades and operating in a cylindrical steel drum open at the top and having over one end a hopper into which the materials are shoveled. The drum is 18 ins. in diameter and 16 ft. long with its end closed by a special discharge door. The shoveling height of the hopper tops is 45 ins. The The engine is 4½ hp. gasoline with belt drive to the paddle shaft. The total weight of the mixer is 2450 lbs. The capacity of the machine with two men is mortar supply for from 50 to 75 masons. The mixer is made by the Eureka Machine Co., Lansing, Mich.



An Improved Form of Water Service Shut-off Box and No-Bolt Cover.

Improved Form of Water Shut-Off Box and No-Bolt Cover.

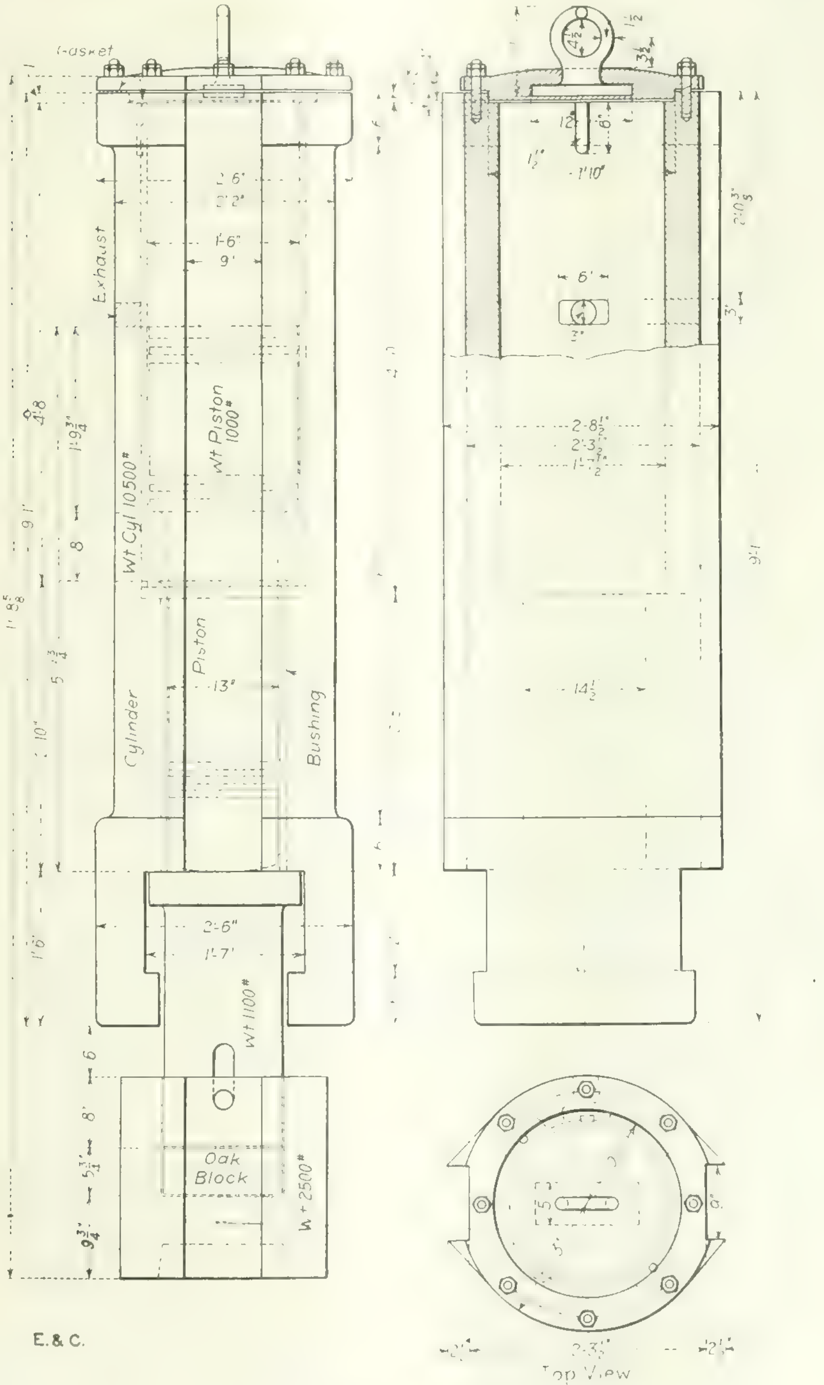
The accompanying illustration shows a new and improved form of water service or shut-off box and a no-bolt cover for this box, which also fits the old style box. The cover is the important development in this design and it was introduced to obviate certain difficulties which arose in connection with the old style cover secured by means of a brass bolt. Such bolts were often broken off accidentally or by designing brass thieves. These bolts also often stuck fast as a result of corrosion, and it was not an uncommon experience for a plumber to spend an hour in removing a corroded bolt. The loss of the bolt meant the removal of the cover and the shaft soon filled with dirt, sticks and stones. Eventually this necessitated the digging up of the box and, if it were located in a concrete sidewalk, this was expensive. The no-bolt cover, here illustrated, fits over the rim of the old-style box. As long as a part of the lug remains the cover can be locked and will make a permanent job. All that is required after setting the lid on is a tap of the hammer to tighten it.

The foregoing uses of the no-bolt cover are for repair purposes. It is also used on the new style box shown. In this case it fits inside of the top of the shaft of the box. This is so the box can be located in the sidewalk without projecting above the grade of the walk to facilitate removal. This removes the source of some personal injury suits. It sets flush with the walk surface and the cover, being inside the shaft, does not bind and is easily removed at any time by a tap from a hammer.

The boxes and covers are manufactured and marketed by the Sanitary Company of America, Linfield, Pa.

New Type of Valveless Pile Hammer.

The accompanying illustration gives details of the "Wilhelm" compound, valveless pile hammer, a new type of hammer with a single moving part—the plunger. The hammer operates either with steam or air, and it is possible so to control the force of the blow as to make it as hard or light as desired. It is compound in operation, using steam expansively, and is operated without the use of wooden plugs or pile bands. The cylinder has a total length of 11 ft. 8⅝ ins., an outside diameter of 2 ft. 2 ins., an inside diameter of 18 ins., and weighs 10,500 lbs. The piston has a diameter of 13 ins. and operates a driving head weighing 2,500 lbs. Other details are clearly shown in the illustration. The hammer is manufactured and sold by the Contractors Machinery Co., care J. E. Wilhelm, president, 1355 W. 87th St., Cleveland, O.



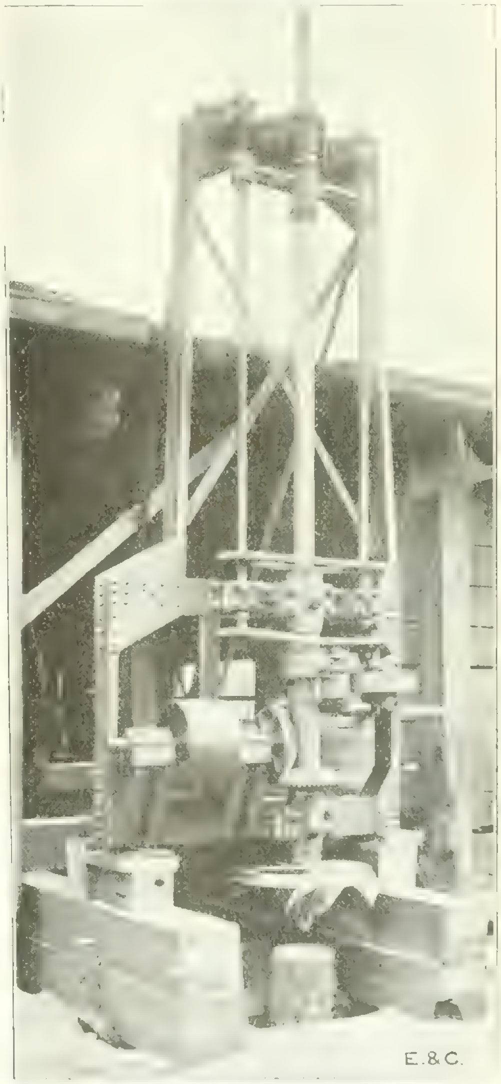
Compound, Valveless Pile Hammer.

A Rotary Stump-Cutting Machine.

(Contributed.)

The accompanying illustration shows a machine that removes stumps in an entirely different way from any previous device. It is known as the Moore rotary stump cutter. The novel features of this machine are its simple mechanism, its portability, and the rapidity with which it cuts out a stump.

The machine is mounted in an A-frame, and can be attached to the front of any standard oil engine tractor of 30 hp. The power to drive the cutter is transmitted with either a link or rubber belt from the main engine shaft on the tractor; the pullies are sized so that the cutter will develop 500 rpm., and the feed regulated to give it a boring speed of 3 ft. per minute, or 1/16 in. per revolution. The cutter has a range of 6 ft., and is capable of boring 20 ins. beneath the surface of the earth. The chips are recovered from the cutter by a vacuum which deposits them to the rear to be either sacked or baled. Chips from the pine stump are very valuable, as they contain rich resinous materials, from which the reduction plants manufacture various by-products. Quoting Mr. R. E. Doolittle's (acting chief of the Bureau of Chemistry) report on May 9, 1912, there are $48.17 of different resinous by-products to the cord of pine stumpage.



Rotary Stump Cutting Machine.

This machine is best adapted to operate in the cut-over pine flats of this country wherefrom it will reclaim the land for agricultural purposes and at the same operation recover the valuable resinous material that is going to waste. The machine weighs 4,000 lbs., is inexpensive and economical to operate, and opens up a new field for contractors. The machine is controlled and manufactured by the Moore Rotary Stump Cutter Co., Inc., 213 Hennen Bldg., New Orleans, La.

BOOK REVIEWS

Scientific Management: A Collection of the More Significant Articles Describing the Taylor System of Management. Edited by Clarence Bertrand Thompson. Harvard University Press, Cambridge, Mass. Cloth, 6x9 ins.; pp. 878; illustrated. $4.

This volume reprints 37 articles selected so as to answer the "wide-spread demand for more detailed information regarding certain phases of scientific management than is given" in the books of Taylor and Gantt. The articles, being selected to meet the demands in some measure of the "practical man," the "thorough student" and the "public at large" are necessarily various in character and of widely different value. As a collection the articles are perhaps as representative as any collection possible; the editor's work has been careful. It is worth while also that an effort has been made to preserve in permanent form scattered articles otherwise likely to disappear.

Use of Water in Irrigation. By Samuel Fortier. McGraw-Hill Book Co., New York. Cloth, 5½ x8¼ ins.; pp. 264; illustrated. $2.

This volume deals with the agricultural side of irrigation. It is a treatise for the irrigator, discussing the selection, location and soil requirements of farms for irrigation, the necessary equipment and structures, the methods of preparing land and supplying water, the waste, measurement, duty and delivery of water and methods of irrigating staple crops. There is no other book in English that covers this field of irrigation as practiced in the United States. This fact alone gives the book a certain distinction. There is, however, much more of merit to be credited to the book. Keeping in mind that its purpose is to serve the irrigator primarily, the book is a very thorough discussion of its subject.

The Regulation of Rivers. By J. L. Van Ornum. McGraw-Hill Book Co., New York. Cloth, 6x9 ins.; pp. 393; illustrated. $4.

This volume is a noteworthy addition to American engineering literature. The United States is a land of great river systems and it is a country of large expenditures both useful and wasteful for river improvement. There is in the aggregate a considerable volume of American literature on river improvement works. This literature, however, exists in scattered papers and reports. One modern book only having a claim to completeness has been previously published and this book by Thomas and Watt is a discussion chiefly of the design and construction of the structures for river improvement. With these features so well covered there was need, in a new volume, concentrating on the philosophy of the subject and fortunately Prof. Van Ornum chose this way in developing his discussion. His book is a remarkably symmetrical treatise on the fundamental theory and practice of river improvement, and it is in the end a judicious blending of theory and practice in their fundamental values that gives success in the solution of any river improvement problem. Practice establishes no design whose equal success is certain in any two places; theory gives no values that can be applied similarly in any two problems; a knowledge of the principles underlying improvement operations and of the experiments and practice demonstrating these principles, is therefore, essential to the beginning of efficiency in tasks of river improvement. It is this idea that has dominated the author in writing the book being considered.

The book contains ten chapters, five of which relate to types of river improvement works as channel construction works, bank protection works, dredging, levee work and current control works. In each of these chapters statement of theory and principles is co-ordinated with results from experiments and citation of works built. Investigations and surveys for river improvement are the subjects of one chapter and a statement of methods of river improvement is the subject of another. For the general engineering reader the chapters of widest interest will be perhaps Chap. I, Commercial Considerations; Chapter II, Accurate Phenomena, and Chapter V, Principles of Regulation. One reading these chapters wishes that in some way their study by every legislator were compulsory. They alone make the reading of the book worth while to every engineer, regardless of his line of work, because it will strengthen him as a guide to the action of the public in policies of waterway improvement.

Structural Engineering. By J. E. Kirkham. The Myron C. Clark Publishing Co., Chicago, Ill. Cloth, 6x9 ins.; 665 pp.; illustrated. $5.00.

As stated by the author the book is intended as a text book for college students and as a self-explanatory manual of structural engineering for practical men. It has also been the aim of the author to arrange for college use the drawing room exercises throughout the text so that the work in the class room and drawing room will go hand in hand. As a review of elementary mechanics is considered essential there are given data on the materialistic phase of that subject. The designs given are entirely the work of the author and are the result of his nineteen years' experience, most of which was spent in structural work. The work treats only of "Simple Structures," as it is the author's intention to cover "Higher Structures" in another volume.

The scope of the book is indicated by the following data, which include the fourteen chapter headings and the space devoted to each subject: Preliminary, pp. 1-8; Structural Draughting, pp. 9-13; Fundamental Elements of Structural Mechanics, pp. 14-50; Theoretical Treatment of Beams, pp. 51-105; Theoretical Treatment of Columns, pp. 106-114; Rivets, Pins, Rollers and Shafting, pp. 115-123; Maximum Reactions, Shears and Bending Moments on Beams and Trusses, and Stresses in Trusses, pp. 124-143; Graphic Statics, pp. 144-161; Influence Lines, pp. 162-171; Design of I-Beams and Plate Girders, 172-194; Design of Simple Railroad Bridges, pp. 195-532; Design of Simple Highway Bridges, pp. 533-569; Skew Bridges, Bridges on Curve, Economic Height and Length of Trusses, and Stresses in Portals, pp. 570-582; Design of Buildings, pp. 583-652. The book also contains 13 pages of tabular data to facilitate the designing and detailing of structural steelwork.

Structural Design—Volume II. Design of Simple Structures. By Horace R. Thayer. D. Van Nostrand Co., New York. Cloth, 6x9 ins.; 487 pp.; illustrated. $4.00.

This volume is the second of three volumes which will constitute a series on structural designs. The work presupposes a knowledge of mechanics, stresses, and the mathematics on which they depend. Although it assumes that the reader has Vol. 1, the independent use of this volume has been given consideration.

The text treats of such structures as beams, girders, viaducts, trusses, buildings, standpipes, and elevated tanks. The headings, and the space devoted to each of the eight chapters of the book, beginning with Chap. VI, the first chapter of this volume, are: Chap. VI, Beam Bridges—Plate Girders, pp. 1-132; Chap. VII, Steel Viaducts and Elevated Railroads, pp. 133-185; Chap VIII, Simple Riveted Truss Bridges, pp. 186-256; Chap. IX, Simple Pin-Connected Bridges, pp. 257-291; Chap. X, Steel Mill Buildings, pp. 292-342; Chap XI, High Office Buildings, pp. 343-435; Chap. XII, Miscellaneous Building Work, pp. 436-460; and Chap. XIII, Standpipes and Elevated Tanks, pp. 461-487.

It will be noted, from the foregoing chapter headings that the author has attempted to cover the design of the various types of structures—including both bridges and buildings—in a single volume of the length noted. Moreover, he has attempted to approach the subjects both from theoretical and practical standpoints, and to give concrete examples. It is obvious that the author's program has been too ambitious, although he has remedied this defect, in part, by frequent references to various original sources. However, the text is well arranged and illustrated and should prove of particular value to those practicing engineers and students who do not care to go into the various subjects exhaustively.

Structural Engineers' Handbook. By Milo S. Ketchum. McGraw-Hill Book Co., New York. Leather, 6x9 ins.; 599 pp. + 281 pp. tables; illustrated. $5.00.

The stated aim of the author has been to give data, details and tables for the design and construction of steel bridges and buildings. The book has been written for the structural engineer and for the students who have had a thorough course in applied mechanics and in the calculation of stresses in structures. The work covers the design of the simple structures ordinarily met with; swing and movable bridges, cantilever and suspension bridges have not been considered. Data to facilitate the calculation of the stresses in walls, bins, standpipes and other structures have been included. The work is a source book and is not a treatise.

The seventeen chapter headings and the space devoted to each subject, which follow, indicate the scope and character of the book: Steel Roof Trusses and Mill Buildings, pp. 3-68; Steel Office Buildings, pp. 69-106; Steel Highway Bridges, pp. 107-147; Steel Railway Bridges, pp. 149-224; Retaining Walls, pp. 225-244; Bridge Abutments and Piers, pp. 245-276; Timber Bridges and Thestles, pp. 277-298; Steel Bins, pp. 299-318; Steel Grain Elevators, pp. 319-338; Steel Head Frames and Coal Tipples, pp. 339-363; Steel Stand-Pipes and Elevated Tanks on Towers, pp. 365-387; Structural Drafting, pp. 389-423; Estimates of Structural Steel, pp. 425-440; Erection of Structural Steel, pp. 441-485; Engineering Materials, pp. 487-522; Structural Mechanics, pp. 525-570; The Design of Steel Details, pp. 571-599; Structural Table, pp. 1-281.

The book contains much material which has been taken directly, or with slight modification, from the other works of the author. About one-sixth of the contents, exclusive of tables, is devoted to reprints of specifications, obtained from various sources. Although it is stated in the preface that the book is written for engineers and students who have had a thorough course in applied mechanics and in the calculations of stresses, the author devotes an entire chapter to the subjects, "Structural Mechanics" and "Stresses." The engineer will, however, find much valuable data in the handbook, arranged in convenient form for reference. The tabular data, some of which were prepared especially for this work, are exceptionally complete. An innovation adopted by the author consists in using a flexible leather binding for a 6x9-in. handbook.

Song of Service.—By Charles H. Mackintosh. M. I. Stewart Co., Duluth, Minn. Paper, 6x9 ins. Price, $1.00.

The well known editor of "Steam Machinery" and advertising manager of the Clyde Iron Works of Duluth, has brought out a pleasing little book of verse, artistically printed and bound, which sings of the joys of participation in the work of the world, whether it be as poet, artist or laborer.

Engineering and Contracting

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Steel.—Manufacturer of agricultural implements in Great Britain wishes to communicate with American manufacturers of steel suitable for welding. Dead, soft, open-hearth steel, cut to dimensions, is wanted. Quotations should be made c. i. f. destination, if possible. No. 15332.

Construction Machinery, Etc.—Italian firm wishes to purchase compressors and pneumatic drills, steel forms for concrete construction work, concrete post molds, wire ropes, motor trucks and equipment and supplies for railroad and mine contractors. No. 15162.

Mining Machinery.—Dealer in Far East desires to receive price lists, etc., and catalogues on mining shovels, picks, etc., steel rope, etc. Catalogues, etc., should be in the Russian or German languages. No. 15165.

Electric Cranes.—Spanish Government will purchase four electric cranes for use in the port of Valencia. Plans and specifications are on file in the office of the Secretaria de la Junta de Obras del Puerto de Valencia, Valencia, and in the office of the Ministerio de Fomento, Section de Puetos, Madrid. A list of persons who are in a position to represent American firms may be obtained from the Bureau of Foreign and Domestic Commerce. No. 15182.

Locomotives and Rails.—One of the neutral countries of Europe is in the market for 20 locomotives and about 27,000 tons of steel rails. No. 15230.

Technical Implements and Machines.—Russian engineer desires the names of American firms exporting or manufacturing technical implements and machines. Correspondence may be in Russian, French or German. No. 15256.

Pumps, Steam Engines, Etc.—Business man in Russia desires names and addresses of firms in the United States manufacturing or dealing in dynamos, steam engines, tools of every description, hand and steam pumps and belting. Correspondence may be in Russian, German or French. No. 15260.

Steam Engines, Electric Machinery.—Firm in Far East desires catalogues, prices lists, and discounts on steam engines and boilers for electric power plants and electric machinery (direct current). Correspondence may be in English.—No. 15265.

Sand-Clay Brick.—Business man in British India wishes to correspond with American firms manufacturing special machine for making brick of sand and clay. No. 15291.

Structural Steel.—Civil engineer in a European country would like to hear from American manufacturers of steel, to be used for structural purposes, bridge building and railway construction. No. 15320.

Road Machinery.—Engineer in Latin-American country recently placed in charge of all Government construction work, desires to receive catalogues, price lists, etc., in English, on road machinery, rock crushers, dump cars, steam shovels, traction engines using wood and gasoline fuel, contractors' outfits, concrete mixers, pile drivers, dredges, excavators, building materials, cement, iron and steel constructional material, instruments for surveyors, etc., electrical meters, etc., office furniture, structural-steel bridges. No. 15327.

Railway Ties.—Company in Near East will ask bids for 80,000 railway ties. No. 15308.

Excavating Materials, Etc.—An American consul in Europe has transmitted a detailed report relative possibilities for the sale of American electrical supplies, excavating, hydraulic, and mining materials in his district. No. 15312.

Automobiles and Motors.—Representative of a large firm in Norway has sailed for the United States for the purpose of establishing commercial relations with American manufacturers and exporters of automobiles, motors, and accessories. No. 15214.

Telephont Plant.—Firm in South America is negotiating with the Government for the installation of a modern telephone system. It is stated that one member of the firm is an American. No. 15251.

Pneumatic Post Machinery.—Dealer in Italy desires to obtain offers, accompanied by catalouges, on pneumatic post machinery and devices, with a view to obtaining the exclusive agency for that country. No. 15192.

Flour Plant Machinery.—Large flour manufacturing firm in South America wishes catalogues of all machinery and materials used in the manufacture of flour. The firm desires to make purchases at once. No. 15337.

Sugar Plant.—Owner of large tract of land in West Indies contemplates the erection this year of a sugar plant, with a grinding capacity of 750 tons (2,500 lbs.) of cane per day. Propositions may be submitted in writing, or by personal interview with the owner of the land while he is in New York, where he expects to be for several days after Jan. 25. No. 15313.

Glass Plant.—Capitalists in Far East are investigating the possibilities of establishing a glass-manufacturing plant. It is desired to use American methods and to employ American experts in building up the industry. No. 15300.

Agricultural Machinery and Motor Cars.—Firm in Sweden wishes to enter into commercial relations with American firms which are in a position to supply agricultural machinery and motor cars. No. 15168.

Electrical Supplies.—Electrical engineer of one of the leading cities in South America wishes catalogues, etc., for electrical supplies, including wire, cable, and conduit, etc. Prices should be f. o. b. New York, or, preferably, c. i. f. destination. Catalogues in Portuguese are preferred. No. 15184.

INDUSTRIAL NOTES

The Cement-Gun Construction Co., Chicago, Ill., has been given the contract to encase all the structural steel works in the new powerhouse now being erected by the Ford Motor Co., at its Detroit factory.

The Corrugated Bar Co., St. Louis, Mo., has received the contract for the supply of about 6,000,000 lbs. of steel bars and reinforcing work for the new municipal cotton warehouses at New Orleans, La.

On February 1, the general offices of the Asbestos Protected Metal Company, including the executive, accounting, sales and engineering staffs, will be moved from the Beaver Falls plant to the First National Bank Building, Pittsburgh. The manufacturing operations of the company will continue as heretofore, at Beaver Falls, Pa., and at Waltham, Mass.

The Underpinning & Foundation Co., 290 Broadway, New York, has been awarded the contract for the Hercules steel piles specified on the revised plans for the foundations of the McKinley School, 8th Ave. & Factory St., Newark, N. J. E. M. Waldron & Co., Newark, N. J., are the general contractors. The work is being done under the supervision of Mr. E. F. Guilbert, architect, for the Board of Education.

NEW CATALOGUES

Drawing Materials and Surveying Instruments.—Cloth, 6x9¼ ins.; 440 pp. B. K. Elliott Co., 126 Federal St., Pittsburgh, Pa.

Complete illustrated catalogue and price list of the drawing materials, surveying instruments, blue printing apparatus, scientific books, etc., manufactured or imported by the above company. It is neatly bound, carefully arranged and well illustrated, giving comprehensive instructions for use of the instruments where necessary, and all the essential data, with complete alphabetical index.

Concrete and Mortar Mixers.—Paper, 6¾x9¾ ins.; 32 pp. Eureka Machine Co., Lansing, Mich.

Describes in detail the construction and operation of the Eureka mixer and the self-mixing device which is its distinguishing feature. Gives instructions as to proportions, testing, etc. Photographs, specifications and brief descriptions of the several types occupy the latter half of the book.

Road Machines.—Paper, 6x9 ins.; 8 pp. Ruggles-Coles Engineering Co., 52 Church St., Chicago.

Describes and illustrates Ruggles-Coles portable and semi-portable dryers and heaters, giving details of construction and principle of operation, with views of plants in use and data as to capacities, fuel saving, etc.

Fan Motors.—Paper, 6¾x10 ins.; 48 pp. The Emerson Electric Manufacturing Co., 2024 Washington Ave., St. Louis, Mo.

Catalogue No. 6700, listing practically every type of fan offered by the above company last season, with the addition of a few new and improved models for 1915. Descriptions and cuts showing the various styles are given with complete specifications. Emerson ventilating fan motors are particularly described, with diagram and tables showing installation, dimensions, etc.

Steel Bound Concrete Curb.—Paper, 4½x7 ins.; 16 pp. Steel Protected Concrete Co., Real Estate Trust Building, Philadelphia, Pa.

Pamphlet giving explicit directions for laying steel-bound concrete curb, including excavation, setting frames and corner bars, setting curves, laying gutters, etc. Contains tangent table and diagrams. Shows use of the Wainwright galvanized steel corner bar.

Field Instruments, Drawing Materials, Etc.—Paper, circulars and bulletins as below. W. & L. E. Gurley, Troy, N. Y.

"Gurley's Solar Ephemeris," for 1915, 3x6 ins., an abridgement of the nautical almanac with table of mean refractions and declination, with pages for memoranda.

"A Reading on the Rod," 3½x9¼ ins., 50 pp., descriptive of the manufacture of leveling rods. The third edition of this booklet, illustrated by color plates and half tones.

"Gurley Light Mountain Transit," 4¾x7¾ ins.; 32 pp., describing this light instrument, especially adapted to mine or mountain surveying, but of equal use in general work. Gives specifications and a fine color plate engraving of the transit and description and illustrations of the various attachments.

"Current Meters," 6x9 ins.; 12 pp. Shows the various types of current meters, points out distinguishing features and gives instructions for use and care and price list.

"Gurley Automatic Water Stage Registers," 6x9 ins., 32 pp.; explains the use, construction, installation and particular advantages of the water stage register, with photographs, diagrams and price list.

"Beaman Stadia Arc," 6x9 ins., 4 pp.; tells of the origin and application of this specially graduated vertical arc, gives suggestions for stadia work and points out the advantages of this attachment.

"Gurley Engineers' Transit No. 16," "Miner's or Dip Compass"; "Cox Stadia Computer," "The Batson Sketching Case," all 5½x6¾ ins., 4 pp., each containing detailed descriptions and illustrations.

"Gurley Explorers' Level"; "The Compass Needle, Instructions for Adjusting and Suggestions for Using"; "Gurley Metal Hook Gage, a New and Improved Type"; "Gurley Reconnoissance Transits"; "Vaughn Flow Meter," all 3½x6 ins.; 4 pp. each.

Miscellaneous circulars describing briefly and showing cuts of (1) The "Wilder" Asphalt or Tar Testing Thermometer; (2) The Army Sketching Case; (3) Explorer's Transit; (4) Gurley products in general, a reprint from Sweet's catalogue; (5 and 6) Spanish, describing Gurley transits and other instruments, giving data and price lists.

CURRENT NEWS

The Doings of the Week.

Many favorable developments in financial and industrial conditions took place during the past week. Marked improvement was shown in many lines, and real progress was made in the basic industries. Money was distinctly easier and the reduced discount rate is favorable for new enterprises and investment. The improved feeling in bond circles has resulted in bringing out many offerings of municipal and state securities. The Board of Public Works of Maryland opened bids last week on $3,600,000 of 4 per cent road bonds, and Philadelphia, Pa., is offering $5,000,000 of 4 per cent bonds. The railways continued their activity in the supply and equipment markets, and while no remarkably large orders were placed, the aggregate was very satisfactory. Improvement was shown in the copper and lumber industries. In the construction field a great deal of new work made its appearance. The amount of new work advertised for bids shows a great gain over the preceding week. Many municipalities began calling for proposals on improvements, and as a result a considerable amount of work is now ready for contractors. In the iron and steel trade there has been great improvement in the last few days. The U. S. Steel Corporation is running at about 50 per cent capacity and some of the independent companies are operating at about 65 per cent. Five or six weeks ago these plants were running around and 35 per cent capacity. It is estimated that the railroads placed about $50,000,000 of business with steel concerns and supply and equipment companies during the first two weeks of this year. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Jan. 13 were as follows:

Finished Iron and Steel.	Jan. 13.	Jan. 6.
Per lb. to large buyers	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.17½	1.17½
Iron bars, Pittsburgh	1.15	1.15
Iron bars, Chicago	0.97½	0.97½
Steel bars, Pittsburgh	1.10	1.10
Steel bars, New York	1.26	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York	1.26	1.26
Beams, etc., Pittsburgh......	1.10	1.10
Beams, etc., New York.......	1.26	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh	1.15	1.15
Steel hoops, Pittsburgh......	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.80	1.80
Galv. sheets, No. 28, P'gh	2.75	2.65
Wire nails, Pittsburgh	1.55	1.50
Cut nails, Pittsburgh.........	1.50	1.50
Fence wire, base, P'gh	1.35	1.30
Barb wire, galv. P'gh	1.95	1.90

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and zees, 3 in. and over, 1.10 cts.

Railways. — Developments of the past week indicates that two important railway construction undertakings may be started in the near future. One of these is the $65,000,000 Union terminal at Chicago and the other is the Government railway in Alaska. Press dispatches quote the Secretary of the Interior Department as stating that actual construction would be started in the spring on the Government railway to connect the Alaskan coal fields with the coast. The commencement of work on the Chicago project now depends on the settlement of certain grants to the Baltimore & Ohio. It is expected that this arrangement will be effected next month. The directors of the Union Station Co. are understood to have decided on measures for securing a considerable sum of money for starting the work. Considerable activity has been displayed by the railways during the past week in advancing their construction undertakings and prospects are good that quite a bit of work will be placed under contract soon. An important contract is reported to have been let by the Southern Pacific Ry. This is said to call for a line from Los Angeles to San Diego. The work is stated to have been awarded to Robert Sherer & Co., Los Angeles. The Wisconsin & Northern Ry. awarded the grading contract for the 27 miles of new line in Wisconsin to Peter Nelson & Co., Minneapolis, Minn.

Roads and Streets.—Several good-sized municipal paving contracts have been awarded recently and a number of large road jobs have also been let. In the state highway field no particularly large undertakings appear to have reached the call for bids stage. California is asking proposals on a 12.6 mile section of concrete road; the County Commissioners at Palo Pinto, Tex., open bids Feb. 8 on about 33 miles of gravel road. A number of municipal street jobs also are being advertised. Most of these, however, are small. Bell County, Texas, awarded a contract for 40 miles of gravel roads; Tampa, Fla., let a 78,365 sq. yd. brick pavement contract; A. H. Barnes & Co. Logansport, Ind., secured the contract at $86,762 for 11 roads in German Township.

Bridges.—Bids are now being asked on a notably large bridge undertaking. This is the Interstate Bridge over the Columbia River in Oregon. Its construction calls for 9,500 tons of steel, 29,000 cu. yds. of concrete and 1,000,000 cu. yds. embankment. A considerable amount of smaller bridge work also is being advertised, The Harrison & Baum Bridge Co., Memphis, Tenn., was awarded the contract at $40,404 for 60 small bridges in Calcasieu Parish, Louisiana.

Drainage and Irrigation.—No particularly large drainage or irrigation undertakings appear to have come up for advertising for bids during the past week. Beltrami County, Minnesota, is calling for proposals on a Judicial ditch requiring about 231,182 cu. yds. of excavation and estimated to cost $52,214. Fred M. Crane, Omaha, Neb., was awarded contract at $115,000 for work for Drainage District No. 1 by Otoe and Johnson counties, Nebraska.

Water Works and Sewerage.—A considerable amount of work in both the water works and sewerage fields reached the call for bids stage in the last few days. Fitchburg, Mass., opens proposals Feb. 8 on its Ashby reservoir supply project, the improvement calling for 60 acres of clearing, 54,000 cu. yds. earth excavation, 4,700 cu. yds. rock excavation and 3,000 cu. yds. of concrete. The Bureau of Water of Philadelphia, Pa., is calling for bids on a sedimentation basin at the Torresdale Filters Among the larger water works contracts awarded recently are the following: William O'Gara and Philips Construction Co. for 6-mile water conduit to cost $300,000 for the Union Water Co., Denver, Colo.; Louis Lock, Monroe. La., at $280,211 for water works improvements for Corpus Christi, Tex. In the way of sewerage work the following are among the larger new undertakings advertised for bids in the last few days: San Antonio. Tex., for the Cherry St. sanitary intercepting sewer, Grove Ave. storm sewer and the Cherry St. storm sewer, the work involving a considerable amount of 24 in. to 70 in. concrete and segmental block sewer; Rockford, Ill., for the sewer system for the southeast end. estimated to cost about $140,000 and requiring 57,000 ft. of 9 in. to 33 in. sewer; Passaic Valley Sewerage Commission, Newark, N. J., for southerly portion of Section 18 main intercepting sewer in Passaic, N. J. Indianapolis, Ind., awarded a $122,000 sewer contract; Baltimore, Md., awarded two contracts totaling over $109,000.

Handy Laborers and Form Construction.

The Public Service Commission for the First District, New York City, has dismissed the complaint of the Brotherhood of Carpenters against the Bradley Contracting Co., alleging a violation of the labor law in failure to pay the prevailing rate of wages to carpenters. The work involved was that of constructing and setting into position wooden forms for concrete construction. The Bradley Contracting Co. was having this work done by a class of men known as "handy laborers," who were paid $2.50 per day. The carpenters claimed that it was carpenter work and should be done by men receiving carpenters' wages, or $5 per day. The same question was decided in 1913 by William C. Rogers, Acting Commissioner of Labor, who held that $2.50 per day was the prevailing rate of wages paid for this kind of work. The Commission's decision followed that of the Acting Commissioner of Labor. At the same meeting the Commission refused to adopt a motion to the effect that only one helper be allowed to each journeyman electrician engaged in city subway work. It was one of the complaints of the Electrical Workers' Union that electricians' work in connection with subway construction was being performed by helpers and that the contractors would employ six or eight helpers to one journeyman electrician. While the Commission indicated that this practice is an evasion of the law, it held that it had no power to specify the number of helpers to be allowed to each electrician, but it instructed its Chief Engineer to see that the spirit of the law is obeyed.

Free Water.

An interesting but by no means new suggestion has been made by the governor of a western state. He suggests that municipalities should furnish their citizens with free water. The plan naturally has met with much favor and it is reported a bill will be introduced into the legislature to permit cities owning waterworks to supply water free to each citizen. Under the scheme the amount of free water would be limited and a charge made for all water used above the maximum. Each person would be allowed say 50 gals. of water per day. A family of 11, therefore, would be given 550 gals. of water on which to subsist for 24 hours. If they used more than this quantity they would have to pav for the extra amount. So far the plan sounds liek a politician's pre-election promise. But the dream of Utopia vanishes when it is discovered that the cost of operating the plant is to be charged against the entire city and that its maintenance would be under the same method as is now followed for maintaining the streets. In other words, the citizen would pay for his water, even to the 50 gals. of "free" liquid, in taxes. Interest, depreciation and sinking fund would be obtained from taxes; water main extensions would be paid for by special assessment of the parties benefited; service connections would be laid at the expense of the property owner. The idea of municipalities furnishing water without cost to the consumer is not a new one; soap box orators for many years have advocated it.

$20,000,000 of Road Work.

The State Highway Department of New York expended over $13,000,000 last year in payments to contractors for construction work. In Ohio state highway improvements calling for an expenditure of approximately $7,000,000 were let in 1914. The total of $20,000,000 for these two states alone is impressive. It indicates pretty clearly the bigness of the highway construction field. This sum provides for many miles of improved road and for many contracts. Some of the latter were as small as $5,000; the average was perhaps $10,000, and a few of the larger ran up into the hundred thousands. The small contractor and the big one had chances to secure jobs suitable to their outfits. The work in Ohio and New York was only a small part of the highway construction put under contract in 1914 in this country. The many other states engaged in improving their highways, counties, districts and other political subdivisions were unusually active in letting road undertakings. A tremendous amount of highway work was placed under contract last year.

THE IRON MOUNTAIN PROJECT, CALIFORNIA.

Irrigation of 225,000 Acres in Sacramento Valley.

Proposed Expenditure, $12,000,000 to $19,000,000.

The Iron Canyon Project is probably the largest scheme of engineering development by irrigation now under consideration on the Pacific Coast. The undertaking contemplates the watering of between 200,000 and 300,000 acres of land in the Sacramento Valley, below Red Bluff, Cal., the supply to be taken from the Sacramento River. This project has been under consideration by the U. S. Reclamation Service for a number of years, a preliminary investigation of storage reservoirs having been made as early as 1904 and 1905. In 1909 the investigations of the Service were resumed and carried to a certain point, but were not completed. In 1913, however, an agreement was entered into between the U. S. Reclamation Service and the Iron Canyon Project Association, whereby the former should make an investigation and report a plan of reclamation. This work was started in the fall of 1913 and the report was submitted last October and has recently been made public. The investigation was carried out by officers of the U. S. Reclamation Service, the engineering work being performed under the general supervision of E. G. Hopson, Supervising Engineer, Portland, Ore.

Ten alternate plans or modifications of plans are given in the report. The contemplated expenditure under these ranges from $12,000,000 to $19,000,000. All of the plans provide for the irrigation of 225,000 acres of land by the supply of 3 acre-feet of water per acre. The various schemes of development fall within two classes—the first being plans that provide for full protection and preservation of navigation interests and even their improvement and extension, and the second class, consisting of plans that do not so provide. The majority of the plans contemplate the erection of a dam at Iron Canyon, a few miles above Red Bluff. Three different heights for this dam are considered, the highest being 134½ ft., with aggregate storage capacity of 709,000 acre feet. Other plans propose a low diversion dam on the Sacramento a short distance below the highway bridge at Anderson and an extension of the canal system up to that point. With a dam at Iron Canyon all water not used for irrigation will pass through this dam into the river channel under pressure heads varying from 60 to 135 ft., depending upon the nature of the development and the stage of the river. By this means all the year round powers of from 50,000 to 70,000 HP. may be developed at this point. This matter also is covered in the estimate of cost of the several plans of development. The main features of the 10 plans are given in Table 1; each plan provides for the irrigation of 225,000 acres.

TABLE 1.—MAIN FEATURES OF PLANS OF DEVELOPMENT.

	——Reservoir——				——Navigation.	
Plan.	Storage capacity in acre ft.	Elevations, L. W. L.	Elevations, H. W. L.	Power with [illegible] per cent. L. F.	Minimum flow in sec. ft.	River navigation improvement below Red Bluff.
A-1	420,000	340	383	..	4,200	None.
A-2	420,000	340	383	60,000	4,200	None.
A-3	603,000	340	392.5	..	4,750	None.
A-4	603,000	340	392.5	70,000	4,750	None.
A-5	231,000	340	370		3,700	Partial.
A-6	231,000	340	370	50,000	3,700	Partial.
A-7	....	..	.		1,970	Comprehensive.
B-1	231,000	340	370		3,700	None.
B-2	231,000	340	370	50,000	3,700	None.
B-3	....	..			1,970	None.

Plan A-1 is a simple irrigation project providing for a rock fill dam at Iron Canyon. The ordinary flow line will be at elevation 383, or 125 ft. above ordinary low water level of the Sacramento. A bypass channel on the south side of the canyon will care for river flow during construction. This will be closed by a masonry structure. The rock and earth fill dam will connect with a solid masonry overflow structure about 5,000 ft. long, which will serve as a spillway after the reservoir is full. Storage of 420,000 acre feet is provided for irrigation uses. The plan makes no provision for power development, for flood control nor navigation improvement. This plan of development is estimated to cost $13,400,000, of which $5,000,000 is for the dam and reservoir and $8,400,000 for the canal system.

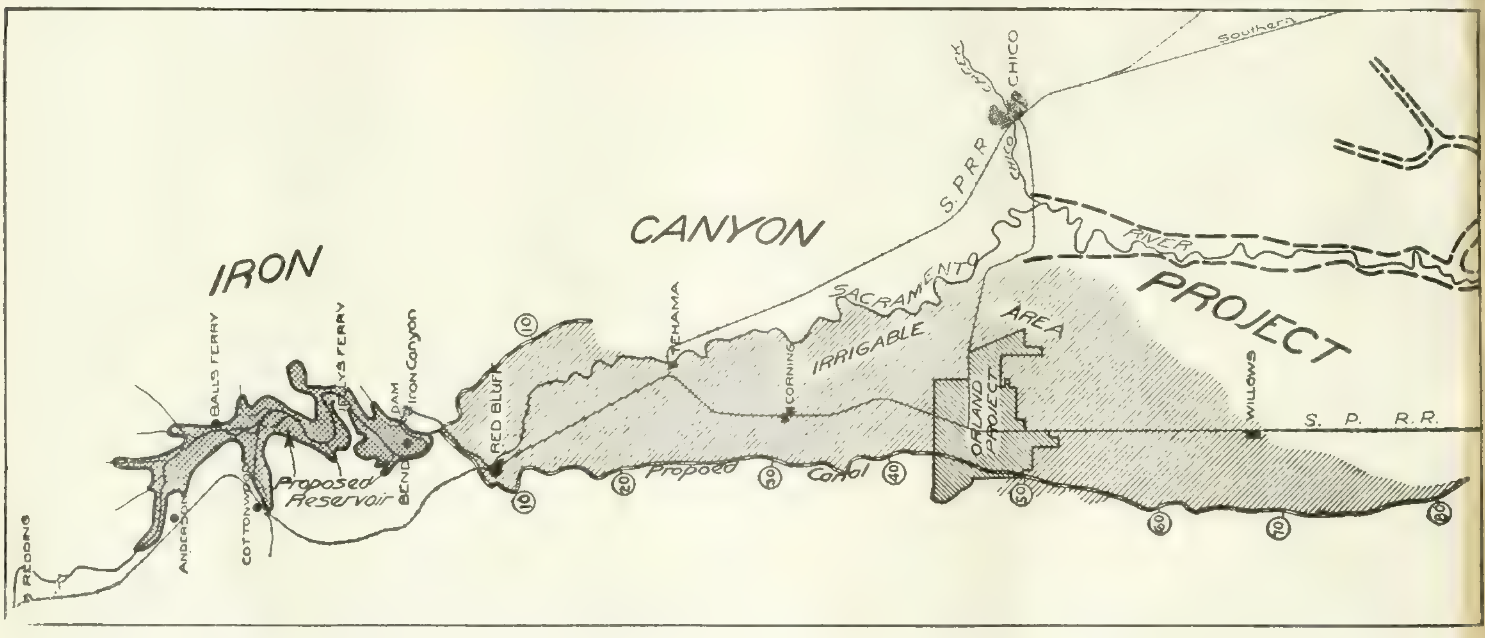
Plan A-2 is identical with A-1, except that provision is made for building a hydro-electric plant at the dam whereby the 4,200 second feet of minimum flow passed for navigation purposes may be utilized for power. A 60,000-HP. installation is considered, and the cost is estimated at about $2,000,000. The gross estimated cost of Plan A-2 is $15,450,000, made up of $7,050,000 for dam and reservoir, including power plant, and $8,400,000 for canal system.

Plan A-3 provides for an important measure of flood control and navigation improvement in addition to the main irrigation feature. The dam would be an earth and rock fill structure, providing for ordinary high water at 134½ ft. above ordinary low water level of the river. The reservoir, with a capacity of 709,000 acre feet gross and 603,000 acre feet net, would be held empty above the canal intake up to March 1 and two-thirds empty up to April 1 for flood control purposes. It is figured that at no time will the rate of discharge below the dam exceed 100,000 second feet. The total estimated cost of the plan is $15,975,000—$7,575,000 for the dam and reservoir and $8,400,000 for the canal system.

Plan A-4 is identical with Plan A-3, save that it provides in addition to the flood control and navigation improvement features a power development of 70,000 HP. The estimated cost is $10,385,000 for the dam and reservoir with flood control and power development and $8,400,000 for the canal system, making a total cost of $18,785,000.

Plan A-5 proposes building as small a reservoir at Iron Canyon as possible. It provides, however, for a spillway of sufficient length to take care of flood flows, which entails a spillway crest elevation at about 370, with a storage of 231,000 acre feet. No power development is provided, nor means of flood control. Low water flow would be reduced to a minimum of 3,700 second feet during a portion of the year. To compensate navigation interests provision is made for river improvement below Chico Landing. The estimated cost under Plan A-5 is as follows:

Dam and reservoir	$4,375,000
Canal system	8,375,000
River navigation improvements	1,500,000



Location of Proposed Works for the 225,000 Acre Iron Canyon Irrigation Project, California.

Plan A-6 is identical with Plan A-5, except that it provides for the development of 50,000 HP. The total cost is estimated at $15,950,000, of which $6,075,000 is for the dam and reservoir, including the power plant. The remaining items are the same as in the previous plan.

Plan A-7 proposes to divert water from the Sacramento near Anderson by means of a low dam. The supply would be taken out on the east side of the river and the canal would follow that side, crossing the river on an aqueduct structure at the Iron Canyon, and thence following the same course as the canal for the other plans. No storage, power development or flood control features enter into the plan. Under this plan the flow of the Sacramento River below the diversion point will occasionally be reduced as low as 1,970 second feet. To offset this the plan makes provision for river improvement between Sacramento and Chico Landing. The estimates are as follows:

Dam at diversion	$ 300,000
Canal system	12,025,000
River navigation	4,000,000

Plan B-1 provides for the lowest possible dam at Iron Canyon and is identical with Plan A-5, save that it makes no provision for river improvement below Red Bluff. It assumes that the low water flow can be used for irrigation without providing compensating navigation improvements. No power development nor flood control features are provided. The total estimated cost is $12,700,000; of this $4,325,000 is for the dam and reservoir and $8,375,000 for the canal system.

Plan B-2 is identical with B-1, save that it includes provision for developing 50,000 HP. It also is the same as A-6, except that it does not include any navigation improvements below Red Bluff. The total estimated cost is $14,450,000, of which $6,075,000 is for the dam and reservoir, including power plant, and $8,375,000 for the canal system.

Plan B-3 provides for diversion near Anderson and is identical with A-7, except that it omits river navigation improvements below Red Bluff. No power or flood control features are included in this plan. The estimated cost totals $12,325,000—$300,000 for the diversion dam and $12,025,000 for the canal system.

The Sacramento gorge at the point selected as a site for the Iron Canyon dam is about 500 ft. wide at the bottom, with side slopes rocky and abrupt, in places being sheer walls of volcanic rock. The ordinary river channel has been cut approximately through the middle of the canyon bottom and is generally a trough about 100 ft. wide and 30 ft. deep. The material at the dam site consists of a porous underbody of unknown depth, capped by fairly tight volcanic tuffs and agglomerates from 40 to 60 ft. thick in the main gorge, except where the ordinary river channel has cut or partially cut through for a width of about 100 ft. and a depth of 30 ft. Two alternate types of dams were considered, the earth and rock fill type and the solid masonry type. The latter was not recommended for adoption. The earth and rock fill dam as proposed consists of a downstream part composed of masses of rock piled as compactly as possible and an upstream portion of earth fill. The rock excavated from the flood and power channels and the bypass, or from quarries established for the purpose, would furnish an ample supply of suitable hard rock. The agricultural lands in the reservoir bottoms immediately above the dam or the large clayey gravel deposits south and west of the dam will afford all the water-tight earth filling required for the upstream part of the work.

The diversion dam on the Sacramento near Anderson is designed as a rock-filled timber crib supporting a low masonry overfall fitted into a removable bear trap crest. The ends of the dam will have heavy masonry abutments connected with levees that extend to the high land on each side. This type of construction involves no serious engineering problems, as the river is broad and shallow at the location and its diversions during the season of low flow can be readily accomplished.

The irrigation project is assumed to include all lands west of the Sacramento that can be covered by a canal taking out at the Iron Canyon at elevation 350. The canal line will pass about 1 mile west of Red Bluff, 6 miles west of Tehama, 3 miles west of Corning, 4 miles west of Kirkwood, 2 miles west of Orland, [illegible] miles west of Germantown and 5 miles west of Willows, the southerly extremity of the area being about 8 miles south of the last mentioned place. The district will be served by a single line of main canal taking out of the reservoir at a point 2 miles southwest of Iron Canyon, where the rim of the reservoir is so low that an embankment will be necessary. This will have a headworks structure with gates of capacity to permit drafts of 2,400 second feet, the capacity of the main canal. Between the headworks and Dibble Creek, near Red Bluff, the location is largely in steep side hill and involves two wide creek crossings. Below Red Bluff the location is almost uniformly in easy, flat country, the only topographical difficulties being the creek crossings, such as Elden, Thomas and Stony creeks, where special structures will be required. The portion of the location immediately west of Kirkwood also has some fairly heavy sidehill and through cut work. The canal has been designed as a concrete-lined structure. It will have 1½ to 1 side slopes, a rounded bottom and low revetment walls at the margin. In general the freeboard above high water is 3 ft. and the banks are 12 to 14 ft. wide on top. The concrete lining will be 4 ins. thick. At the large creek crossings, Dibble, Blue Tent and Reed Creeks, the canal will be carried by a masonry aqueduct structure at water grade. This type also will be used at several other smaller crossings. Inverted siphons of masonry will be used generally for crossing large creeks south of Red Bluff. The numerous small drains or gullies that cross the canal line will be provided with overflow inlets into the canal, which in turn will have water gates. Special structures have been provided for the turnouts, waste gates, chutes, etc., and all highways will be provided with reinforced concrete bridges at canal crossings.

The canal, aside from its magnitude, presents no difficulties in design or location of an unusual character. The excavation of the main canal south of Iron Canyon will amount to about 3,300,000 cu. yds., mostly earth. Traveling excavators and conveyors that with one operation will excavate and convey to the spoil banks appear to offer the best solution of the construction problem. The estimated cost for excavation is 25 cts. per cubic yard for the work south of Red Bluff, where it is believed to be all in earth. North of Red Bluff, where more hardpan occurs, 30 cts. has been taken as a fair average. All excavation is believed to be such that it can be handled by excavating machinery without blasting, save in exceptional cases.

Conditions are believed to be favorable for the placing of the concrete lining. Cement can be obtained cheaply and expeditiously. The work is within short railroad haul and comparatively short road haul. The highways are firm and hard and motor trucks can deliver all material along the line of the work. Gravel and sand can be obtained at practically all the numerous creek crossings intersecting the canal line. Water also is obtainable from the creeks or from wells. The estimated cost of the concrete lining is $6 per cubic yard, exclusive of overhead expense. The price is for concreting on 1½ to 1 slopes without forms. For similar concrete work with forms the figure is assumed at $7 per cubic yard.

The irrigable area below the main canal is subdivided into units by the natural drainage channels crossing the main canal line. The various laterals will take out from the main canal and follow the crests of the hogbacks, between the drainage depressions, in a generally easterly direction. Sublaterals will in turn take out from the main laterals and continue in still smaller ramifications down to the minimum channels serving units probably as small as 40-acre subdivisions.

The estimated cost of the canal system is as follows:

	Total
Headworks at Bend Embankment.	
Excavation, 17,[illegible] cu. yds.	$[illegible]
Concrete masonry	
Foundation cut-offs and collars, 2[illegible] cu. yds.	1,[illegible]
Conduit and retaining walls, 1,950 cu. yds.	[illegible]
Gatehouses and walls, 610 cu. yds.	[illegible]
Arches, [illegible] cu. yds.	[illegible]
Bridge steel, 14,500 lbs.	1,400
Reinforcing steel, 150,000 lbs.	9,000
Railing and floor	[illegible]
Gates and hoists	18,[illegible]
Total	$[illegible]
Canal, Bend Embankment to Red Bluff.	
Excavation, [illegible] cu. yds.	$[illegible]
Embankment, [illegible] cu. yds.	[illegible]
Concrete lining, [illegible] cu. yds.	[illegible]
Concrete lining, [illegible]	[illegible]
Aqueduct bridges, [illegible] ft.	[illegible]
Bridges and miscellaneous structures	39,500
Total	$[illegible]
Canal, Red Bluff to North Fork Willows Creek.	
Excavation, [illegible] cu. yds.	[illegible]
Embankment, [illegible] cu. yds.	[illegible]
Concrete lining, [illegible] cu. yds.	[illegible]
Aqueduct bridges, 4,300 ft.	390,000
Creek crossings (siphons), 1,200 ft.	87,000
Waste ways and gates	[illegible]
Special structures	[illegible]
Bridges	57,500
Total	$[illegible]
Canal, North Fork Willows Creek to Sta. [illegible]	
Excavation, 39,700 cu. yds.	$99,250
Embankment, [illegible] cu. yds.	[illegible]
Concrete lining, 38,000 cu. yds.	228,000
Flumes, 2,600 ft.	[illegible]
Miscellaneous structures	[illegible]
Total	$[illegible]
East Main Canal.	
Excavation, [illegible],000 cu. yds.	$[illegible]
Concrete lining, 11,880 cu. yds.	71,280
Miscellaneous structures	[illegible]
Total	$113,580
East Branch Canal.	
Excavation, 44,000 cu. yds.	$[illegible]
Concrete lining, 7,825 cu. yds.	[illegible]
Miscellaneous structures	1,600
Tehama Co., S. line canal	[illegible]
Total	$[illegible]
Miscellaneous.	
Telephones, [illegible] miles	$[illegible]
Fencing, [illegible] miles	[illegible]
Right of way	[illegible]
Total	$[illegible]
Total main canal	$[illegible]
Engineering and contingencies, 25%	1,207,500
Grand total for main canal	$6,037,500
Distributing system for 225,000 acres at $[illegible]	[illegible]
Total cost of system	$[illegible]

The board of engineers appointed by the Secretary of the Interior to review the investigation of the Iron Canyon project recommended that all public lands and state lands required for the project be withdrawn or continue withdrawn from entry or sale and that the State Legislature pass an act permitting the withdrawal of water. It also was recommended that Congress enact a law permitting diversion of water from the Sacramento River for irrigation purposes regardless of navigation, and that upon the above acts being passed the Secretary of the Interior co-operate with the state of California and with the interested organizations in rendering available the sum of $100,000 for the more complete investigation and determination of the project along the lines proposed in the report.

SEAWALL OF SEATTLE, WASH.

Plans Being Prepared for First Section.

The city of Seattle, Wash., is now planning to build the first section of a permanent seawall along the waterfront. The section is about 1,275 ft. in length and extends along the southwesterly margin of Railroad Ave. from Madison St. to Washington St. Construction will be somewhat complicated on account of existing improvements. From Madison St. south to the south margin of Marion St., a distance of about 300 ft., Railroad Ave. is carried on a pile trestle bridge, and over this portion excavation will be light. From Marion St. south, however, the remaining 975 ft. of the avenue is supported by an earth fill retained by a timber pile-bulkhead. This bulkhead occupies the site of the proposed new wall, so that considerable clearing and excavation will be necessary, and a temporary bulkhead will be required to retain the existing earth fill. The existing piers will add further difficulty to the work proposed. On the other hand, the surface of the water, protected as it is by the natural harbor and existing piers, is usually quiet and therefore free from many of the difficulties which attend such operations in the open.

The mean range of the tide at this point is 7.66 ft., of from +2.35 ft. at mean high tide to —10.01 ft. at mean low tide, city datum. Mean lower low water is —13.04 ft., while the highest and lowest tides observed are +2.06 ft. and —17.14 ft., respectively. The tide dropped below —14.00 ft. 69 times during 1914, and 157 times below —13.00 ft.

Considerable filling of the waterfont has been made from time to time in this vicinity, so that the original beach is now from 10 to 30 ft. below the existing surface. The filling in most places is of substantial materials, but some of it consists of an old slab and sawdust pile. It is probable that, for bearing piles, at least, a penetration to elevation —45.00 will be necessary. The building grade along Railroad Ave. is at elevation +6.50 and the seawall will support a portion of the concrete sidewalk which will be laid at this elevation. The presence of the Teredo Navalis, which is very active in many places in Puget Sound waters, prevents the use of timber in any exposed position.

Of the 1,275 ft. of wall to be built, 465 ft. will be located at the ends of the different slips between the piers, and the remaining 810 ft. will be located along the private property. In the latter case it is proposed to build a gravity section of 1:3:5 concrete, supported by untreated timber piles. The piles will be cut off at elevation —7 00 and will project about 1 ft. into the concrete. A cobblestone fill will protect the piles wherever exposed until such time as the property may be filled. In some places this section of wall is to be used as a support for the piers. For the portion in front of the slips bids will probably be called for on a gravity section and on an alternate section of reinforced concrete design. The gravity section will be supported on timber piles cut off at elevation —13.00 and protected by cobblestone and riprap fill. The body of concrete will be a 1:3:5 mixture with a rich mortar surface. The reinforced section will consist of one of the more recent types of construction, probably involving a single row of reinforced concrete sheet piling capped with a fairly heavy reinforced section above elevation —10.00 and tied back at intervals to heavy concrete anchors and timber anchor piles. A row of heavy concrete bearing piles placed outside of the sheet piling will be necessary to support the load at the toe of the wall.

Plans for the wall are being prepared under the direction of A. H. Dimock, City Engineer, Seattle.

STORM KING HIGHWAY, N. Y.

A $200,000 Contract for 1.27 Miles of Road.

Bids were opened last month by the New York State Highway Department on one of the most difficult pieces of road construction ever attempted in this country. The work calls for the building of 1.27 miles of the first link of the road across the face of Storm King Mountain north of West Point, N. Y. The following particulars of this undertaking are abstracted from the New York Highway News:

The contract starts at Bay View Ave., Cornwall, 190 ft. above the Hudson River, runs to an apex 200 ft. higher up and then descends to an elevation of 213 ft. at its southerly end. The grades change from 6.3 per cent for 250 ft. at the start, shifting between 3.2 and 5.7 per cent until the summit is reached about ¾ mile further on. From the summit the road descends a distance of ¼ mile on a 7 per cent grade. On this section the contractor will be obliged to construct a 187.6 ft. steel truss bridge and a 72.9 ft. steel reinforced concrete structure. The larger bridge will be a steel deck Warren truss structure with two equal spans supported in the center by a concrete abutment. Including abutments, it will require 218,000 lbs. of steel, 12,000 lbs. reinforcing bars and 7,000 lbs. expanded metal. The smaller bridge will consist of steel cross girders encased in concrete, stretching from a large steel plate girder on the outside up the roadway to solid rock anchorages. Its construction will require 22,800 lbs. steel, 1,200 lbs. corrugated steel and 2,000 lbs. expanded metal.

Midway between the two bridges the cut varies from 35 ft. of ledge rock at the center of the highway to a depth of 83 ft. on the extreme inside. The largest cut shows 1,573 cu. yds. while the maximum fill is 7,500 cu. yds., consisting of 78 ft. at center, 89 ft. from grade to lowest point and 182 ft. of horizontal width at base. This is made necessary by the gouging out of the rock to form a shelf for the roadway. This work commences on the descending grade and continues for about ¼ mile, when the excavation changes from ledge to boulder cut.

Masonry walls will be built on a slope of 4 to 1, the lower side resting on the step foundation in the rock. For this construction it is required that at least 75 per cent of the masonry shall be one-man stone or larger, and that all holes shall be filled and all stones wedged in place with suitable spalls. At least 25 per cent of the face stone will be headers 3 ft. in length and at least twice as deep as they are thick.

The work will involve many constructional difficulties. The tracks of the West Shore R. R. lie at the base of the cliff. This makes its necessary to use extreme care in handling the excavation. For a considerable distance the rock will be quarried and used in fills. The contract includes an item of $10,000 for installing and operating a traveling crane and car, which will be used on the present switch of the West Shore R. R. for the removal of any rocks that might be blown upon the tracks. Telephone service is to be installed between the points of operation and the railroad tracks for use of switchmen in insuring safety of trains. Compressed air lines also will lead to the railroad to facilitate the removal of boulders of rock from the track.

The construction of the 1.27 miles of road calls for 35,132 cu. yds. of excavation in ledge rock and 16,581 cu. yds. of earth and boulder excavation. The retaining walls average 7,190 cu. yds. per mile or a total of 9,138 cu. yds. The cuts and fills have been balanced so that little excavation will have to be wasted.

The highway will be surfaced for a width of 16 ft. with waterbound macadam. The engineers' estimated cost is $228,718, exclusive of land damages.

Bids for the construction of the 1.27 miles of road were opened on Dec. 10, the three lowest bidders on the work being as follows: James Garafans & Sons, Inc., Mt. Vernon, N. Y., $196,998; Moynehan & Hodgins, Port Henry, N. Y., $199,962; Langan Construction Corp., Albany, N. Y., $203,153.

A $366,850 Sewage Disposal Plant for Trenton, N. J.

Detailed plans and specifications for a sewage disposal plant for Trenton, N. J., have been submitted to the City Commissioners by Hering & Gregory, consulting engineers, 170 Broadway, New York City. The estimated cost of the plant is $366,850, and its operation will cost about $27,300 annually. Of the latter sum $1,800 is for superintendent-chemist, $22,000 for labor, power, supplies and miscellaneous expenses at the sewage pumping station, and $3,500 for labor, supplies, etc., for the sewage disposal works.

The main features of the plant consist of an overflow chamber, a gate house, a screen and grit chamber, sewage pumping station, Venturi meter, 12 settling tanks of the Imhoff type, and 24 sludge drying beds. The plant is designed to treat the entire dry weather flow of sewage of the entire city and will have a capacity of 225,000,000 gals. per 24 hours. As the works have not been planned to handle much storm water in addition to the dry sewage, it has been recommended that the combined sewers be provided with automatic regulators, so that in times of rain only the first wash from the street will be taken to the plant. It is also recommended that extensions to the sewers shall be made upon a plan providing separate mains for storm and domestic sewage

The Imhoff tanks are rectangular in plan and each will be 33 ft. wide, 98 ft. long and 27 ft. 2½ ins. deep. Each of the sludge drying beds will be 20 ft. wide and 78 ft. long, with a total area of 37,440 sq. ft. The beds will have an average thickness of 12 ins. of graded gravel and broken stone. The sludge will be transported from the beds in small cars operating upon a narrow gage railway. The plans also include the construction of a levee around the works as a protection against high water from the river.

State Highway Construction in New York.—The completed mileage of state and county highways in New York state on Dec. 1, 1914, was 5,156, and on that date 1,330 additional miles were under contract. It is estimated that the payments to contractors for construction work in connection with highway improvements in 1914 exceeded $13,500,000.

14.6 Miles of Roads to Cost $220,000, for Stark County, Ohio.

Highway construction estimated to cost nearly $220,000 and covering 14.6 miles of work will be placed under contract in the next few months by the Commissioners of Stark County, Ohio. Plans have been prepared for the improvement of six roads and they will be let some time in the early spring. The following roads are to be surfaced with bituminous macadam:

Name of road.	Miles.	Width, ft.	Estimated cost.
Navarre-Justus	2.49	15	$28,220
Alliance-Bolton ..	1	16	....
Magnolia-Sparta	3.12	15	38,853
Waco-Mapleton	1.9	16	21,998

Roads to be improved by paving with brick are:

Name of road.	Miles	Width, ft.	Estimated cost.
Massillon-Millersburg.	3.6	15	$76,495
Louisville-Freeburg ...	2.5	15	53,400

The estimated cost on the brick roads includes concrete curb, concrete base and brick metaling with tar filler. W. L. Bender, Canton, O., is County Surveyor of Stark County.

Twenty Miles of Sewer and Water Main Extensions.

Bids are now being asked by the city of Columbia, S. C., for the construction of extensions to its water distribution and sewerage system, the work involving about 10 miles of mains and a like amount of sewers. The water pipes will be laid at an average depth of 4 ft. and will involve the following quantities:

Size pipe. Ins.	Lin. ft.
6	30,525
8	2,305
10	12,150
12	5,416

The sewer construction requires the following:

Size. Ins.	Lin. ft.	Cut, ft.
8	11,675	8 to 20
10	5,340	8 to 12
12	1,120	8 to 10
15	1,790	8 to 10

Bids for the water and sewer extensions will be received by the city commissioners of Columbia, until 10 a. m., Jan. 29. F. C. Wyse is engineer-superintendent.

Reduction in Engineering Forces by New York State Engineer.

Changes decided upon by the State Engineer of New York will result in reducing the number of employes of the department by 400. The departments of barge canal and terminals will be consolidated, the position of division engineer of terminals abolished, and the work now handled by such engineers will be carried out under the direction of the three division engineers of the barge canal. According to press dispatches the changes will bring about a saving in salaries of $1,350 per day, and will cause the laying off of the following:

1 terminal division engineers at $4,000.
5 supervising engineers at $3,000 to $5,000.
12 resident engineers at $3,000.
77 assistant engineers at $5 to $7 per day.
12 bridge designers at $125 to $150 per month.
18 levelers at $4 to $5 per day
15 masonry inspectors at $4 to $5 per day, and
257 other employees of the State Engineer's Department.

A 12.6 Mile Concrete Road.

A contract calling for the construction of 12.6 miles of concrete road is now being advertised for bids by the California Highway Commission. The work is located in Butte County and extends from Nelson to Chico. The estimated quantities are as follows: 40,000 cu. yds. excavation without classification; 264 lin. ft. 12 in. corrugated iron pipe; 198 lin. ft. 18 in. corrugated iron pipe; 72 lin. ft. 24 in. corrugated iron pipe; 220 cu. yds. Class "B" Portland cement concrete (culverts and monuments); 15,950 cu. yds. Class "B" Portland cement concrete (pavements); 2,300 lin. ft. guard rail; 121 each, hauling and setting monuments. The commission will furnish pipe railing for culverts, reinforcing steel, corrugated iron pipe, Portland cement, sand and coarse aggregate. Bids for this work will be received at the office of the commission, 515 Forum Bldg., Sacramento, until 2 p. m., Feb. 1.

Rogers Pass Tunnel Progress in December.—Good progress was made during December by the contractors on the construction of the Rogers Pass tunnel for the Canadian Pacific Ry. The record for the month was as follows:

	Ft. driven.
East end pioneer heading..	511
East end center heading...	523
West end pioneer heading..	862
West end center heading...	686

The last two headings were driven through slate having small quartzite bands. The East End pioneer heading was through quartzite with some schist and the East end center heading was through schist with some quartzite. Foley Bros., Welch & Stewart are the contractors, A. C. Dennis, Glacier, B. C., being their superintendent for the work. Joseph Murphy is assistant superintendent for the East end, and Joseph Fowler is assistant superintendent for the West end.

The University of Illinois has abandoned the Short Course in Highway Engineering, advertised to occur Jan. 11-22, 1915. This action was taken to prevent the possible spread of the foot and mouth disease.

Recommendations for Irrigation Work in Oregon.—The Oregon Irrigation Congress at its final session at Portland, Ore., on Jan. 9, adopted a resolution to petition the 1915 General Assembly to levy a ½ mill tax on all property in the state, the proceeds to be used for the reclamation of arid land. It is estimated that the tax would net the state about $500,000 per year. It also was decided to recommend to the General Assembly a constitutional amendment, making possible the use of the state's credit to aid in financing irrigation enterprises, preferably those organized on the district plan or those which the Federal Government will assist in financing. The congress also adopted a resolution urging that the State and Federal Governments co-operate in investigating and issuing reports on the following proposed irrigation projects: Lower desert project; Tygh Valley-Wamie project; Peninsula district between Dischutes and Crooked Rivers; Harney Valley District of 25,000 acres; Silver Creek project of 50,000 acres; Malheur Warm Springs reservoir project; Dead Ox Flat District; Ochoca and other districts.

State Highway Construction in Ohio.—During the year ending Nov. 15, 1914, the State Highway Department of Ohio awarded contracts amounting to approximately $7,000,000, and covering about 550 miles of road. In the same period the department completed about 140 miles of highway, maintained or repaired 307 miles, and assumed the future cost of maintenance and repair of 600 miles.

NEWS LETTERS

St. Louis Items.

R. E. Cash, Atlas Bank Bldg., Cincinnati, Ohio, was low bidder on 50,000 yards of property work in Cincinnati. Will get started on this as soon as weather permits. He also has a 35-ton Traction shovel working every day on road work near Cincinnati.

M. L. Windham is wintering his outfit at Marion, Ill. Windham is in the market for any kind of grading

Promoters of the proposed interurban from Central to Western Illinois and which is to be known as the Chicago, Peoria and Quincy, are confident that construction will commence this spring. The City of Peoria has subscribed $350,000, the City of Canton $300,000, while a number of smaller cities have taken smaller amounts of the stock. The people of Quincy have been asked to take $300,000 in stock. E. L. Coleman and R. L. Kelly have been selling stock in behalf of the Chicago company that is financing the proposition, and both are confident that cars will be running within a year. It is estimated that it will require two years to construct the road between Peoria and Quincy.

Mrs. E. Y. Sutherland, wife of the well-known St. Louis pile driving and bridge contractor, died here on Jan. 2 of a stroke of paralysis.

Morris, Sheppard & Douherty of St. Paul, Minn., will finish their grading of the roadbed of the Paducah & Illinois R. R. to the site of the Burlington bridge near Paducah, Ky., shortly. This firm has also been awarded the contract for the track-laying on this line.

Roach & Manigan Paving Co. of Memphis was awarded a contract by the city of Fort Worth, Tex., to lay 100,000 sq. yds. of asphaltic concrete at a total cost of $235,000. The streets to be paved are in the packing house district of Fort Worth and the time allowed for completion is one year from date of contract. Roach & Manigan Paving Co. maintain an office in Fort Worth. The firm recently has been doing much work in the Lone Star state. Only a short time ago the concern obtained a $125,000 contract to pave the principal downtown streets of San Antonio. C. D. Smith, head of the firm, will leave next week for Texas to shape up the forces for immediate work on the new contract and will move sufficient equipment to complete the job on contract time.

H. H. Unterbrink of Alton, Ill., secured the contract to build two large barns near East Alton, Ill. Each will be 800 ft. long by 40 ft. wide and accommodate 1,400 horses, Eight car loads of lumber will be used in construction. The barns are being built under a contract with an East St. Louis commission concern which is purchasing horses for the British government.

Mulvill Bros. of Alton, Ill., are building a short spur near East Alton, Ill., into the new large barns that are being built there to accommodate horses being bought for the British government.

Frank W. Buffum, state highway commissioner, employed a civil engineer in St. Louis last week to establish the lines and right of way for the proposed eastern branch of the Red Ball improved roadway to be constructed between St. Charles and Clarksville, Mo. The branch road will leave the Red Ball route at St. Charles and would reconnect by a spur running west from Clarksville. It will form a part of the St. Louis-to-Keokuk highway. It will parallel the Burlington tracks between Old Monroe and Clarksville, and will be on water level the entire distance from St. Charles road improvement district under the town "eight-mile" law already are being formed. Commissioner Buffum expects to have all the preliminaries completed before spring, so actual construction work may be started coincident with favorable weather conditions. Mr. Buffum stated that he would present no road bills to the legislature until late in the session, if at all. First, he said, he is desirous of learning the views of the different road legislators. When a large number of bills have been presented he expects to have a conference with the authors of all of them to counsel with them and to determine which measures seem deserving to the larger number.

Charles V. McCormick & Son were awarded the contract for the erection of the proposed depot of the Columbia Transfer Co. at the southeast corner of 12th and Spruce St. The building will be a large two-story structure covering a lot 80x152 ft., to be used as a warehouse, loading depot and stables. The contract includes all lines of construction except the heating apparatus, and amounts to about $80,000.

The Merritt-Gilbert Contract Co. of New York are installing two very large drag lines, both having 125 ft. booms. They are going to place these on their big drainage contract in Cape Girardeau County, Mo. They have placed orders for two more similar machines which also will be put to work on this job. Their contract calls for the moving of approximately 9,500,000 yds. of earth. Under their contract they have two years and a half to complete this job, but Messrs. Merritt and Gilbert are going to stay right with it and will beat this time from three to six months.

L. B. Davis, vice-president and general manager of the Davis Commissary & Supply Co., left here for Cape Girardeau the other day, where he closed the contract with the Merritt-Gilbert Contract Co. of New York to board all of their employes that they are going to use on their big drainage contract in Cape Girardeau County.

The first of 20 new stills being built by the Standard Oil Co. at Wood River, Ill., began operations on Jan. 8. E. M. Clark, superintendent of the plant, is the inventor of the stills. The Wood River plant now has 145 stills.

Whether sand taken from the bed of the Mississippi River is clean, unfrozen earth suitable for levee construction was a subject of debate beginning last week, when the injunction suit brought by the East Side Levee and Sanitary District against the Illinois Dredging & Construction Co., which came up in Judge Crow's division of the Circuit Court of Belleville, Ill. The district is attempting to prevent the construction company taking the sand from the river and putting it in the $6,000,000 levee being built in East St. Louis. They say the contract calls for clean, unfrozen earth. Isham Randolph, one of the engineers in charge of the construction of the Panama Canal and Geo. M. Wisner of Chicago gave expert testimony that sand is not clean, unfrozen earth. The case hinges on the definition of sand since the district, in obtaining a temporary restraining order several months ago, alleged the construction company, in placing the sand in the new levee, was violating a clause in the contract, which calls for clean, unfrozen earth. The contract was originally let to the Illinois Dredging & Construction Co. and sublet by them to the Kinser Construction Co., who is actually doing the work. The construction company is contending that the material they are using is suitable and up to requirements.

A. V. Fetter & Co. of Quincy, Ill., have subbed a contract for revetment and shore protection work on the Mississippi River near La Grange, Mo., from the J. W. McMurray Contracting Co., who secured two of these jobs at the last Government letting in Rock Island, Ill.

Chas. Nagel, representing A. V. Fetter & Co., was here last week buying and making preparations to begin work on their new revetment job near La Grange, Mo., as soon as weather permits this spring.

Mrs. Henrietta Scherer, 515 Rutger street, on Jan. 15 filed a suit in the Circuit Court for $7,500 damages against the James McMahon Construction Company and the Carter Construction Company. Mrs. Scherer alleges blasts set off in excavation work for the Mill Creek Valley sewer caused the plaster to fall off the walls and many windows of her home were broken. She alleges the danger was so great that she and her family were compelled to move out of the home and go to live on Potomac street. The suit is the third filed as a result of the sewer work.

F. M. Nichols and Dick Keaton were awarded the contract for furnishing brush to the J. W. McMurray Contracting Co., which will be used on their revetment and shore protection work on the Mississippi River near Grafton, Ill.

The request of the Terminal Railroad Association for permission to lay tracks across Atlantic street and Scott avenue, west of the Compton avenue Viaduct, was referred by the Board of Public Service to itself as a committee of the whole. Director of Public Utilities Hooke was instructed to confer with the Terminal officials to ascertain the details of their plans for the use of the tracks and report next week. The site for the use of which the permit is requested is part of the Ranken tract, on which the Terminal has a ninety-nine year lease. Atlantic St. and Scott Ave. are platted thoroughfares that have not been made. The Terminal has been seeking to use the tract for railroad yards for about six years. A bill giving it permission to use the entire tract was defeated in the House of Delegates in March, 1910, after a fight of more than six months.

At a meeting attended by representatives of the Chicago, Burlington & Quincy Railroad, the Alton, Granite & St. Louis Traction Company, Highway Commissioners of Wood River Township and officers of the Alton Board of Trade in Alton on Jan. 15, tentative arrangements for the overhead crossing of the street car line to the State Insane Hospital site was agreed upon. The plans will be sent to the Illinois Utilities Commission for approval, after which the work of extending the line will be taken up.

P. J. Hannon & Co. opened an office here in Room 520, Boatmans Bank Bldg.

J. W. McMurray passed through St. Louis the other day on his way to New Orleans, where his company has a claim against the Frisco R. R. Co. for some work done several years ago.

The East St. Louis Board of Public Improvement passed on the Kansas-Division Ave. sewer project the other day. The planned sewer will extend along Kansas and Division Aves. from 16th to Twenty-first St., and will empty into the main sewer at 16th St. Its cost will be $10,284. The hearing on the supplemental assessment for the Exchange Ave. sewer between First and Seventh Sts., was postponed until Jan. 29. The original estimate for this work was $23,000; the supplemental assessment was $3,847.62.

Major W. H. Wells, Chief Engineer of Construction for Southern Railway, arrived in Cairo, Ill., on Jan. 11 to purchase about 40 acres of ground on the Illinois Side and the same amount on the Kentucky side of the Ohio River. As soon as this ground is purchased and permission obtained from the Government Engineers the Mobile & Ohio R. R. will begin the construction of their proposed $2,500,000 bridge across the Ohio River at that point.

The new depot built by the Iron Mountain R. R. Co. at Hot Springs, Ark., to replace the one burned over a year ago, was completed last week at a cost of $22,000.

The Nashville, Chattanooga & St. Louis Railroad is going to reconstruct its lines between Huntsville and Gadsden, Ala. They will also build several miles of new track along the Tennessee River between Guntersville and Hobbs Island, Ala., early in the spring.

Ransom & Cook, Ottawa, Kan., have between 15,000 and 20,000 yards of wheeler work on road near Merrian, Johnson County, Kan., to sublet.

Jim Feren has his outfit at work on the Burlington R. R. near Weston, Mo.

A. B. Koenig.

PERSONALS

Mr. Frederick C. Noble, civil engineer, has opened an office in the Hudson Terminal building, 50 Church street, New York City, for consulting practice. Mr. Noble is a member of the American Society of Civil Engineers.

Mr. H. M. Nabstedt has opened an office as civil and consulting engineer at Cornelia, Ga. Mr. Nabstedt was for eight years in the employ of the Ambursen Companies as engineer and superintendent of construction. Prior to that he was superintendent of public works at Stoneham, Mass.

Mr. Carl H. Fuller, who has been for a number of years connected with the Macon Railway and Light Co., as engineer of way and buildings, has opened an office as consulting engineer at 307-8 Woods building, Evansville, Ind. Mr. Fuller is an associate member of the American Society of Civil Engineers, and has had a varied and extensive experience in the construction and operation of steam and electric railways, shops, terminals, bridges and heavy construction work connected with such projects.

Mr. Friend P. Williams has been appointed division engineer of the Western Division, Department of State Engineer and Surveyor of New York. This division covers 140 miles of Barge Canal work, as well as special appropriations for river improvement work, etc. His headquarters will be in Rochester, N. Y. Mr. Williams was for five years on construction work with the Pittsburgh, Shawmut & Northern Railroad. For 10 years past he has been resident engineer on Barge canal construction with headquarters at Mechanicsville.

Mr. Irwin S. Osborn, consulting engineer of Toronto, Ont., has been retained by the commissioners of the District of Columbia, to make an investigation and report on refuse collection and disposal for the city of Washington. Mr. Osborn is engineer in charge of refuse collection and disposal for the department of street cleaning of Toronto, and is also consulting engineer to New York City on garbage disposal. He has had wide experience in this field, having been chief engineer for the Edson Reduction Machinery Co., from 1905 to 1907, and engineer in charge of refuse collection and disposal at Columbus, Ohio, from 1908 to 1912. During the latter period he designed and installed the system now in effect in Columbus. In 1912 he was called upon by the city of Philadelphia to investigate and report on the possibilities in that city, and in 1914 was employed in a similar capacity by the city of Chicago. He has also been retained as consulting engineer by various companies interested in refuse work.

Mr. E. Ben Carter has been appointed to the position of chief engineer for the Florida East Coast Railway, with headquarters at St. Augustine, Fla. Prior to entering the service of that railway in 1892 Mr. Carter was engaged in miscellaneous survey and construction work in the middle western states for ten years, and from 1881 to 1886 he was locating and construction engineer of the Jacksonville, Tampa & Key West Railway in Florida, now part of the Atlantic Coast Line Railway. Between 1886 and 1892 he was engaged in miscellaneous engineering work in Florida. His first position with the Florida East Coast Railway was that of division engineer on construction which he held for two years. He was then appointed engineer and general roadmaster, which he remained until 1909. Since that time he has been superintendent of maintenance of way. Mr. Carter has been practically chief engineer of the road since 1894, and upon his receiving the title on Jan. 1, his former position was abolished.

Mr. W. W. Marr, whose appointment by Governor Dunne as Chief State Highway Engineer of Illinois was noted in a recent issue, is an engineer of wide experience in highway construction and maintenance and street paving work. He is a native of Chicago, born in 1876. He acquired his technical education at Notre Dame University, receiving his civil engineering degree in 1896. For nine years Mr. Marr was in charge of the construction of pavements and highways in Chicago and Cook county, and as division engineer on the west side of Chicago under the Board of Local Improvements he had charge of work amounting to more than $5,000,000. In 1910 with Mr. P. E. Green of Chicago, Mr. Marr formed the Aetna Engineering Bureau, consulting civil and sanitary engineers of 17 S. La Salle street. That firm at present is acting as consulting engineer to a score of cities in the middle west. Mr. Marr is a member of the American Society of Civil Engineers and of the Illinois Society of Engineers and Surveyors.

Mr. Henry Welles Durham has resigned as Chief Engineer of Highways, Borough of Manhattan, New York City, and will leave that position on Feb. 1. Mr. Durham has been in charge of the bureau for the past three years, during which period he has directed the repaving of about 25 per cent of the total area of streets in the Borough. This work has cost about $7,000,000. In addition about $1,000,000 per year has been spent in work under Mr. Durham's direction. In 1913 he was designated by the late Mayor Gaynor to represent the city at the International Road Congress and make a study of European pavement. The report on this is now being published in book form. Mr. Durham was graduated from the School of Mines of Columbia University in 1895 as civil engineer. Subsequently he was on preliminary surveys for the New York Subway, for the U. S. Geological Survey, and for the Nicaragua Canal. From 1900 to 1904 he was assistant engineer in charge of subway construction in New York City; 1904 to 1907 he was resident engineer in charge of design and construction of Panama water supply, sewers, street paving and roads for the Isthmian Canal Commission; 1907 to 1912 he was resident engineer in charge of preliminary surveys, design and construction of the Cape Cod Canal.

Prof. Charles M. Spofford, head of the department of civil and sanitary engineering at the Massachusetts Institute of Technology, has been appointed expert adviser for the city of Cambridge, Mass. Prof. Spofford is a graduate of the Institute and has been connected with the civil engineering staff since 1896, with the exception of four years, 1905 to 1909, when he was professor of civil engineering at the Brooklyn Polytechnic Institute. For the past six years he has been Hayward professor at the Institute, and since 1912 has been in full charge of the department of civil and sanitary engineering. Prof. Spofford has also had a wide experience in practical and consulting engineering work, having been connected with the engineering staffs of the Phoenix Bridge Co., and the city of Boston on special bridge designing work. He has been engaged as consulting engineer, largely on bridge work, by the cities of New York, Cambridge, New Bedford, Nashua, Boston and various smaller communities and has also been engaged upon many miscellaneous engineering projects. He is a member of the consulting engineering firm of Fay, Spofford & Thorndike, 308 Boylston street, Boston, which was established in July, last. Prof. Spofford is the author of numerous articles appearing in the technical press and of a text book on structural engineering. He is a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the Brooklyn Engineers' Club, and the New England Water Works Association.

CONTRACTORS.

Mr. Lester F. Alexander, 834 Audubon Bldg., New Orleans, La., who was recently awarded a contract for furnishing and placing riprap in the jetties at Southwest Pass, Mississippi River, has had an extended experience in work for the Federal Government. He has constructed about $100,000 worth of buildings and and pile driving at Southwest Pass for the U. S. Engineers, and about the same amount of buildings and wharves for the New Orleans quarantine station at the mouth of the Mississippi River. He also has done some pile driving work for the Quartermaster's Department at Fort St. Philip, La. He constructed the lock in the Inter1Coastal Canal at Schooner Bayou, La., drove 5,300 lin. ft. of the first experimental dovetail sheet piling in the levee at Hard Times Landing for Major C. C. Sherrill, U. S. Engineer, and has furnished about 100,000 tons of stone to the 4th District Mississippi River Commission at New Orleans and Vicksburg, Miss. He also has carried out various other work, including the insulation of the U. S. A. T. McClellan for a refrigerator ship for transporting fresh beef to the troops at Vera Cruz. His present contract amounts to about $310,000 and calls for the furnishing and placing of 70,000 tons of riprap. This is divided into three contracts, of which two of them, aggregating one-half the total, will be completed this month. Mr. Alexander was with the corps of Engineers, U. S. Army, for 10 years on river and harbor work in Havana, Cuba, and Louisiana. He was superinteendent for Christie & Lowe, General Contractors, for one year. He has been in the contracting business for himself for the past five years. Associated with him is Mr. J. L. Dickey, who for 12 years was engaged on river and harbor work in Louisiana for the Government.

Civil Service News.

The U. S. Civil Service Commission announces an examination for the position of aeronautical mechanical engineer, $2,400 per annum, Feb. 10.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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Will the War Cause Scarcity of Investment Capital and Depression?

Much is said by "economists" as to the vast destruction of capital now in progress and the subsequent ill effects to be experienced in the financial world. Capital is of many kinds and variously located. Most of it is not easily destroyed, even in a war area. Money is not destroyed by war, although it may leave its accustomed haunts. Crops may vanish in some places, but the soil and its most expensive improvements remain even in the very wake of wars. Railway tracks may be torn up, but roadbeds and rights of way—by far the most expensive parts of a modern transportation system—remain. Roads and bridges suffer, but even in the very course of war must be maintained. Many factories close, but relatively few are destroyed. All this in the paths of battles, in the comparatively small areas of conflict. Turn to a map of Europe and note how insignificant an area of the warring countries has been scarred. Clearly, then, the destruction of the instruments of production—the "working capital" of these stricken countries—is an almost negligible part of the vast total. What war *does* destroy is lives, credit and business confidence; and of these only the first mentioned is a lasting loss. But even the lost lives of producers have a minor effect on subsequent industrial revival, for so long as men enough remain to man the industrial ship there need be no fear of general disaster or even general discomfort.

Writers on economics commonly speak of the current expenses of war as "destruction of capital," when the fact is that nearly all such expenses mean merely the diversion of human energy from peaceful pursuits to strife. To simplify the economic problem of war let us conceive a tribe of Indians living peacefully, some of the tribe idle, others engaged in making ornaments and implements, others in hunting, others in tanning skins, weaving, etc. Let war be declared between this tribe and another. Immediately there follow many changes of occupation. Less of ornament, less of clothing, less of certain food delicacies, less perhaps of needed food will be secured. More of bows, of arrows and of spears will be provided. At the close of the war the tribe will return to its accustomed occupations, its fields of chase and to the use of its skilled fingers and century-old knowledge, little altered by the conflict.

Complex systems of credit and instruments of modern production obscure the financial effects of war, and make temporary losses seem permanent or of long duration. The money spent for gun-powder would have been spent, let us say, for fine clothes. The iron that goes into shrapnel would have gone into plow shares. The war, in a word, has *diverted* production and has stopped progress, but the stoppage will scarcely last beyond the end of the war even in the warring countries.

"Yes," says the credit-broker, "but consider the vast war debts incurred by governments. Taxes will drain the gold of the producers for generations to follow." Here again is entire misconception of the after effects of war. A government debt is an obligation to pay. A tax is the means used to meet the obligation. But since both the creditors and those who pay the taxes are one and the same people—the citizens—it follows that no money capital is taken away from a nation that finances its war with money borrowed from its own people. For the most part, all long, severe wars are thus financed of necessity. There will be as great a per capita circulation of gold in France after the war as before. So, too, in England, Germany and Russia. War taxes will be paid every year, and as fast as paid the money will return to those who originally loaned it. By them it will be reinvested. Whence comes the fear that money will be scarce after the war?

If we turn to the great American war, now half a century ended, do we find scarcity of money seeking investment at its close? Quite the contrary. In eight years following the end of the civil war, railway building and other financiering had proceeded at such a pace that a great panic occurred. The panic of 1873, like the panic of 1893, was due largely to excessive promotion of industrial enterprises—to "over production." A poor monetary system served to aggravate the ill effects of this "over production," but even the best of monetary systems could not have prevented hard times from "over production."

The psychological effect of a long war is not unlike that of a long winter. Peace, by its contrast, makes for a rebound of spirits, such as one feels in the spring of the year. Business men crave exercise of their talents, and the longer they have been compelled to hibernate the keener the desire to exercise when the storms are gone. So, too, the investor. And labor, having tasted the dregs of idleness, also rebels at further taste of it. So, when a long war ends, the industrial triumverate—manager, investor and employe—is at one in eagerness to work. Post-bellum days are days of industrial activity.

Duration of Mixing and Strength of Concrete.

Practically all of our progress in the use of reinforced concrete has been the direct result of experimentation, much of which has been done by those in charge of our engineering schools. Elaborate and carefully conducted experiments have been made to determine the strength of plain and reinforced concrete and the effect of changing the proportions of the ingredients in concrete. A lesser number of tests have been made of, and considerably less thought has been given to, the quality of the aggregates themselves. One factor—duration of mixing—an exceedingly important one—has received practically no consideration by those in charge of experimental work. This is not at all strange when one considers that the human element practically always is the last to be considered. Although engineers and contractors have long believed that "duration of mixing" was an important factor, the economic necessity of large production has precluded adequate consideration of this factor. It is undoubtedly true that few, if any, manufacturers of concrete mixers have considered the subject to be of sufficient importance to warrant their making a comprehensive series of experiments to determine the speed and number of turns which would produce a concrete of maximum strength—they can, however, tell you the rated maximum capacity of their mixers.

It will at once be conceded that all parts of a concrete structure do not require concrete of uniform strength. Maximum unit strength is not so important in heavy foundation work where the form cost is often relatively small as it is in reinforced concrete columns, in beams, or in slabs, for which the cost of the forms is relatively high and the members must necessarily be as small as practicable. The usual method of securing high strength has been to make a rich concrete mixture—possibly equally good results in many cases could be obtained by proper duration of mixing.

In this issue we are publishing an incomplete series of tests, the sole object of which is to determine the effect of duration of mixing on the strength of concrete. Although it would be useless to attempt to draw definite conclusions from the tests reported, the results are, nevertheless, interesting and instructive. In these tests only one type of mixer—a small one at that—was used, although the concrete proportions and the mixing conditions were varied considerably. The seven series of tests reported show a range of from 27 to over 50 per cent increase in strength for 10 or 18 minutes duration of mixing over that given by ½ or 1 minute mixing. Between certain limits (in this case between 10 and 18 minutes) the effect of mixing on the strength of the concrete was slight; for both shorter and longer periods, however, there was a decided decrease in strength, the latter possibly being due to initial set in the concrete.

Too much credence should not be given to the results, expressed numerically, of these tests as it will at once be realized that the speed of the mixer and its construction are important factors. The tests do, however, indicate that it is possible to determine, for each type of mixer, the duration of mixing which will give concrete of maximum strength, for a concrete of stated proportions and materials. We realize that there is an economic necessity, under certain conditions, for high production, but we also believe that high production is not the only essential element. It is hoped that the need of exhaustive data on this subject will be met by manufacturers and by those in charge of our experiment stations.

What Is the Truth About the Los Angeles Aqueduct?

From the beginning of construction the Los Angeles Aqueduct has been a target for criticism. This is a danger risked by every great engineering work, but in respect to the Los Angeles Aqueduct work experience records a variation from the normal. The most severe criticism urged has been directed against the engineering of the project. Also the virulence of the criticism has not decreased with the virtual completion of the engineering work. Engineering society proceedings and engineering journals have within a few weeks published specific signed attacks on the engineering of Los Angeles' costly work for improved water supply. Denial has been made of all charges, but they still persist and they are doing damage to engineering. The conditions may perhaps best be indicated by a summary, chiefly from recollection, of the criticisms most frequently repeated:

Cement manufactured at the municipally owned cement plant has cost between $2.75 and $2.85 per barrel at the mill. The city could have purchased first-class cement on the market at less than half these prices. It was represented to the people of Los Angeles that cement could be made at the plant for $1 per barrel and this fiction is still believed by many. Not only has the cost of this cement been high, but its quality is inferior. The defective concrete resulting from the use of this cement of inferior quality will eventually cost the city several millions of dollars more than had good commercial cement been utilized in the first place. Caterpillar traction engines were purchased for hauling freight with the result that the cost of hauling was nearly doubled. After a few months these engines were "junked" with a net loss to the city of several hundred thousand dollars. The construction of the Sand Canyon Syphon is called an unwarranted engineering experiment. There was a California precedent to show the impracticability of constructing a concrete lined pressure tunnel through the frail rock traversed. The concrete lining should have had an inner lining of steel. The Haiwee reservoir is called "one of the most stupendous failures." It has failed to hold water and extensive work has been carried on to stop the leaks for more than a year past, but without success. No sanitary investigations of the water were made, but the city rushed into the project without knowing the quality of the proposed water supply. It was stated that pure mountain snow water would be obtained. Now it develops that the intake of the aqueduct is located below the inhabited portion of the Owens valley; that over 40,000 acres of irrigated land returns its seepage to the river above the intake and that numerous towns, of considerable size, such as Bishop, Big Pine and Independence, are located so as to drain into the river and aqueduct. It was not difficult to deceive the public in regard to the kind of water available from the aqueduct, by reason of the great distance to the source of supply, and the fact that pure water could have been obtained; had the aqueduct been diverted from the tributaries of the river along the foothills, instead of from the main river in the Owens Valley after this has served as the outfall sewer of a populous section. Certain newspaper owners and their associates, who wish to profit by obtaining water for large areas of dry land in the San Fernando Valley, created the public sentiment for this project and caused it to be placed in the hands of incompetent men who would do their bidding. The water is fit only for irrigation and not for domestic consumption. The construction work is characterized as "tissue paper construction work." Finally one of the most pertinent examples of inefficiency is that, after the city brought to its doors the aqueduct water at a cost of $25,000,000 to $40,000,000, there is now no distributing system, and the city is carrying a charge of $1,500,000 to $2,000,000 annually, because no plans for distribution were made.

The hasty reader is reminded that the quoted charges are not endorsed by the editors of this journal. Upon the truth and justice of these charges we take no stand—the evidence does not warrant final judgment. One fact persists, which is that a great and widely advertised engineering work is being knocked about in a manner detrimental to the interests of engineering. If these charges are true they spring from a condition which will tend to discredit all large municipal engineering enterprises in the West. The cities of the coast cannot afford to have such a great constructive work unjustly discredited in a sister city, nor can the engineers of the country remain indifferent to such severe charges against members of the profession. The full truth regarding the Los Angeles Aqueduct as a municipal enterprise and as an engineering work should be established. We therefore urge that a commission of engineers be appointed to establish once and for all the truth or falsity of such charges. If the City Council does not act in this matter we think the engineering societies of the country should interest themselves in making or in having made such an investigation as we suggest.

Practical Politics and State Highway Commissions: Governor Whitman's Message to the New York Legislature.

The creation of a commission of three men appointed by the governor with the consent of the state senate to supervise road construction work in New York is recommended by Governor Whitman in his first message to the Legislature. The first three commissioners are to be appointed for terms of two, four and six years respectively, the full term thereafter to be six years. It is further recommended that not more than two members shall be of the same political party and that one of the commissioners shall be an engineer. A bill embodying these recommendations has been introduced in the legislature.

Governor Whitman bases his recommendations upon a study of the history of the New York State Highway Department and a frank admission as to the necessity of considering politics in the administration of state roadwork. Summarizing the history of the commission he states that it started under the supervision of the state engineer and surveyor. Under the administration of Governor Hughes a commission similar to the one recommended was appointed. This commission accomplished much work of a pioneer nature and developed an efficient corps of trained engineers. With the following change in administration the personnel of the commission was modified in order to secure control of the large force of employees and to develop a partisan machine. Scandal resulting from this change brought about the appointment of a single commissioner but had no effect on the use of the department for political purposes.

The governor believes that by appointing commissioners with overlapping terms of office the political party in power would have the opportunity of placing a representative on the commission but would not be able to change the entire personnel of the working force. He believes the administration of the state road department is a business enterprise that is susceptible to economical management if its use as a political machine is abandoned. That with the large number of men employed under one central management the temptation to further political ends by securing control of the management is great, and that this danger must be recognized and guarded against.

That the governor's recommendation is theoretically a good one needs no comment. The experience of New York has been of profit to other states in working out their plans for the supervision of highway work. In Ohio, Wisconsin, Illinois, Michigan, Iowa and Kentucky the employment of large numbers of men under one management has been avoided by the development of the county engineer system of supervision of road construction and maintenance under the general supervision of a small but efficient state organization. The absence of any effect of politics upon the economy of construction work actually accomplished in the states named is noteworthy.

The Importance of Full Knowledge of Water Distribution Systems.

The failure of the average American city to keep accurate records relating to the physical features of water distribution systems is most conspicuous. This failure while probably more common to the smaller cities is also the rule rather than the exception, in cities of the first and second magnitudes. Thus the city of Philadelphia is now engaged in the relocation and mapping of the uncharted portions of its water distribution system. An article in the water works section of this issue describes the procedure being employed and formulates general principles to govern the making of such investigations and the recording of the data collected.

It may be surprising to some to learn that in a city the size of Philadelphia "mind" records have so long been employed to piece out the incomplete records in black and white. We venture the opinion that the same state of affairs is practically universal. That it should not be so all progressive water superintendents will admit.

The importance of providing adequate records capable of but one interpretation by any properly qualified individual cannot be disputed. Water superintendents who aspire to efficient management should make the preparation of such records one of their first concerns; it is logically the first step in good management. Not only are records held in the minds of old employes likely to be faulty but they give the services of such employes an artificial and fictitious value. In many water departments men are retained on the payroll because of their supposed knowledge of the unrecorded portions of the distribution system. Thus a premium is put on the retention by an individual of knowledge which should be public property. Many water superintendents, of purely political origin, consider themselves expert in water works management after they have gained, from covert peeps into these "mind" records, a fairly accurate knowledge of the location and function of the various pipe lines, valves and other appurtenances. The truth is, of course, that the elemental knowledge thus laboriously extracted should be at once available in the form of properly prepared records to the new man taking charge of the department. He would then be free to consider improvements, with an accurate knowledge of existing works as a starting point.

DRAINAGE AND IRRIGATION

Irrigation by Pumping at Del Rio, Texas—Detailed Description of Plant With Special Reference to Design and Operation of First Large American Humphrey Gas Explosion Pump.

In reporting upon the project to irrigate certain lands in Texas, owned by the G. Bedell Moore Estate, extending along the Rio Grande from Del Rio to within ten miles of Eagle Pass, the consulting engineer, Mr. Alexander Potter of New York City, had to decide between a gravity system involving the construction of a supply canal some sixteen miles long to water about 12,000 acres of land, and a pumping project to irrigate at once about 6,700 acres and to be extended to meet the needs of the Estate. The present article considers the economic aspects of the two projects and relates in detail to the second project which was the one adopted. The article also describes in detail the 66 in. Humphrey gas pump designed for this service which is the first large American Humphrey pump to be constructed. Our information is from the plans and report prepared by Mr. Potter and from descriptive matter and photographs supplied by Mr. C. C. Trump of the Humphrey Gas Pump Co. of Syracuse, N. Y.

The tentative plans and report prepared by Whiteaker & Washington, of San Antonio, Texas, showed that the supply canal of the gravity project could be constructed for about $300,000, and that the annual expense for fixed charges, maintenance and operation would be in the neighborhood of $40,000 irrespective of the use made of the canal. On the other hand, it has been found that the pumping project as outlined in Mr. Potter's report can be built for $60,000 and will entail an annual expense for fixed charges and depreciation, of $6,000, and for maintenance and operation, based on pumping yearly 20,100 acre-feet, sufficient to cover the tract to be irrigated to a depth of 3 ft., $7,700. As the pumping project appears so much more attractive financially than the gravity project, the engineer recommended its adoption.

TYPES OF PUMPING INSTALLATIONS INVESTIGATED.

To perform the work of pumping, two principal types of installation were considered;

namely, centrifugal pumps driven by internal combustion engines, and a Humphrey gas pump. The decision of the type to be used was influenced to a very great extent by the kind of fuel that can be obtained at the pumping station. As the intake for the pumping station is located 15 miles by road from Del Rio, the nearest railroad station, the transportation of fuel is an important factor. It has been found that Eagle Pass bituminous coal can be delivered at the site for about $4 per ton and that fuel oil will cost in the neighborhood of $2 per barrel. As much of the land to be irrigated is covered with mesquite wood and will have to be cleared, the use of this mesquite wood for fuel makes a rather attractive proposition and the possibility of its use as a fuel was investigated with satisfactory results.

Table I is a comparative statement of the fuel consumption of the various economical types of pumping engines investigated.

TABLE I.—COMPARATIVE STATEMENT OF FUEL CONSUMPTION OF THE VARIOUS ECONOMICAL TYPES OF PUMPING ENGINES INVESTIGATED.

(Capacity of Plant, 67 cu. ft. per sec.; lift, 37 ft.)

Type of installation.	Fuel.	Fuel consumption, 24 hrs.	Fuel cost per acre ft. (lift 37 ft.)
Humphrey gas pump	Wood	8.83 cords	$0.100
Humphrey gas pump	Bitum. coal	4.80 tons	0.145
Centrifugal pump and Diesel engine	Fuel oil.	14.00 bbls.	0.211
Centrifugal pump and gas engine operated on producer gas	Wood.	11.35 cords	0.128
Centrifugal pump and gas engine operated on producer gas	Bitum. coal.	6.13 tons	0.185

Table I is based on the following assumptions:

Thermal efficiency of Humphrey pump (overall pumping hp.), 20%.

Thermal efficiency of gas engine (brake hp.), 24% + pump = 16%.

Thermal efficiency of Diesel engine (brake hp.), 32% + pump = 21%.

Thermal efficiency of producer, lignite fuel, 75%.

Thermal efficiency of producer, wood fuel, 65%.

Mechanical efficiency of centrifugal pump, 65%.

Eagle Pass bitum. coal, $4.00 per ton, 12,000 B.t.u. per lb.

Mesquite wood, $1.50 per cord of 2,500 lbs., 6,000 B.t.u. per lb.

Fuel oil, $2.00 per bbl. of 335 lbs., 18,000 B.t.u. per lb.

In view of the low cost of fuel consumption of the Humphrey gas pump, together with the advantage of low cost of installation and maintenance, the engineer studied the European installations of this type, including that at Chingford near London and the immense Mex (Egypt) plant, which would be now under construction but for the war. As a result of these investigations in Europe and the very satisfactory test made on mesquite fuel in the Akerlund type of gas producer, a Humphrey Gas Pump and Akerlund Gas Producer were recommended.

DESCRIPTION OF PROPOSED PUMPING STATION.

The pumping station as shown in Fig. 1 is located directly upon the banks of the Rio Grande at a point where a rock ledge extends entirely across the river. This rock ledge creates a slight fall in the river and will satisfactorily serve the purpose of a diversion weir. A forebay is to be excavated in the bed of the river adjacent to the pumping station, just above the rock ledge. At the downstream end the forebay is to be closed by a small concrete dam. In this dam is placed a 66-in. circular sluice way which can be closed by a 66-in. butterfly valve. Normally, this valve, which can be operated from the interior of the pump pit, is to be kept open so as to keep the forebay free of silt deposits. The intake to the pumping station is 5 ft. in diameter. At its outer end it is protected by a screen inclined at a slope of one vertical to three horizontal. With such a flat slope it is assumed that no trouble will be experienced in keeping the screen free of floating debris as this will have a tendency, because of the flat slope, to work upward and gradually clear itself. The essential details of the pumping station are shown in Fig. 2.

HUMPHREY GAS PUMP.

The Humphrey gas pump recommended is made under Humphrey and Smyth patents and is guaranteed by the Humphrey Gas Pump Company, of Syracuse, N. Y., to pump not less than 28,000 gals. per minute against a static head of 37 ft. The engineer has every reason to believe that the pump will deliver in the neighborhood of 30,000 gals. per minute, and all structures have been designed accordingly. The thermal efficiency of the pump is guaranteed by the manufacturer to be not less than 20 per cent when using producer gas having a heat value of not less than 100 B. T. U.'s per cubic foot. Both the pump cylinder and the play pipe are 66 ins. in diameter. The total length of the play pipe is approximately 100 ft.

PUMPING PLANT.

The pump is housed in a reinforced concrete well 28 ft. in diameter and 34 ft. deep, see Fig. 2. This well is constructed entirely of reinforced concrete and is designed to resist the full hydrostatic pressure of the flood waters. The operating floor is placed 3 ft. above the lowest river level, which is maintained at low stages by the rock ledge extending across the river at this point. The water level in the pump well is maintained at a constant elevation irrespective of the water level in the river by means of a hydraulically operated gate valve. This gate valve is to be operated by the pressure obtained from an elevated tank which supplies water to the producer.

A gas holder is placed in the gas main conveying the gas from the producer to the pump, and a receiver forms the section of gas main where it passes down the well wall. This consists of a tank 3 ft. 6 in. x 25 ft. designed to resist an internal pressure of 100 lbs. per square inch. Such a receiver is far safer than a gas bag as in case of back fire due to carelessness in blowing out the gas pipes no injury can be done.

Adequate provisions are made for ventilating the pump pit. The top of the conical roof of the superstructure is provided for the purpose with a 36 in. ventilating cowl of the exhaust type. Fresh air is admitted to the pump pit at the level of the operating floor through a 24-in. pipe, the top of which is provided with a ventilator designed to force air into the pit under the action of the wind. At the point where this ventilating pipe enters the pump pit, an 18-in. electrically driven blower is to be erected so that fresh air can be forced mechanically into the pump pit whenever the wind velocity is too slight to secure sufficient ventilation automatically.

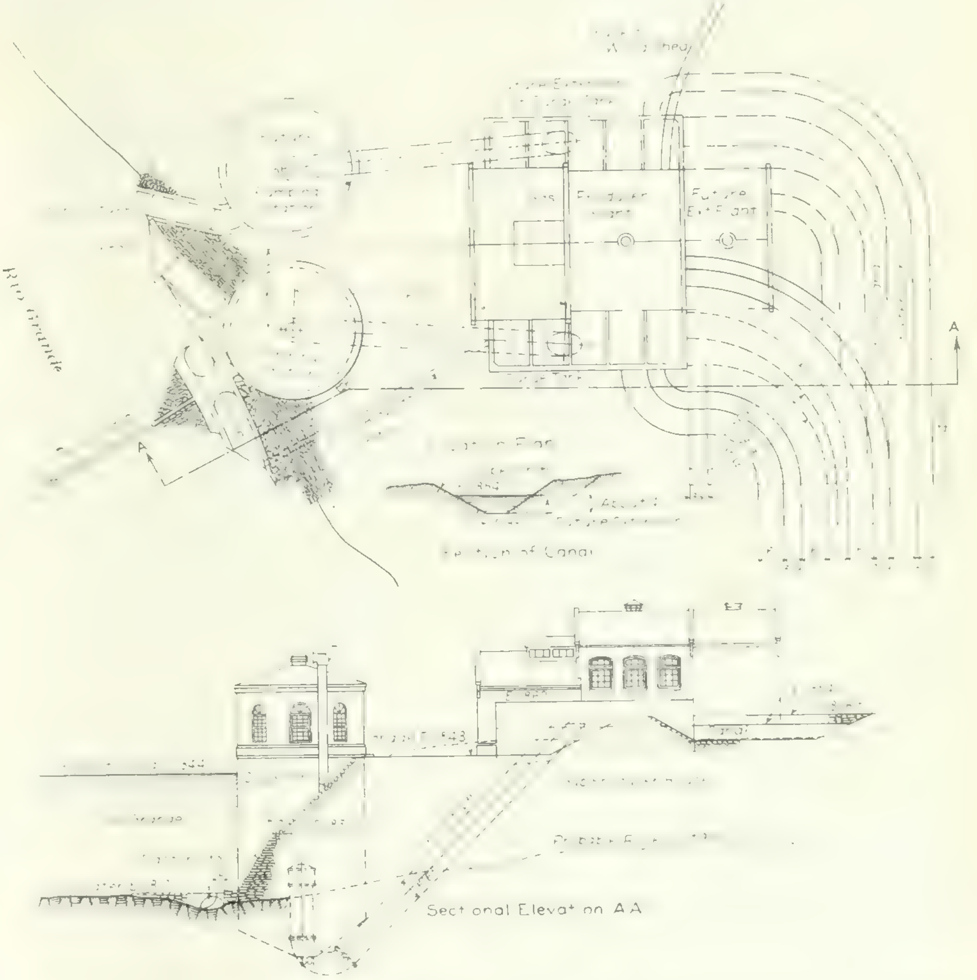

Fig. 1. General Plan and Sections of Pumping Station and Headworks, Moore Irrigation Project, Del Rio, Texas.

SURGE TANK.

The play pipe discharges into the surge tank shown in Fig. 1. This surge tank is 36 ft. long and 12 ft. wide and is constructed entirely of reinforced concrete, as shown in Fig. 3. The discharge pipe extends 9 ins. above the normal water level in the canal. The guaranteed lift of the pump is fixed at 37 ft. This is not sufficient to irrigate a tract some 500 acres in extent in the immediate vicinity of the pumping station. To irrigate this land it is intended to take advantage of the wave action in the surge tank and raise thereby a small quantity of water 4 or 5 ft. above the elevation of the water in the supply canal. The arrangement to be used for this purpose is shown in Fig. 3. The surge tank is also designed to act as a grit chamber, the grit to be washed into the river through an 18-in. cast iron pipe.

OPERATION OF PUMP.

The operation of the pump is similar to the four-stroke Otto Cycle with the exception that in the Humphrey gas pump there is complete expansion, whereas in the Otto Cycle the exhaust losses are considerable, the exhaust taking place under a 45-lb. back pressure.

To start the pump, the proper mixture of air and gas is forced into a cylinder by a small air compressor of the two cylinder type, one cylinder pumping air and the other pumping gas. A compressor of this type is essential for safety in order that there may be no explosive mixture in the air compressor. The compressor is driven by a gas engine operated on gasoline.

Two separate systems of ignition are furnished, one consisting of special spark plugs operated from storage batteries and the other from an electric generator.

To start the pump, after the proper mixture of air and gas is forced into the cylinder by the compressor mentioned, the charge is fired by an electric spark, all the valves being shut at the instant when the explosion occurs. The charge of gas and air is exploded directly over the surface of the water, no piston or moving parts being used. The increase in pressure resulting from the explosion, all valves being closed, drives the water in the pump head downwards and sets the whole column of water in the play pipe in motion. This column of water attains kinetic energy during the period when work is being done upon it by the expanding gases. By the time the gases resulting from the explosion have expanded to atmospheric pressure, the water in the play pipe is moving at a very high velocity. As the motion of this column of water cannot be suddenly arrested the pressure in the explosion chamber falls below atmospheric pressure. When this takes place both the scavenging and water valves open. A certain amount of water enters through the suction valves, most of which follows the moving column in the play pipe and the rest rises in the explosion chamber. To assist the scavenging action a certain amount of air is admitted to the explosion chamber to mix with the spent gases. Most of the kinetic energy in the moving column is expended in forcing water into the surge tank. As soon as the column of water in the play pipe comes to rest, it starts to move back towards the pump and gains in velocity until the water reaches the level of the exhaust valves which are shut by impact. A certain quantity of the burned products mixed with the scavenging air is now imprisoned in the cushioned space and the kinetic energy of the moving column is expended in compressing this gas cushion to a very much greater pressure than due to the static pumping head. As a result of the energy stored up in the entrapped compressed gases, the column of water is again forced outward. The pressure in the gas head is again reduced to atmospheric pressure and below, at which a fresh charge of gas and air is drawn into the explosion chamber. Again the column of water returns under the pressure in the play pipe, compresses the charge of gas and air which is then ignited to start a fresh cycle of operation.

The period of cycle of the pump is determined primarily by the length of the reciprocating column of water in the play pipe. The reciprocating motion of this water is similar to the swing of the pendulum of a clock, and its period of vibration is governed in the same way by the length of the water column as the period of swing of the clock is determined by the length of the pendulum. As a general rule, assuming the column to be of uniform section, the period of vibration is almost proportional to the square root of the length of the water column. The Del Rio pump will average about twelve complete cycles per minute.

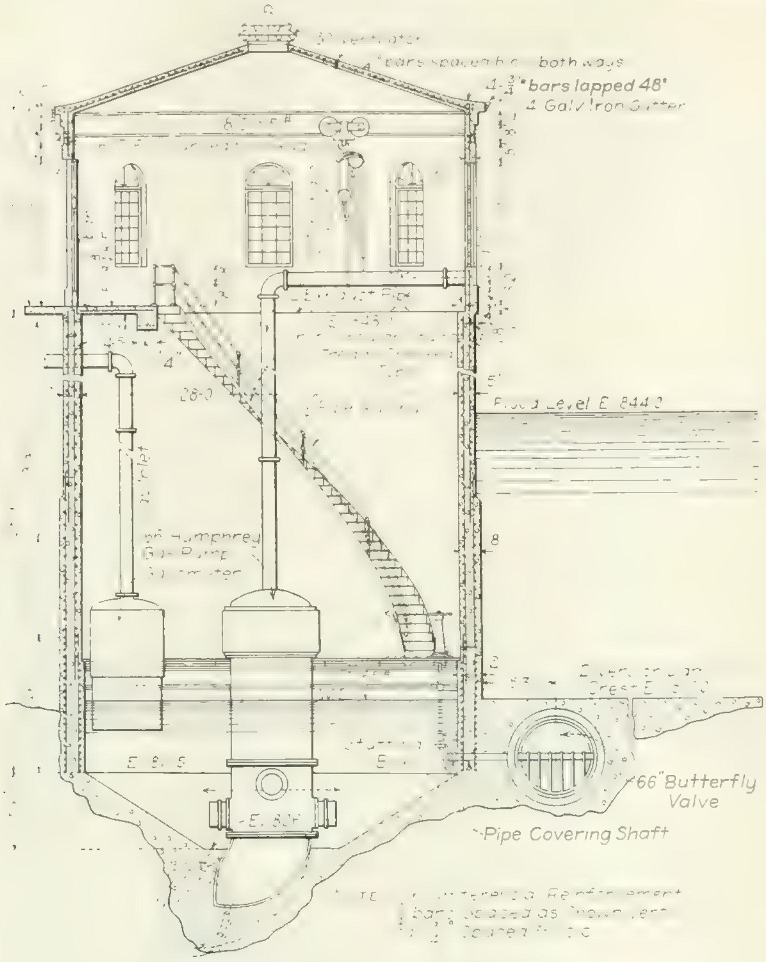

Fig. 2. Vertical Section Through Irrigation Pumping Station for G. Bedell Moore Estate.

HIGH THERMAL EFFICIENCY OF HUMPHREY GAS PUMP.

The thermal efficiency of the pump, as mentioned, is guaranteed to be not less than 20 per cent. This appears to be very conservative in view of the fact that the official tests made on the five Humphrey pumps at Chingford show that the large pumps possess a thermal efficiency ranging from 22.19 to 24.07 per cent. The small unit at Chingford showed up still better as it had an average thermal efficiency of 26.36 per cent. Table II is a summary of the results of the 30 official tests made on the five Chingford pumps.

GAS PRODUCER PLANT.

The gas producer plant will be located adjacent to the surge tank, as shown upon the general plan, Fig. 1. The producer system to be used is that of the Standard Gas Power Co., of New York City. It comprises a vertical down-draft generator with a water pan on top and a vapor ring around the combustion belt; air is admitted to the vapor ring and the mixture of air and steam enters the fuel chamber above the green charge. The gas is let in in succession through a spray-cooler, wet-scrubber, exhauster, dry purifier

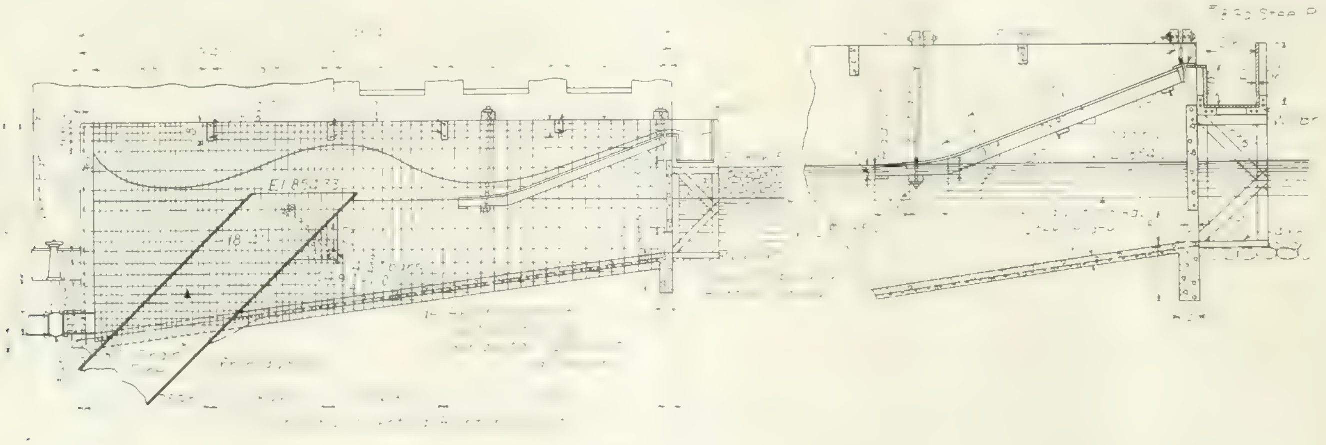

Fig. 3. Details of Surge Tank, Moore Irrigation Project.

and a delivery pipe. The outside dimensions of the generator are 10 ft. 2 ins.x11 ft. 6 ins.

The producer, when using moderately dry mesquite wood, will have a capacity per hour of 5,000,000 B. T. U. generated in the form of gas. The minimum heat value of the gas per cubic foot is guaranteed at 100 B. T. U., the quality of the gas not to vary more than ten per cent. from the average. These quantities are based on the results obtained at a test with mesquite wood made by the Standard Gas Power Co. at their Jersey City plant with a similar type of producer. This mesquite wood was cut just prior to shipment and the test was made soon after its arrival in Jersey City.

The results were even better than anticipated, and were as follows:

Average quantity of wood gasified per hr., lbs.	135
Average quantity of gas generated per hr. cu. ft.	23,850
Average heat value per cu. ft. of gas. U. S. S., B.t.u.	114.5
Average quantity of wood per hp.-hr., lbs.	1.76
B.t.u. per lb. of wood	7,000 to 8,000
Net thermal efficiency of producer	75 to 85%

The use of mesquite wood as a fuel makes a very attractive proposition. First, large areas of the land that is to be irrigated are covered with mesquite wood which will have to be cleared away preliminary to irrigation. Second, the tests made show that mesquite wood compares most favorably with other hard wood fuels and is especially well adapted for gas making. Third, the ashes resulting from the burning of mesquite wood in the producer are a very valuable by-product as they can be used as a fertilizer on the lands to be irrigated. The commercial value of such hard wood ashes as fertilizer ranges between $15 and $20 per net ton.

ECONOMY OF PUMPING PROJECT.

The estimated cost of constructing the pumping station, including head works, forebay, diversion dam and surge tank, is $60,000, of which amount the machinery, including the producer, represents approximately 50 per cent. The annual cost of maintaining and operating this pumping station, including fixed charges and depreciation, is $13,606. This amount is based upon irrigating the entire tract of 6,700 acres to a depth of 3 ft., corresponding to a fuel cost of 30 cts. per acre irrigated and a gross charge of $2.06 for all fixed charges and maintenance, including fuel.

The gravity project, on the other hand, involves an immediate expenditure of $300,000 and a yearly expenditure for fixed charges, maintenance and operation, of $40,000. As the gravity canal would irrigate some 12,000 acres, this would place the gross charge per acre at $3.33.

The pumping project will show up still better than the gravity project during the development period. For instance, assuming one-quarter of the land in each project to be under irrigation, the gross charge under the pumping project would be $6.79 per acre, and under the gravity project, $13.35 per acre. This would be decreased to $4.62 and $6.68, respectively, when one-half of the land in each project is under irrigation.

DETAILS OF PUMP DESIGN AND OPERATION.

The design of the 66-in. Humphrey gas pump differs from the English design in several important details. The requirements of American pumping engine practice, as well as the experience with the Humphrey pump abroad, have made it advisable to simplify the construction in every possible way. Further, the opportunity to standardize the working parts to fit a line of pumps of different sizes has been seized and wherever possible, as especially in the case of the water valves, that type of construction has been adopted which has stood the test in long years of actual service. The aim has been to combine high economy with the American requisites of simplicity, reliability, durability and low cost of maintenance.

TABLE II. SUMMARY OF RESULTS OF 30 PUMP TESTS MADE ON FIVE HUMPHREY PUMPS AT CHINGFORD.

Pump No.	1	2	3	4	5
No. of tests	6	6	6	6	6
Average duration of tests, mins	9.27	8.95	8.37	9.67	10.0
Lift, in feet	30.01	30.24	30.06	32.6	30.24
Water pumped, gals. per min	40,088	39,327	39,656	39,196	21,739
Water horsepower developed	303.9	300.4	301.1	322.7	166.0
Gas used per min. at 60° F. and 30 ins. mercury, cu. ft.	395.4	393.3	391.5	400.1	191.6
Calorific (lower) value of gas, B.t.u. cu. ft.	145.7	146.4	146.2	142.2	138.1
Average thermal efficiency, per cent	22.39	22.19	22.33	24.07	26.63
Anthracite used per water hp.-hr., lbs.	.946	.957	.949	.881	.796

The combination of explosion cylinder valves and play pipe which forms the pump takes the shape of a short legged V, the play pipe extending up the bank of the Rio Grande at 45° from a two part 135° bend upon which the water valves and power cylinder are set. The upper end of the play pipe is held in a reinforced concrete surge tank, while the lower end and bend is imbedded in the bottom of the concrete pump well.

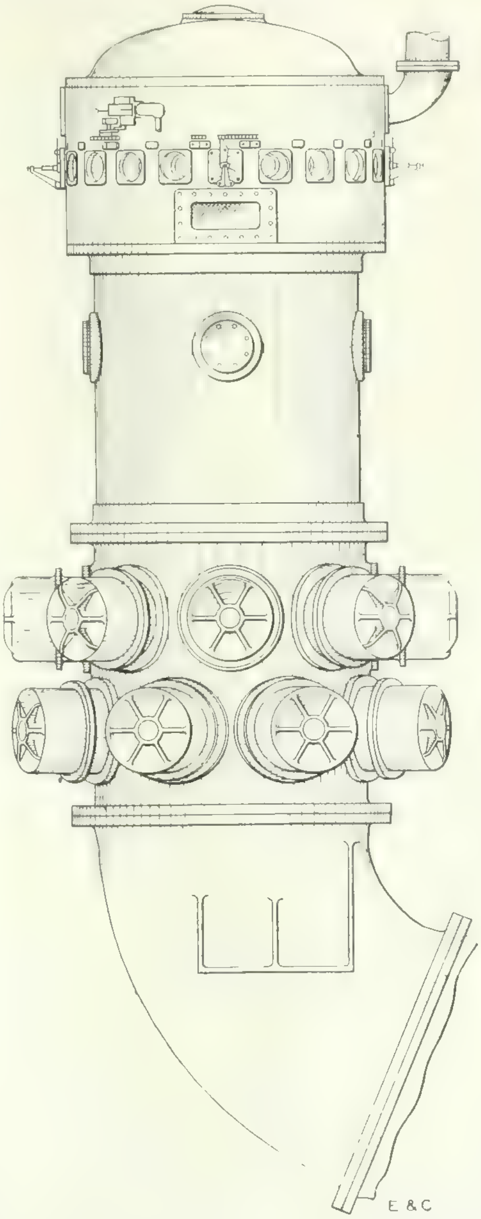

Fig. 4. Assembly Drawing of 66-in. Humphrey Gas Pump for Moore Irrigation Project, Del Rio, Texas.

The major parts of the unit are of steel; the straight parts of play pipe and cylinder are of plate with welded or riveted joints. The more intricate parts, such as cylinder head, belt for gas valves, box for water intake valves, and the two bends are unusually large steel castings. For smaller parts, such as valve cages, a special cast iron, known as "semi-steel," is used simply for convenience and time saving in manufacture. Working parts subject to corrosion from actual contact with water, such as valves and their seats, are made from manganese bronze.

Play Pipe.—The delivery, having a total length in its straight part of 73.5 ft. is made in three parts for convenience of transportation and economical distribution of metal. The two rings farthest from the power cylinder, where the pressures are low, are made of 5/16-in. plate, with a tensile strength of 60,000 lbs. per square inch. The other eight rings are each thicker than the one before by 1/16-in. until the one nearest the bend has a thickness of ⅞-in. All the seams are riveted butt joints with outside straps and heads countersunk inside the pipe.

Bend.—The 135° bend between the play pipe and cylinder is made of two steel castings bolted together, for convenience in handling and transportation. The two 67.5° parts are identical except that the tenons are reversed. Even the foundation brackets remain in the same position on the pattern, those on the upper part serving to support the water intake valves and cylinder when the pump is set on the foundations, while those on the lower part (reversed) are in proper position to take the thrust of the column of water in the play pipe.

Water Valves.—Immediately on top of the bend is set the box for water intake valves with its "hat" unit construction. The box itself is a steel casting weighing some 13,000 lbs. It has openings for 16 "hats" or cages, containing 25 valves each, or a total of 400 for the pump. This box is shown in Fig. 5. The valve cages are semi-steel castings into which the valve seats of manganese bronze are forced with a taper fit of 1 in. to the foot. The box is no heavier than the corresponding valve chambers of any pumping engine of equal capacity, and it gives a good impression of the large size of the machine.

The water valves themselves are of a standard type, according to the Freeman specifications of the Associated Factory Mutual Fire Insurance Companies.

This valve differs from the Standard Underwriter valve in that it is 5 ins. in diameter, the largest standard valve being 4 ins. The larger valve is permissible in view of the slower speed and more gradual closing of the water valves. The use of the plain rubber or fibre disc, rigid center stem, large spring and self-retained guard make it a reliable and convenient valve. The valve discs on the Del Rio pump, because of sand in the river water, will be of a composition which has given satisfaction in water works service under similar conditions. Every feature of the entire water valve construction has been tested in years of service on all kinds of pumping engines. Its adaptability to the Humphrey pump has been proved by experiments during three years' actual operation.

Power Cylinder.—The cylinder, which is placed just above the water valve box, forms part of the combustion chamber. It is, in this case, a piece of riveted pipe, 66 ins. inside diameter and 89 ins. long. The plate is 15/16 ins. thick with triple riveted butt strap joints inside and out. The rivets are 1 3/16 ins. in diameter with the heads inside the pipe countersunk. The flanges are of cast steel riveted on, drilled for 44 2¼-in. bolts.

Supply and Exhaust Valves.—The belt for gas valves carries the important working parts of the pumping engine. A view of the gas belt is shown in Fig. 6. The belt itself is a steel casting weighing about 9,500 lbs. It forms a double walled section of the 66-in. cylinder, through which openings are provided for valves for the inlet of gas and air mixtures and the exhaust of products of combustion. These openings are 20 in number, all at one level; 12 are for exhaust and 8 for mixture valves. In order to have an even distribution of flow of gases into and out of the cylinder, these openings are arranged in groups of two for mixture and three for exhaust, separated by a dividing wall which runs over exhaust valves and under mixture valves, around the annular space between the outer and inner walls of the belt itself. Thus the belt is divided into an upper chamber provided with a rectangular opening, to which the gas pipe is connected, and a lower chamber with two larger similar openings faced and studded for attaching two non-return valves and the exhaust pipes. The exhaust gases are led downward to allow any water carried with them to drain off. Drain pipes for this purpose are in the bottom of the non-return valve casings.

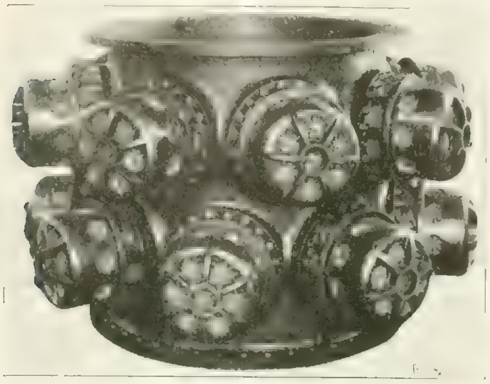

Fig. 5. View of 66-in. Box for Water Inlet Valves with Valve Cages Assembled, 66-in. Humphrey Pump.

The non-return valve, seat and casing comprise three parts. The seats are iron castings fastened to the belt openings with studs. The brass swing check valves themselves are pivoted at the center and hung from hinge bolts carried in the upper corner of the casings. These are cast iron and are bolted to the flanges of the seat castings. The exhaust pipes are led vertically upward from a round opening in the top of each non-return valve casing.

Each mixture valve cage is assembled as a unit, as shown in Fig. 7. It comprises a double, flat faced bronze valve of the mushroom type with a 1-in. tubular stem expanded into the valve head casting and fastened with a driven taper plug. The tubular stem is recognized construction for large air compressors where the valves work horizontally, and is light and durable. The outer end of the valve stem is threaded inside for a locking nut or head, which is fastened by an expanding bolt acting inside the quarter-threaded projection. The seat on which the valve works is also double faced, two concentric openings being provided of equivalent area. The inner one is for air drawn from the atmosphere directly through the cage cover around the valve stem. The outer one takes gas directly from the upper chamber of the belt. This arrangement keeps any tar or other impurities which may be carried in the gas, as far as possible away from the moving stem. The seat casting is of bronze and fits into the opening through the inner wall of the gas valve belt, while it is carried in a cast iron cage which is bolted into the corresponding openings in the outer wall.

Four studs through the corners of the cage cover serve to hold the entire mixture valve unit in place and allow its removal without disturbing any connections whatever. On this cover is carried the locking lever, hung on a pivot stud, set at such an angle as to allow the hooked end to wedge under the stem head and lock the valve tight. This feature alone on a small pump was found to reduce the gas consumption by several per cent. These locking levers are so shaped that they hang in position to lock the valve and no spring is required. Their upper end is button-shaped to engage with a lug on the interlocking chain which displaces them to unlock the valve. The spring which closes the mixture valve is of close wound tension helical form and is adjustable by means of a screw held in a cast iron bracket bolted to the cage at its lower edge. This bracket also retains a throttle plate with pie shaped openings corresponding to those in the cage cover, whereby the supply of air to be mixed with the gas may be controlled. A set screw through the spring bracket to hold the adjustment when once made completes the unit.

Paper, copper or asbestos packing can be used under the inner joint of the valve seat with the cylinder wall. The outer joint is made under the cage cover by a round packing of gutta percha or rubber squeezed into a corner by a conical bevel so that the endwise distances need not be too exact.

The exhaust valve cage unit is interchangeable with that for mixture and differs from it in only a few details, as shown in Fig. 7. The valve is of the same mushroom shape as the mixture valve, except in having only one flat face as its outer circumference. This makes it lighter in weight, which is of special advantage since the exhaust valve is closed suddenly by the rising water in the cylinder. The valve also is opened by the outside spring and much depends upon getting it open immediately at the end of the expansion to atmospheric pressure to secure a full volume of scavenging air by the subsequent suction. This air is drawn in through the exhaust valve cage directly. A spring closed scavenging valve which has its seat against the inside of the exhaust cage cover prevents the products of combustion from escaping into the air, and the non-return valves between the belt and the exhaust line keep the exhausted gases from returning into the cylinder instead of the fresh air.

The exhaust seat is a bronze casting similar to that for the mixture valve, but without the concentric walls necessary to divide gas from air passages. The full length steam guide is used as a rider for the scavenge valve and the four ribs hold its Tobin bronze spring in place. The cast iron cage is from the same pattern but finished for the scavenging valve seat and not for any throttle plate. The locking lever is simply reversed in angle of pivoting and locks the valve in the opposite direction. The spring bracket is the same except for the adjusting screw which is designed to guide a larger open coiled compression spring. Thus the unit construction of the gas valves gives the cylinder a workmanlike appearance, and the advantages of having to carry only one complete valve assembly as a spare for each kind of valve are obvious.

Valve Interlocking.—Upon the interlocking mechanism depends the entire possibility of the four stroke cycle. As will be remembered from former descriptions of the Humphrey pump, the operation, briefly, is as follows:

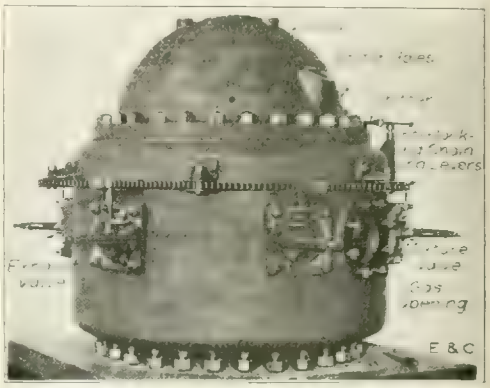

Fig. 6. View of 30-in. Gas Belt for Humphrey Pump, Showing Interlocking Mechanism of Valves for Mixture and Exhaust.

A charge of gas and air is exploded in the power cylinder above the water column which forms the working piston. The water is driven downward, the water valves are closed and the liquid in the whole play pipe is set in motion. Inertia of the water column permits expansion of the exploded charge to below atmospheric pressure when first the scavenging, exhaust and water valves open. A return surge of the play pipe column follows, and near its end the exhaust valves are closed by impact of water. A second forward surge is set up by the trapped and compressed gases and, when the pressure falls below atmospheric, a fresh charge of gas and air is drawn in. Finally this is compressed by the second return surge and exploded, whereupon the cycle repeats.

From the foregoing it is seen that it is necessary to lock the mixture valves and unlock the exhaust valves during the expansion following the power stroke, and to lock the exhaust valves and unlock the mixture valves during the charging stroke. This is accomplished by a sprocket roller chain stretched around the belt above the gas valves and carrying lugs which engage the locking levers of the exhaust valves in one direction and the levers of the mixture valves in the other direction. With each explosion the chain and lugs are moved against the upper ends of the exhaust valve lock levers, but the valves do not open until the pressure is below atmospheric. On the following "cushion" the chain

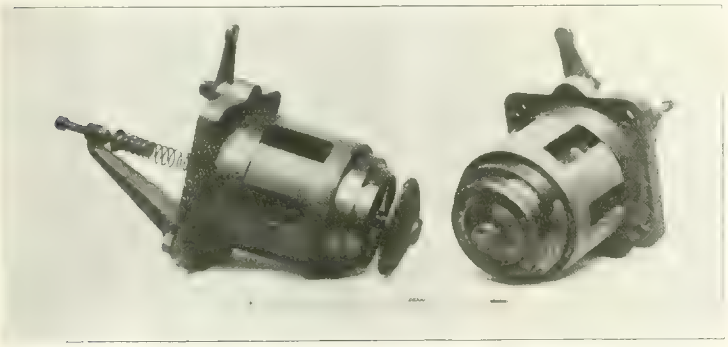

Fig. 7. View of 5-in. Exhaust (Left) and Mixture (Right) Valves Assembled in Cages Standard for Pumping Engines from 24 to 72 ins. in Diameter.

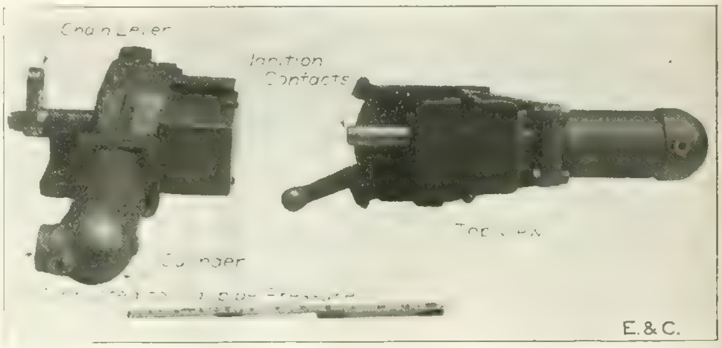

Fig. 8. Views of $2\frac{1}{2}$-in. Shifter for Interlocking Mixture and Exhaust Valves and Timing Ignition (Electric) for Humphrey Gas Pump.

is moved in the opposite direction which disengages the exhaust valve levers and allows the valves to be locked by gravity, and engages the mixture valve lock levers, moving them to unlock position from the gravity lock previously assumed.

The chain is moved by two small hydraulic engines called "shifters," two views of one shifter being shown in Fig. 8. Each consists of a spring loaded horizontal piston in a single acting cylinder of 2½-in. diameter connected with the play pipe pressures. It is seen that a spring placed between piston rod spearhead and chain control lever causes the spearhead to engage upper and lower studs on the chain lever, securing the reverse motions desired. The chain lever of the shifter is connected directly through a shaft. All working parts of the shifter are bronze.

Ignition.—The shifters also serve to actuate the timers, or contact makers, for the electrical ignition system. Contact is made only near the end of compression and the exact timing and duration may be varied to produce the correct effect upon combustion.

The whole ignition system is one of the most important details, and to secure complete reliability under the peculiar conditions was a difficult task. The presence of water in the combustion chamber precluded everything but electric ignition and high power jump spark systems are employed.

In the jump spark system a special spark plug was required, incapable of being short circuited by water. Two powerful ignition systems are provided for each pump, and there is in addition a set of the conventional automobile plugs, spark coils and storage batteries for hand firing of the initial charge in starting.

All of the spark plugs for these several ignition systems are placed in the cylinder head; a steel casting of a flattened dome shape. The induction coils, or transformers, are fastened as near to their respective plugs as possible to reduce the danger of leakage of high voltage discharges and are protected as far as possible from moisture.

The domed head is also pierced with numerous holes for connections to admit air and gas for starting. Starting is carried out with a two cylinder compressor, pumping air and gas in proper proportions by separate pipes to a T just outside of the dome. The first cylinder full of inflammable mixture fired will often be enough to start the column, fill the play pipe with water and set up surges strong enough to make the pump pick up its regular cycle. The ignition and valve interlocking system may be operated by hand and one of these large pumps can be put in full operation from cold condition in less than a minute.

Once started, little skilled attention is required. There are none of the heating and lubrication troubles sometimes found with big gas engines. The worst that can happen is to have the pump stop from lack of water, gas or ignition. With the means of supply for each of these duplicated, as in the Del Roi pump, this failure becomes very unlikely.

The pump was designed and the installation made under Humphrey and Smyth patents by the Humphrey Gas Pump Co., of Syracuse, N. Y. Mr. W. H. Smyth, of Beverly, California, is the inventor. He was among the first in the United States to raise water by direct explosion of fuel gas.

Design and Structural Details of Concrete Lining for Irrigation Canals.

In the United States irrigation canals are for the most part excavated in earth, and, except in a few cases, a large percentage of the water, estimated at 40 per cent of the amount taken in at the heads of the main canals, is lost by absorption and penetration along the routes. Some of this water leaking at high levels is recovered by the canals at lower levels so that it is estimated that the amount wholly lost may be 25 per cent. Loss of water in irrigation canals is due to several causes but by far the greatest loss is due to seepage. Prevention of seepage loss is best accomplished by lining the canals and of all linings tried concrete is most satisfactory and is being most used. In "Concrete Lining as Applied to Irrigation Canals" by Samuel Fortier, chief of Irrigation Investigations, U. S. Department of Agriculture, the design, structural details and methods and costs of construction of concrete lining of canals are discussed, and from this discussion we have prepared two articles, one on design and structural details which follows and one on methods and costs of construction which will appear in our issue of Feb. 24, 1915.

CARRYING CAPACITY.

Data pertaining to the carrying capacity of 18 canals were assembled and summarized. Perhaps the most important conclusion to be drawn from the 76 measurements of the 18 canals summarized is that the so-called coefficient of friction *n* is on an average larger than has usually been assumed by engineers. The results show that only in rare cases, where conditions are more or less ideal, is one justified in assuming a value as low as 0.012 for *n*. The Ridenbaugh Canal of the Nampa and Meridian irrigation district of Idaho belongs to this class. The flow in this concrete-lined canal has been measured by at least five engineers and their average result as regards the value of *n* is a trifle below 0.012. In the results assembled, one also finds a value of *n* as high as 0.0197 and five others greater than 0.018. Again, in the concrete-lined canals of southern California a coating consisting of a vegetable and mineral accumulation was found adhering to the perimeters. The effect of this coating on the flow of water is seen in the high coefficient of friction for these channels. The following approximated values for *n* may serve as a guide to those who are required to estimate, prior to construction and operation, the discharge of lined canals.

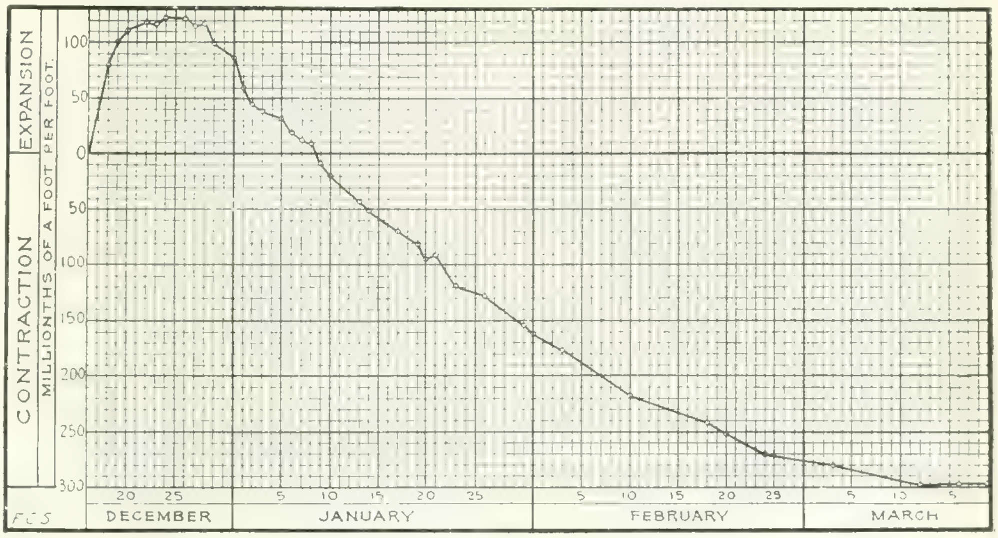

Fig. 1. Curves Showing Expansion and Contraction of Concrete from Actual Measurements Made on a 10-ft. Slab.

I. $n = 0.012$ for concrete-lined canals having a smooth sidewalk finish, clean bottom, no moss, uniform cross section, well-formed joints, long tangents, flat spiral curves, no perceptible undulations on the surface of the water, and in general the best construction and the best conditions obtainable in practice.

II. $n = 0.013$ for concrete-lined canals having conditions slightly better than those of Type III and not so good as those of Type I.

III. $n = 0.014$ for concrete-lined canals having an unplastered or rough troweled surface, clean bottom, uniform cross section, well-formed joints, medium curvature, no spirals, slight surface undulations, no aquatic vegetation, and in general good construction and favorable conditions.

IV. $n = 0.015$ for concrete-lined canals having conditions similar to those of Type III, but with greater curvature and some debris or other retarding influences.

V. $n = 0.016$ for concrete-lined canals of average workmanship and medium conditions, having a rough surface, imperfect joints, and sharp curves; also for canals of smooth lining and good workmanship, but having one or more unfavorable conditions, such as sand and gravel in the bottom or projecting joints which decrease the velocity of water.

VI. $n = 0.017$ for concrete-lined canals roughly coated, but otherwise in medium condition.

VII. $n = 0.018$ for concrete-lined canals coated as in Type VI and having the bottom more or less covered with sand and gravel, or else a clean bottom but poor alignment, irregular cross section, broken gradient, or the like.

ECONOMY OF CONCRETE LINING.

In determining the economy of concrete lining for a given canal, one has to consider and compare the cost and benefits of such work. The principal benefits to be derived from lining are briefly discussed under the following heads:

(1) *Seepage Water and Its Value.*—The possible saving in seepage losses by lining can be readily determined for canals already in use, and the portions in which this is important can be located by measurements of the discharge. In some cases the loss in short distances may be sufficient to make the lining of these desirable, although it would not be practicable to line the canal as a whole. In nearly every irrigated district of the West water which can be saved through the prevention of seepage has a value. As the demand for water increases, the value of any saving will also increase until methods of canal lining at present too expensive to be considered may become practicable. The value of the water which may be saved varies widely in the different portions of the country. On the larger systems now being constructed, water rights are being sold for from $25 to $50 per acre, and in some cases for even higher prices. Based on the final estimated cost and acreage included, the average estimated cost per acre July 1, 1910, was $48.14 for the United States Reclamation Service projects and $21.75 for the Carey Act projects. The duty of water delivered under these rights is also variable and will probably average 1 sec.-ft. to 100 acres. Inasmuch as any saving in canal seepage can be delivered to the user with small additional loss, each 0.01 sec.-ft. saved should make it possible to serve another acre. The additional expense required for such irrigation would be for the lateral system only, as the storage and diversion works would not be affected. On this basis each second-foot of water which can be saved should have a value of from $2,500 to $5,000. Allowing $750 for

the additional cost of the distributing system leaves $3,000 as a general average for the value of each second-foot saved by lining.

(2) *Increase in Carrying Capacity.*—The volume carried by a canal in earth is as a rule much less than that carried by a concrete-lined canal of the same dimensions and grade. This is due to the smoother perimeter of the latter, and its greater uniformity in cross section, alignment, and grade. The discharge of a typical canal in earth having a mean velocity of 2.5 ft. per second and a coefficient of friction (*n* in Kutter's formula) of 0.0225, may be increased from 25 to 80 per cent by lining with concrete. A gain of 25 per cent in the volume carried is readily obtained as the result of lining, but to secure a gain of 80 per cent involves the construction of first-class lining and conditions favorable to the maximum discharge of water in such channels.

(3) *Reduction of Charge for Operation and Maintenance.*—On many systems, particularly where the canal follows a side hill, much difficulty is encountered from breaks on the lower bank when the canal is crowded to its full capacity or when an opening may be made by a gopher or other burrowing animal. A concrete lining should prevent such breaks except in cases where the water overtops the bank due to stoppage or other causes. Faulty location of the canal and weak places developing later can very often be largely corrected by a good concrete lining. Where the original grade is such that scour occurs, or where excessive curvature causes cutting of the sides, a similar remedy may be used. Maintenance charges also will be materially reduced by the lessening of weed growth and the prevention of the shifting of the channel through scouring. In some systems the fall of the country is too great to be taken up by the grade of the canal and many drops are required which may form a considerable proportion of the cost and necessitate high maintenance expenses. The use of a concrete lining frequently permits a sufficiently high grade to be used so that no drops are needed, the saving in these structures paying part of the cost of the lining.

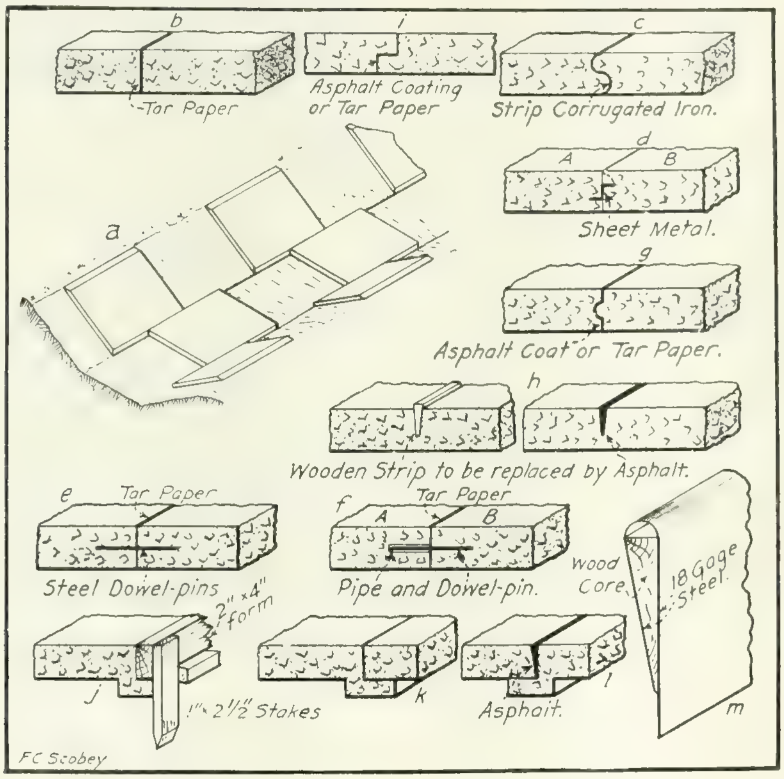

Fig. 2. Typical Joints for Concrete Lined Canals.

(4) *Insurance Against Damage to Crops.*—As the losses from the lack of water at critical times during the irrigation season are often much greater than the actual cost of repairs, a portion of the cost of any canal lining may be considered as an insurance against such accidents. An instance of this occurred on the Turlock Canal, of California, in 1910, when a break thought to have been due to a gopher hole caused 1,000 ft. of the main canal on a steep side hill to be washed out. The canal was out of service for six weeks during the period when water was most needed for crops. The actual cost of repairs was $20,000, but the estimated damage to crops was $1,000,000.

GRADES FOR LINED CANALS

In deciding upon suitable grades, cross sections, and alignment for lined canals, one has to take into account the two types of canals which are lined. One of these is represented by the canal in operation designed for earth, the other by the new canal designed for concrete lining. The grade which is suitable for a canal in earth is not the most economical grade for the same canal when lined with concrete. It is not, however, feasible to make any material change in the grade of an old canal preparatory to lining it. The irregularities can and should be removed so as to secure a uniform gradient, but more than this can not be done without changing the location.

The disclussion of suitable grades must therefore be confined to new canals intended to be lined before carrying any large percentage of their maximum capacity. Disregarding all other features and considering only the most economical method of conveying water, the steep grade with its correspondingly high mean velocity is best. The fact is now fairly well established that water can pass over a concrete surface at a high velocity without injurious effects. It is only when fast-flowing water strikes against concrete or is obstructed by it that damage is likely to result. Mr. A. P. Davis, chief engineer of the Reclamation Service, cites a case in which a concrete chute on the south canal of the Uncompahgre project, discharging 300 cu. ft. per second at a velocity of over 20 ft. per second for one year, not only showed no perceptible wear, but it had acquired a growth of slimy moss over the concrete surface subject to this velocity.

In the summer of 1913 Justin T. Kingdon made an examination of a concrete chute on the main canal of the Orland project, Orland, Cal. The canal maintains a fairly constant flow throughout the season. It was measured shortly after the observation and found to be discharging 84 sec.-ft. of water which at the bottom of the chute had a velocity of 17 ft. per second, and like the south canal of the Uncompahgre project, this concrete showed no wear on its wetted area, and the growth of slimy moss which it had acquired was especially noticeable over that portion of the surface subject to the highest velocity.

It would therefore appear that the permissible velocity in lined canals depends largely on considerations other than damage to the lining. The mention of three of these causes may serve to make this statement clear. Assuming that a concrete-lined canal will successfully withstand velocities up to 20 ft. per second, the fall necessary to produce such velocities must be considered, since the sacrifice of so much head might entail greater cost than the building of a larger canal on a lighter grade. Again, the extra cost and inconvenience in making suitable turnouts to divert water from such a canal would serve to lessen the advantages gained by having a high velocity. Lastly, pulsations are a common feature in all channels in which the water flows at a high velocity. The water surface consists of irregular waves which travel at various distances apart and an extra height of lining is required to prevent the waves from overtopping it. It is believed that a mean velocity of between 8 and 10 ft. per second is about as high as should be adopted in lined canals under ordinary conditions.

ALIGNMENT OF LINED CANALS.

In locating a new canal for concrete lining, sharp curves should be avoided if possible. The reduction of curvature in a location over a rough country with steep slopes may increase considerably the amount and the cost of excavation, but this additional expense may be more than compensated by the advantages gained in having flat curves. In flowing around curves the surface of the water tends to rise on the outer side due to centrifugal force. The height to which it will rise in any given case will depend on the velocity of the water and the sharpness of the curve. In order to maintain a uniform height of lining above the water surface of the canal, the practice has been to raise the outer lining. In the case of the Tieton main canal of the United States Reclamation Service, Yakima project, Washington, on the sharpest curves, having a radius of 57.6 ft. and a velocity of 9 ft. per second, the superelevation amounted to about 1 per cent of the width. The presence of a large number of sharp curves likewise increases the cost of both the earth trimming and the laying of the concrete.

EFFECT OF ALKALI ON CONCRETE LINING.

Throughout the West are to be found here and there instances of concrete construction having been disintegrated through the action of alkali salts. While some uncertainties remain regarding the exact nature of such action, there seems to be no question but that the principal reason for it arises from the reaction between the various alkali salts and the calcium hydroxid of the cement. The new compounds formed have a greater volume than the replaced hydroxid and their formation weakens or destroys the concrete by forcing apart the particles of cement. In order for this action to occur it is necessary for the water containing alkali to percolate into or through the concrete. Under field conditions "these reactions referred to are much retarded if not entirely suspended in most cases, due probably to the carbonization of the lime of the cement near the surface or the formation of an impervious skin or protective coating by saline deposits." It is also doubtless true that "wetting and drying or freezing and thawing will hasten the destruction of the cement by extending the cracks already started."

In experiments with oil-mixed Portland cement concrete, the concrete was dampproofed by the incorporation of semiasphaltic oil. In hand mixing, the sand, cement, and water were first mixed to a mushy consistency, the oil added and mixed until no trace of it was visible on the mortar surface, and then the broken stone or gravel was mixed in. In machine mixing the sand, cement, and water were first mixed to a mortar followed by alternate batches of stone and oil which were added and mixed. The proportion of oil used was based on a comparison of its weight to the weight of the cement used in the concrete. The results of tests show that oil-mixed mortar, containing 5 to 10 per cent of oil, is dampproof as well as waterproof, and indicate that its use may prove desirable in the construction of irrigation canal linings exposed to the action of alkali (Fig. 1).

Good practice in concrete lining construction where alkali must be reckoned with necessitates the following precautions: (1) Do not use sand, gravel, or water containing alkali. (2) Keep soil waters charged with alkali from coming into contact with the concrete by the use of suitable drainage. (3) Give careful attention to the proper proportioning of materials and use more cement than is needed to fill the voids. (4) Protect the surface by a thin plaster coat of dense mortar of granular sand. (5) Both the concrete and the mortar used for the lining may be dampproofed by the addition of 5 to 10 per cent of semiasphaltic oil when mixing the materials.

EXPANSION AND CONTRACTION OF CONCRETE.

Field Tests at Logan, Utah.—During the summer of 1913 field experiments were conducted by Prof. B. P. Fleming, of the State University of Iowa, working under the direction of this office, at Logan, Utah, for the purpose of determining the coefficient of expansion of concrete slabs. An effort was made to secure conditions as nearly as possible like those found for canal linings. It will be noted, however, that the slabs were not tested to find the effect produced by being wet on one side. The variations in length were measured with two micrometer microscopes focused upon lines in the highly polished tops of two steel pins projecting above the surface of the slab, one at each end. This device permitted making direct readings from the micrometer scale, giving measurements to 0.0008 millimeter. The thermometers used were graduated to 0.10° C. and could be estimated easily to 0.025°. All measurements of the slab length were direct, and no part of the apparatus was in contact with the slab. The idea of maintaining the latter condition was to prevent in every possible way influences which might affect the expansion of the slab. Except for a roller placed under one end, each slab was lying on ground composed mostly of loose gravel. The slabs were 12 ins. wide, 6 ins. deep, and 11 ft. long. The steel pins inserted vertically in the top were spaced 10 ft. apart, thus leaving 6 ins. length of slab beyond the pin at each end. A wet hand-mixed concrete mixture was used for each slab, numbered 1 and 2, and volumetrically proportioned 1:3:5 and 1:2:4, respectively. Each slab was of rectangular cross section throughout. The general average coefficient of expansion measured was 0.0000043 for slab 1 and 0.0000042 for slab 2.

Laboratory Tests at the State University of Iowa.—In the fall and winter of 1913-14 the experimental work initiated at Logan, Utah, was continued in the laboratory of the State University of Iowa under the same supervision as before. The sand and gravel used were taken from the bed of Iowa River. This raw material was screened through a 1-in. mesh screen and again through a ¼-in. mesh screen. The material failing to pass the latter screen was considered gravel. The sand was unscreened, but it was fine and clean. Three horizontal slabs were cast with the same dimensions as those made at Logan. The apparatus and equipment were practically the same, except that the laboratory permitted a somewhat careful control of influencing conditions not possible in the open-air work. In addition, a specially devised apparatus permitted the making of observations for change of length within 30 minutes after water had been added to the dry materials used in making the concrete. Brass pins with their upper ends highly polished were used instead of steel pins. The methods employed for temperature determination and control were quite satisfactory and it is believed gave results fully as accurate as the investigations warranted. Two slabs of seasoned concrete were used for determining the coefficient of expansion. A third one was used to determine the influence on change of length due to setting. Each slab was made of hand-mixed concrete, using the materials composing the concrete in the following proportions:

	Number of slab.		
	1	2	3
By volume:			
Cement	1	1	1
Sand	3	2	3
Gravel	5	4	5
By weight:			
Water	100	72	75
Cement	118	99	79
Sand	319	203	244
Gravel	552	441	431

The general average coefficient of expansion measured was 0.00000627 for slab 1 and 0.00000632 for slab 2. Slab 3 was kept at a temperature of about 80° F., though at times it fell to 70° and even 65° during Saturdays and Sundays. Daily observations were made early in the work, but later on observations were made only once a week. It is interesting to note (Fig. 1) the immediate and rapid expansion following pouring, lasting about one week. This caused a change of length of about 0.00012 ft. per foot. This action was doubtless due to the physical rearrangement of the particles of concrete in the process of crystallization. So far as its effect upon concrete lining for canals is concerned, if joints were not provided, it would cause severe compression of the slab as a whole for about a week or 10 days, which might cause a slight buckling and crushing. Where joints are used and filled with asphaltum or similar material the tendency would be to force some of it out of place, and for this reason the filling material should not be placed until about two weeks after the lining has been laid. It will be noted, however, that the expansion is only 0.012 ft. in 100 ft., which accounts for its effect being of no marked importance in practice.

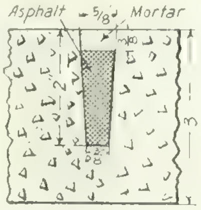

Fig. 3. Joint for Concrete Lining of Canal of Patterson Land & Water Co., California.

It will also be noted (Fig. 1) that following the expansion period in slab 3 there is a period of contraction lasting about 75 days and during which there is a total contraction at the rate of about 0.042 ft. in 100 ft., thus leaving the slab 0.03 ft. shorter for a 100-ft. length than when laid. If this factor were considered for a concrete lining, assuming that its contact with the material through which the canal were constructed would not retard the expansion, having a coefficient of expansion of 0.0000045, it would allow a total rise of temperature of about 67° F. before two adjoining slabs would be in contact after the contraction due to setting had been completed. It is evident, therefore, that if a slab were laid in the winter at a temperature of 40° F., the joints opened by contraction would not be closed until the slab had reached a temperature of 106° F. in the summer. Concrete lining is usually placed in canals during the winter or at least when the weather temperatures are cold enough for the above conditions to obtain. If the water carried in the canal is at a temperature of between 40° and 60° F., it is evident that the effect of contraction in concrete lining laid at corresponding temperatures will be most noticeable at a time when water-tightness is most desired. For this reason it is essential that some provision be made to secure water-tight joints. It may also be quite necessary to use some elastic material like tar paper to allow for expansion in excess of that which can be taken up by the space formed due to contraction in setting, for in some sections of the West temperatures are likely to be met which will cause this extra expansion, and unless a compressible material is provided buckling or crushing is very likely to occur.

In summing up the results of the experiments at Logan, Utah, and those at the State University of Iowa, it may be stated that for concrete slab construction such as canal lining, where only one side is exposed and with the other side in contact with earth, a coefficient of expansion of 0.0000045 should be used, but in the case of concrete construction where all sides are subject to equal temperatures and are not under the conditions of moisture and earth contact found in canal lining and similar construction, a coefficient of 0.0000063 can be used with safety.

JOINTS IN CONCRETE LINING.

Owing to the fact that concrete lining expands in warm weather and contracts in cold weather, joints would seem to be an essential feature of such construction. Where no provision is made for expansion and contraction by means of joints, the concrete lining is certain to be subjected to high internal stresses, which increase in intensity until the lining is ruptured. These ruptures occur at the weakest points, and following the directions of least resistance result in irregular fractures which are difficult to repair. They frequently are so small and so irregular that it is practically impossible to introduce any filler into the seams. Even when this is done the alternate opening and closing of the fracture, due to changes in temperature, lowers and in time destroys the effectiveness of such repairs.

On the other hand, joints in concrete lining constitute a weak feature. In strength, durability and water-tightness the best formed joint is inferior to the continuous lining. For these reasons, to which may be added that of extra cost, the distance between joints should be as great as possible consistent with changes in volume due to temperature and the adoption of suitable forms and proper methods of construction.

When forms are used their length is usually limited to the size and weight which can be readily shifted by hand without the aid of special equipment. Even when the forms are of the simplest kind the methods of construction commonly employed place other limitations on the distance between joints. Again, in lining curves the frequency of the joints depends upon the degree of curvature, the sharper the curve the shorter the distance between joints. Notwithstanding these limitations, the tendency in the past has been to insert too many joints, particularly on straight portions of canals.

The subject of joints in concrete lining is also closely related to the manner in which the lining is laid, whether continuously or in alternate sections. Joints which are adapted to one of these methods may be a misfit when applied to the other. In using either method it is advisable to break joints between the floor and the sides, as indicated in Fig. 2 *a*.

Kinds of Joints.—Various kinds of joints are used to prevent cracks in concrete linings:

(1) One of the most common is the plain abutting joint. This joint is simple, cheap, and easily made. Expansion, likewise, is provided for in the frequency of the joints. It has, however, several weak features which render its use questionable. One of these is the lack of any bond between the sections. Were it not for the connection with the bottom at the toe each side section might be regarded as a separate slab, liable to be thrust upward by pressure from behind or to fall backward when the earthen support is removed. Both of these effects are quite probable. Another defect is the difficulty experienced in filling the seam with any ma-

terial which will render the joint water-tight, it being too narrow to calk.

(2) The abutting joint is frequently modified by introducing one or more plies of tar paper (Fig. 2 *b*). While the paper provides for extra expansion and renders the joint impervious, it adds nothing to the bond between sections.

(3) An interlocking device (Fig. 2 *c*) consisting of a 4-in. strip of corrugated iron, was inserted in each joint of the lining of the North Side Twin Falls Canal, Idaho. If the metal strip is thickly coated with asphalt before being inserted it may prevent leaks. The device likewise secures a fairly good bond.

(4) A pliable metal sheet protected from rust, of the form shown in Fig. 2 *d*, has also been used for such purposes. When section *A* is being laid the metal assumes the form of a right angle, the vertical part being placed against the form. Before section *B* is laid the upper portion of the vertical is bent down to a horizontal position, as shown.

(5) In the Ridenbaugh Canal of the Nampa and Meridian Irrigation District, Idaho, tar paper was inserted between the abutting joints, which are spaced 16 ft. 3 ins. apart, and a good bond between the sections was secured by short ½-in. steel rods Fig. 2 *e*).

(6) To overcome the objection of projecting rods in laying by the method just described, the plan of bonding shown in Fig. 2 *f* has been devised. A socket is formed in section *A* by means of a short ½-in. pipe, and into this is inserted one end of a steel rod 5/16 in. in diameter and double the length of a pipe. This contrivance adapts the joint to the alternate method of laying, as illustrated in Fig. 2 *a*.

(7) The form of joint used on the Snake Ravine retaining walls of the Turlock Irrigation District of California is shown in Fig. 2 *g*. In laying the lining in alternate sections the joint with its concave surface may be coated with hot asphalt or lined with tar paper before the adjacent section is laid.

(8) In lining the Davis and Weber Counties Canal in Utah, a thin strip of wood coated with asphalt was placed in each joint and extended through about two-thirds the thickness of the lining. The specifications called for the withdrawal of these strips and the filling in of the spaces with hot asphalt, but this was not done. As a result, many of the wooden strips became loose and project more or less above the surface of the lining, thus retarding the flow of water. In other respects the joint has proved satisfactory. (See Fig. 2 *h*.)

(9) A somewhat similar joint (Fig. 3) was used by the engineers of the Patterson Land & Water Co. and the East Contra Costa Irrigation Co. On both canals the wooden strips were removed and the spaces filled with hot asphalt to within ⅜ in. of the surface, the remaining space being filled with cement mortar. When inspected by the writer during construction he questioned the advisability of so wide a joint, and was advised that a smaller joint could not well be filled with asphalt.

(10) Where conditions are adapted to its use, the type of joint shown in Fig. 2 *i* possesses some advantages over those previously discussed. This is merely the carpenter's shiplap or half-timber joint applied to concrete. It provides for all the expansion necessary without weakening the lining by too wide a joint space. It also permits a certain amount of "creeping" in the section without misplacement and furnishes an excellent opportunity to secure a watertight joint by the use of an elastic material like asphalt.

(11) In adapting the shiplap joint to thin concrete linings a greater thickness of lining is used at each joint. The sections shown in *j*, *k*, *l*, and *m*, Fig. 2, represent this modification showing two joints and methods of construction, as designed by A. F. Parker for the lining of the Davis and Uinta Counties Canal in Utah.

WATER WORKS

General Principles Governing the Relocation and Mapping of Uncharted Portions of Water Distribution Systems.

For the adequate control and effective operation of the distribution system of a city water works, the location of pipes and valves should be definitely known, and also the function performed by such pipes and valves. Data should be recorded in such a way as to be readily understood and interpreted, and should be accessible for immediate use, in case of an emergency, by more than one person.

The more complex the system, the more important becomes definite and easily used recorded information as distinctive from information stored only in the minds of certain individuals. For one reason or another, too much dependence has been placed upon the personal knowledge of the individuals, or, perhaps, a single employee, and too little has been done upon the work of recording facts and data in such shape as to be of use by any person, incidentally extending thereby the usefulness of many persons. The lack of proper records and plans may be felt in a minor degree as an everyday handicap, but is likely to be particularly emphasized in case of an accident, such as a break in a main. Here the flow of water must be stopped, and the circulation readjusted, so as to cause as little annoyance and inconvenience to consumers as possible. This means that a number of valves must be first found, and then operated in such a manner as to produce the desired results, and such work must be done quickly.

Of scarcely secondary importance is the necessity of similar records for service pipe connections from the mains in the streets to the properties of the consumers. Affiliated with these latter records are the data recording the arrangement of water piping inside buildings or private properties, with special reference to unauthorized outlets or connections with a private, and possibly contaminated, water supply for fire or manufacturing purposes.

The relocating and mapping of water mains and valves is now under way in Philadelphia. In a paper before the recent annual meeting of the American Association for the Advancement of Science Mr. Carleton E. Davis, chief of the Philadelphia Bureau of Water, outlined the general principles controlling such work. The matter here given is from that paper.

The original water works of Philadelphia were constructed about 1801. The first cast iron pipe was laid in 1817, and considerable pipe which was in the ground as early as 1820 or 1830 is still doing service in the distribution system. The present city is an amalgamation of a number of distinct municipalities, some of which had a water supply at the time of incorporation with the larger community. Such water works were joined to the Philadelphia supply and are even now a part of the general system. As the city of Philadelphia has grown, various water supply projects have been developed, used, outgrown and abandoned, in whole or in part. During the last 15 years the introduction of a filtered water supply has brought about a radical readjustment of the principal supply mains and a realignment of the distribution districts.

Comprehensive Record Scheme.—Certain general maps and plans are available, invaluable as a basis of a more comprehensive and useful record scheme, and representing a large amount of research in the past, hard work, and wise foresight. These particular maps in Philadelphia were compiled by Mr. William Whitby, of the Bureau of Water. They are now being developed and expanded with a view of increasing the amount of detailed information, distributing such information widely throughout the water bureau, and putting it in such shape that a larger number of employees can be used to a greater advantage by reason of its existence and accessibility.

The scheme provides certain general features: (1) Data used chiefly for controlling and regulating the amount of pressure of water throughout the system, or in other words, data used in operating the supply. Under this head are maps defining the limits of the several distinct distribution areas, which maps are accompanied by data showing the sources of supply for each area and a list of valves controlling the supply; likewise general maps showing all large mains, reservoirs and pumping stations, together with detail maps of the piping system and operating valves at the pumping stations, filters and reservoirs. (2) Data used chiefly for repairs and maintenance. Under this head are detail maps showing the complete gridiron of distribution pipes on which the location of all valves and hydrants are indicated. The detail of such maps is expanded by intersection plans showing on a larger scale the situation at each street intersection. Each street intersection is mapped on a separate plan of a size convenient for use in the field. (3) Data used chiefly for the business relations between the consumer and the bureau of water. Under this heading come data relating to service pipe connections, such as the location, depth, size, date of insertion, kind of pipe, etc. These data are listed in a card index and filed by streets and numbers. The system likewise proposes, under this head, full plans of all pipes in important establishments which may have a special supply for sprinkler systems or other fire protection. These plans will indicate the relations between pipes carrying city water and private pipes, which may carry possible polluted water from a private source, introduced for the purpose of fire protection or manufacturing. The necessity for the complete severance of these dual supplies can be readily seen.

Assuming an available force of sufficient size and individual experience and capacity, the work of mapping pipes and valves proceeds normally along three lines: (1) Compilation of existing data wherever and however those data may be listed. Reports and plans were searched and examined, though, of course, the chief mine of information was found to be in the memory of old employees. Considerable tact and discriminating judgment were necessary to elicit the information stored in the minds of these old employees and give to such information its true value and assign to it its proper place. (2) An investigation and determination of the present and possible function and use of the several parts of the system.

Pitometer Force.—In investigating the use and possibilities of the present pipes, pitometer corps, equipped with apparatus readily to measure the flow in any pipe, have been used to great advantage. These pitometer corps served a twofold purpose, for, while measuring and studying the flow of water and determining its fluctuation, they, at the same time, detect leaks and locate points of undue use or waste. Incidental to this study of the flow is the operation of control valves in the course of which the location of valves is verified, their condition and character noted, and other data obtained which forms a part of the detail location maps. More or less information is likewise brought to light concerning service pipes, even some unknown ones being unearthed. Various devices are on the market which aid in locating lost service pipes, though sometimes nothing but digging will bring the desired information. Governing the rather restricted operations of the pitometer corps, is an overhead study of the whole distribution field, including investigation of proposed changes in the major control system.

General Repair and Maintenance Force.—Like the pitometer corps, which obtains certain incidental facts while working along definite lines for the purpose of obtaining other information, the general repair and maintenance forces are likewise utilized for the same purpose. Without adding noticeably to their labor, they turn in much that is valuable in the shape of permanent records. Each foreman in charge of a repair or maintenance crew is furnished with a pad of paper showing the lines of typical street intersection with house lines, curb lines, etc., printed on it. Whenever and wherever such a crew is called for work, the formean is required in his spare moments, which always occur in such an operation, to list up on these blanks such data as an intelligent inspection of his immediate vicinity will discover. He likewise is required to operate such valves as can be conveniently handled and turn in a record of such operation. These field records are sent in to a central office and are used in verifying permanent records or for making new records on the detailed maps. (3) The proper recording of new work and the reduction to tangible shape of existing data.

The system in vogue in Philadelphia depends upon the centralized overhead control. All new work is directed from a central office, thereby insuring uniform practice and procedure, stimulating branch offices by the feeling that their returns are scrutinized and compared with similar returns from other branch offices. As the attempt is made to secure results from what would otherwise be lost time, or in other words, a utilized by-product, this introduction of competition is valuable. Uniform practice and procedure is essential, as a man transferred from one section of the city to another feels at home among the familiar records, even though the geography of the district is strange. Book records have been discarded as far as possible in favor of records capable of easy and rapid reproduction. A complete and satisfactory record, distributed as widely as desired, may not be obtained for some time to come, but enough has already been accomplished to prove the worth of the system.

A Study of the Failures and Partial Failures of Dams in Pennsylvania.

A study of the failure of dams supplies practical knowledge concerning proper methods of design and construction. Following the failure of the Austin Pennsylvania dam the Pennsylvania Water Supply Commission made it a point to obtain information relative to the failures and partial failures of dams in that state. The results of the studies are given in the annual report of the Commission for 1912, which was recently published. The information here given relates to 28 dams which have failed partially or completely during the past 25 years. The report mentioned gives details relative to about half of these failures. The present article gives the general conclusions based upon the study of all these failures.

Three great catastrophies have resulted from the failure of dams, in Pennsylvania, as follows: At Johnstown in 1889, at Oakford Park in 1903, and at Austin in 1911. The losses of life in the failures were 2,142, 23 and 77, respectively. The majority of injured dams have been small, unimportant structures, causing little injury. When large and important dams have failed, investigation has proved that sufficient caution and thoroughness have not been exercised in the design, construction and maintenance.

Table I gives 28 of the larger dams suffering total or partial failure. Some have resulted in absolute demolition of the structure and complete and rapid emptying of the reservoir, requiring entire rebuilding or abandonment. Others affected only portions of the dam and did not result in the entire loss of stored water. Many caused property loss only in so far as the structure itself was concerned.

In the full report descriptions of certain of the failures or partial failures listed in Table I are given. An analysis of Table I indicates that 16 of the 28 dams were earthen structures, 6 masonry and 6 timber crib. Table II indicates the cause of the failures or injuries in each of the three types of dams.

It will be observed that the principal cause is insufficient spillway capacity, and that this occurs in earthen structures, resulting in overtopping the embankment and its subsequent erosion or destruction. In one case of this sort the presence of a concrete corewall within the embankment apparently saved the structure from being carried entirely away.

The second largest number is from improper construction, which means that if these dams had been built with care and thoroughness, with the same dimensions, they probably would have been stable. In the case of the four earthen dams which failed or were damaged from this cause, two were not built of material suitable for the purpose, while the other two failed during construction; in one instance because suitable provision was not made for taking care of the flood flow in the stream and in the other because the corewall was built almost to its full height in advance of the embankment. In the case of the single masonry failure the concrete was poor, while the timber dams were either not suitably filled with stone or had been allowed to decay.

TABLE I.—LIST OF FAILURES OR PARTIAL FAILURES OF DAMS IN PENNSYLVANIA DURING 25 YEARS.

Name of Dam.	Type.	Cause of failure or partial failure.
Lake Leigh	Ambursen	Faulty foundation.
Austin	Concrete-gravity section	Faulty foundation.
Austin	Timber crib	Faulty construction.
Macdonaldton	Concrete-gravity section	Faulty foundation.
Kittanning Point	Earthen	Insufficient spillway capacity.
Mahanoy City Water Co.	Earthen	Faulty construction.
South Fork	Earthen	Insufficient spillway capacity.
Oakford Park	Earthen	Insufficient spillway capacity.
Fort Pitt	Earthen	Insufficient spillway capacity.
Green Lick Run	Earthen	Faulty foundation.
Hosfeld	Concrete-gravity section	Faulty design and construction.
Clover Run	Timber crib	Insufficient spillway capacity.
North Strabane Water Co.	Timber crib	Insufficient spillway capacity.
Dunbar Furnace Co.	Concrete	Faulty design and construction.
Brookville Water Co.	Earthen	Insufficient spillway capacity.
Lebanon City, No. 2	Earthen	Faulty design and construction.
Boydstown	Earthen	Insufficient spillway capacity.
Connellsville Water Co.	Earthen	Insufficient spillway capacity.
Latrobe Water Co.	Timber crib	Faulty design and construction.
Ketner	Earthen	Faulty construction.
Tyrone Gas and Water Co.	Earthen	Faulty construction.
Tumbling Run	Earthen	Insufficient spillway capacity.
Kauffman Run	Earthen	Faulty construction.
Birdsboro Water Co.	Earthen	Percolation along pipe line.
Irondale	Timber crib	Faulty construction.
New Brighton	Timber crib	Faulty construction.
Colonial, No. 4	Concrete-gravity section	Faulty construction.
Salt Lick Creek	Stone and earth	Insufficient spillway capacity.

The four dams which failed from faulty design and construction are unfortunately typical of many such structures in which the layman failed to realize the necessity and advantage of securing engineering advice, and it is remarkable that so many of such structures have withstood the test of service. It can be claimed that the dams having insufficient spillways were faulty in design, but the distinction has been made on account of the large percentage of failure from this cause.

Four of the dams had faulty foundations. Three of these were masonry structures, and one was earthen. It is needless to say that a good foundation is absolutely essential for stability and efficiency in a dam, and that the importance of securing such foundation increases with the height of the structure.

One dam proved unsuccessful because of percolation along the pipe lines through the embankment, a condition which may jeopardize others.

There are many dams, possibly a thousand or more, of various types in Pennsylvania, and of these between three and four hundred store considerable volumes of water and in failing might cause disaster. As the state becomes more densely populated it becomes more necessary to prevent insecure dams from being built, as the liability of damage from a dam failure increases. Few have failed, and in these cases the cause is usually quite evident. Many of the smaller structures were designed and built by men inexperienced in engineering; and it is believed that, by insisting on proper engineering talent in the designing of such structures, the state may, by a critical review of the plans and specifications and by careful and systematic inspection during construction, insure a smaller ratio of insecure dams. In the case of earth filled dams, as above stated, the spillway capacity is a vital point, and it is hardly to be expected that a man not familiar with the variability of stream flow will be able properly to estimate the dimensions required for safety. It has been found that in the plans which have been placed before the commission, in connection with applications for construction of new dams, in few cases has the spillway capacity been sufficient, according to the standards of the commission.

At one time, the predominating type of dam in Pennsylvania was the timber crib structure, stone or earthen filled, used for logging and ice pond purposes, and for improving navigation. Many of them have been in existence for scores of years, but not being properly maintained and kept in repair their deterioration has been rapid, and numerous failures have occurred.

Another feature deserving attention is the existence of abandoned dams. Such structures are a menace and should be removed. Of this class are dams which have been built for logging or ice ponds, and their usefulness has expired by reason of discontinuance of the operations which made their construction necessary. The attention of the owners of such dams is directed to the potential danger in these structures.

TABLE II.—CAUSE OF FAILURE OR PARTIAL FAILURE OF DAMS IN PENNSYLVANIA.

	Cause of failure or damage.				
Type	Faulty foundation	Faulty construction	Faulty design and construction	Insufficient spillway capacity	Percolation along pipe line
Earthen	1	4	1	9	1
Masonry	3	1	2	0	0
Timber crib	0	3	1	2	0
Total	4	8	4	11	1

Chinese School of Conservancy Engineering. The President of China recently issued a decree authorizing the establishment of a school to teach conservancy methods, setting aside certain revenues for this purpose.

The Canadian production of all kinds of finished rolled iron and steel in 1913 amounted to 967,097 tons, an increase of 105,873 tons, and also was the largest in the history of the industry in Canada. Of this, 95,881 tons were iron and 871,216 tons were steel.

Notes on Representative Iowa Water Supplies.

During the summer of 1914 water works statistics for 38 Iowa cities, with the meter rates of 70, were collected by the Extension Division of the State University of Iowa. The data were collected during visits to the plants. The facts obtained are reported in the tables and descriptive matter contained in University Extension Bulletin No. 8. The data were collected under the direction of and the Bulletin was prepared by Prof. John H. Dunlap. The following notes are from the Bulletin mentioned:

FRANCHISES OF PRIVATELY OWNED WATER WORKS.

In the water works franchises of the Davenport Water Co. and the Citizens' Water Co. of Burlington some very interesting features will be found. Two such features may perhaps be mentioned here. First, one of the questions which causes a great amount of trouble in the operation of privately owned water works is the question of the percentage of profit enjoyed by the water works company. The consumers are apt to feel that the charges are exorbitant, and that excessively high rates of interest are being realized by the stockholders in the private water companies. Because of this feeling much unpleasantness results. There seems to be no way to settle such disputes without complete publicity on the part of the private water company in regard to its financial operations. In the states already having public service commissions such publicity has long since ceased to be an objectionable novelty. In the State of Iowa, since we at present have no public service commission, our privately owned public utilities may look with disfavor upon this suggestion. In the case of the Davenport franchise, which took effect on Jan. 1, 1914, it is expressly stated in paragaph three of Section 16 that for the purpose of enabling the city council to determine properly whether or not the rates charged by the Davenport Water Co. are reasonable, the company shall file with the city clerk a full statement of its business for the calendar year. The statement shall show the following items: gross receipts, operating expenses, officers' salaries, taxes, bond interest, dividends, number of metered consumers, number of unmetered consumers, extension and improvement to plant and system, and such other information as may be of assistance to the city council in determining the reasonableness or unreasonableness of the rates being charged by the company. No way will ever be found to settle differences of opinion regarding rates, other than complete publicity such as this modern franchise contemplates.

Second, one of the dangers facing any privately owned water works company is financial loss at the expiration of its franchise. The examples of this danger are numerous. A city may purchase at an unfair valuation, or a city may render the property of the private company worthless by constructing a duplicate municipal plant. Accordingly it seems wise that the modern water works franchise should contain certain reasonable provisions which will remove such possibilities. No unnecessary risk should be borne by the water works company. It is a well established fact that risks must be paid for in dollars and cents. If a city forces upon a water company a franchise unreasonable in this regard, owing to the company's assumption of risk, higher rates must be charged. In Section 13 of the Davenport franchise the method of purchase by the city at the expiration of the franchise is clearly set forth. In sections 14 and 15 of the Burlington franchise, this element of risk is practically removed.

COST OF WELLS.

A number of the cities studied derive their water supplies from wells. The cost data given in Table I pertain to these wells and are for the well complete with casing unless otherwise stated.

CONSUMPTION OF WATER.

The first point of difficulty in estimating the amount of water consumed is that the amount of water actually pumped is usually unknown.

TABLE I.—DATA ON COST, DEPTH AND STRATA PENETRATED FOR WATER SUPPLY WELLS IN IOWA.

Place.	Population 1910.	Source of supply		Date of construction.	Number.	Depth.	Water stratum.	Diameter,		Tot. ft. cased.	Cost with casing.
		Original.	Present.					Top, ins.	Bottom, ins.		
Algona	2,908	Deep well.	Same.	1898	1	818	Sandstone.	4[1]	6	100	......
				1914	1	998	Sandstone.	12	10	374[2]	$ 5,100
Boone	10,347	Deep well.	Shallow wells.	1911	28[3]	30-45	River sand.	12	12	30-45	33,823[6]
Cedar Falls	5,012	Springs.	Deep wells.	1912	3	125	Limestone.	10	8	120[4]	1,800
Charles City	5,892	....	Deep wells.	1905	1	1,589	Sandstone.	10	8	851	5,346
				1914	1	250	Limestone.	6	6	75	426
				1914	1	250	Limestone.	12	10	75	1,000
Cherokee	4,884	Deep well.	Same.	1889-1913	5	200-210	Sandstone.	4	..	....	....
					1	200	Sandstone.	10	..	....	1,920
					1	209	Sandstone.	8	..	117	700
Clarinda	3,832	Driven wells.	Same.	1908	2	55	Gravel.	6	6	55	60[5]
			Dug well.	1905	1	65	Gravel.	10' cement curb.			5,000
Emmetsburg	2,325	Deep well.	Dug well.	1897	1	25	Gravel.	20' brick curb.			....
Fort Dodge	15,543	River.	Deep wells.	1907	1	1,828	......	15	5	....	8,000
					1	670	......	20	..	....	....
					1	215	......	8	..	....	....
				1913	1	200	......	8	..	....	1,500
				1914	1	Under construction.		8	..	....	....
			Infiltration galleries.	....	..	3	Beneath Des Moines River.	10" to 24" tile. Total length, 1,500 ft.			....
Glenwood	4,052	Deep well.	Same.	1891	1	2,000	......	10	4	1,773	7,265
Hampton	2,617	Springs.	Springs.	1891	Group.	....	......	..	..	....	....
			Deep well.	1900	1	1,709	......	12	..	....	....
Humboldt	1,809	Spring.	Spring.	1893	1	....	......	..	..	....	....
Ida Grove	1,874	Driven wells.	Shallow wells.	1897-1914	3	22-28	Gravel.	11' to 18' brick curb.			....
				1914	1	30	Gravel.	22.5' brick curb.			2,200
Le Mars	4,157	Shallow wells.	Same.	1888-1913	16	60-65	Gravel.	6	6	60-65	2,950[7]
					1	60-65	Gravel.	5	5	60-65	....
					5	60-65	Gravel.	8	8	60-65	....
					1	60-65	Gravel.	10	10	60-65	....
					1	60-65	Gravel.	36	36	60-65	500
Marshalltown	13,374	River.	Shallow wells.	1900-1914	51	37.5	Gravel.	6	6	37.5	5,610
Mason City	11,230	Spring.	Deep wells.	1892	6	650	Limestone.	..	..	....	....
				1911	1	865	Sandstone.	10	8	175	2,712
				1912	1	1,217	Sandstone.	16	10	160	6,295
				1913	1	1,200	Sandstone.	20[9]	12	280	5,975
Muscatine	16,178	River.	Shallow wells.	1902	14	48-50	Gravel.	6	6	48-50	1,400[8]
Odebolt	1,283	Shallow wells.	Same.	1884-1909	4	20-24	Sand.	6' to 16'.		....	....
				1910	1	23	Gravel.	16'	..	....	....
Onawa	2,026	Deep well.	Same.	1906	1	862	Limestone.	10	6	500	[10]1,724
Osceola	2,416	Surface.	Same + deep well.	1913	1	1,275	......	8	8	....	6,500
Primghar	733	Deep well.	Shallow wells.	1907	1	12	Gravel.	10' conc. curb.			....
				1912	1	30	Gravel.	3' conc. curb.			....
Red Oak	4,830	River.	Shallow wells.	1906	2	40	Gravel.	18' conc. block curb.			....
					1	59	Gravel.	18' conc. block curb.			5,500
Rockwell City	1,528	Shallow well.	Deep wells.	1904	1	950	Limestone.	10	6	500	4,750
				1912	1	1,543	Sandstone.	12	6	1,470	7,340
Sac City	2,201	Shallow well.	Springs.	1890	5	....	Sand.	Conc. block curb.			
Sheldon	2,941	Shallow wells and tile gallery.	Same.	1896	4	25-30	Gravel.	8' to 10' brick curb.			....
					1	30	Gravel.	24" tile.		....	....
Shenandoah	4,976	Shallow wells.	Same.	1892	6	46-48	Gravel.	6	6	46-48	1,200
					1	46-48	Gravel.	8	8	46-48	....
					1	46-48	Gravel.	10	10	46-48	....
Sibley	1,330	Shallow well.	Same.	1900	1	30	......	10'	..	....	....
			Deep well.	1907	1	314	Gravel.	10	10	314	....
				1914	1	Under construction.		..	..	....	....
Sioux City	47,828	Deep wells and driven wells.	Same.	1882-1914	60	80-100	Gravel.	2	2	80-100	....
					7	350-400	Sandstone.	8 to 16		....	....
					16	75	Gravel.	..	..	....	....
					1	370	Sandstone.	8	..	....	....
Spencer	3,005	Shallow well.	Same.	1888	3	16	Gravel.	10', 20', 30' brick curb.			....
Villisca	2,039	Spring.	Shallow wells.	1909	3	30	Sand.	8' brick curb.			....
Waterloo	26,693	River.	Deep wells.	1904-1905	1	1,373	Sandstone.	16	8	862	5,956
				1905-1907	1	1,377	Sandstone.	16	8	776	8,054
				1910-1911	1	1,365	Sandstone.	20	12	860	10,855
				1913-1914	1	1,377	Sandstone.	..	..	....	8,356
Waverly	3,205	River.	Deep well.	1899	1	1,720	Sandstone.	12	8	100	3,300

[1] Four-inch diameter at top due to change made when the well was recased. Originally the well was 6 ins. at the top.

[2] The 10-in. case is 374 ft. long, and extends to surface inside the 12-in., which is 304 ft. long.

[3] Ten wells not needed at present and not connected.

[4] Double cased with 70 ft. of 12-in. casing and then 120 ft. of 10-in. inside.

[5] Cost without casing and strainer.

[6] Cost complete with casings and suction system.

[7] Estimated cost of reproduction of the 23 6 to 10-in. wells.,

[8] Cost of the 14 wells with casing, exclusive of suction system.

[9] Drilled 24 ins. in diameter and filled with concrete outside 20-in. casing to cut off surface water.

[10] This cost of $2 per foot is contract cost for drilling without casing.

In only 6 of the 38 plants visited are accurate meters used on the discharge mains from the pumps. In six of the remaining plants the method of measuring is by counters registering the number of strokes of the plungers of the pumps. In these six cases the displacement as given by the counters has been corrected by an assumed factor for slip. In five of the plants the number of strokes is used direct without the slip correction. In 14 of the plants the amount pumped is known only by methods of estimation, neither counters nor meters being available.

The second difficulty is that even when the pumpage is accurately known the exact number of persons using the water is not known. It was ascertained, in the case of the cities visited, that the per cent of water users varies from 32 to 100. The per cent of the population reached by the mains was 33 to 100. The consumption per water user ranged from 49 gals. at Charles City, a town of 5,900 population, to 160 gals at Le Mars, a town of 4,157. At the latter place the railroads take 30,000 gals. per day. At Charles City railways and manufacturing plants take 108,000 gals. per day.

OTHER DATA.

The Bulletin gives numerous other data. Information is given concerning the equipment and fuel cost of pumping in 19 of the plants visited. Similar facts are given with reference to electric pumping. The principal facts concerning the distribution system in the 38 cities are given. The general facts in regard to average domestic and fire pressure are given for 31 cities. In the table on water rates and service an attempt is made to associate the actual price paid for water with the service rendered. A study of the data given shows that no connection is apparent between the rates and cost of service. The need of rate readjustments is obvious.

Provision Against Corrosion of New 48-In. Cast Iron Force Main Across Salt Marsh at Atlantic City, N. J.

During the past eight years two force mains have been constructed at Atlantic City from the pumping station on the mainland across the intervening salt marsh to the city, a distance of about 26,000 ft. A description of the first main, of wooden stave pipe, was published in Engineering and Contracting of July 10, 1912, and this line was practically the city's sole water supply dependence until the new 48-in. cast-iron line was laid. It is to prevent the corrosive action of the salt marsh that it was thought advisable to elevate the main above the surface, a suitable foundation for the line being the chief obstacle to this form of construction. Brief reference to the solution of the latter problem was made in the article on the external corrosion of cast iron pipe which was published in Engineering and Contracting of Oct. 21, 1914. Further information on the new cast iron line is here given from a paper by Lincoln Van Gilder in the Journal of the American Water Works Association for December, 1914.

The surface strata of the marsh consists of soft muck of a depth varying from 5 ft. to 25 ft. constantly saturated with water to the grass roots and underlaid with sand, gravel and clay. While this muck rapidly destroys iron and steel it is a preservative of wood and, therefore, particularly adapted for the use of pile foundations, provided the piles are not exposed to the atmosphere above the point of constant saturation.

The finished foundation consists of a double row of pine piles freshly cut from growing timber driven in pairs 3 ft. 6 ins. centers transversely and approximately 6 ft. centers longitudinally. Each pair of piles is capped with a reinforced concrete bolster cover to fit the pipe, the bottom of the bolster being in breeching form to surround the piles and carried well below atmospheric action. By this arrangement every length of pipe is carried on two bolsters supported by four piles.

The bottom is so irregular that the piles vary in length from 20 to 45 ft., the weight of the hammer being sufficient to sink a large proportion of them from 20 to 25 ft. without a blow and others requiring a water jet to set them deep enough for lateral stability.

To provide for expansion and contraction due to temperature changes each spigot is held not less than ¼ in. clear of the bell shoulder by inserting a gage ring in the joint; all gages are withdrawn after the pipes are placed in permanent position. All joints are poured with molten lead not less than 3 ins. deep and thus every pipe is carried on its own bolsters and is connected to adjoining pipes only by the lead joint rings. As a safeguard against any possible chemical action between cast iron and concrete a 3/16-in. gasket of hard fiber is placed between pipe and bolster. Valves, manholes and blow-offs are placed at intervals of about 3,000 ft. to facilitate internal inspection and repair.

At the city end the main crosses a navigable stream about 500 ft. wide with a 200-ft. channel 12 ft. deep at mean low tide. This crossing is made by a 48-in. bell and spigot inverted siphon with flexible joints at all deflection points, all laid on piling with timber caps. The entire structure is below the present stream bed. The bottom is beach sand and a 12-in. cast iron pipe 30 years old just removed from the same location is hard and in good condition.

The construction of this main contained so many uncertainties that it was deemed expedient to build it sectionally. The work was so successfully accomplished that the contract for the balance, except the thoroughfare siphon, was let Nov. 6, 1913. The anticipated difficulties proved to be imaginary rather than real.

The piling did not exceed the estimate and the proximity of the Pennsylvania and Reading Railroads so facilitated the handling of materials that by the use of a work train and railroad derrick, pipe, piling, gravel, sand, cement, etc., were distributed at the approximate cost of handling on the city streets.

The cost of the finished main approximates $415,000 and the experience gained in building the first and smaller section together with a closer price for pipe, specials and valves resulted in a net saving of about $65,000 in the cost of the last section, assuming that the unit prices in the first contract would have been the same had the whole project been included in the first letting while the cost per foot of main complete, including valves, valve housings, special castings and thoroughfare siphon was about $16.

The original 6,000 ft. was completed early in October, 1913, and stood empty since completion and test, until about August of 1914. As no serious disturbance was apparent in the joints the assumption is warranted that ample provision was made for temperature stresses.

The question has been asked "Why is it necessary to build a new main at this time if the wood stave main is successfully performing the work for which it was intended?"

The pumping station is located 5 miles from the city and the force mains must of necessity be built for the greater part of their length across salt marsh, under one or more railroads and across a navigable stream. The chances of accident are too great to be ignored and the city cannot afford at any cost to have its water supply cut off.

Two of the old mains are abandoned and the third (20-in. cast iron) has so nearly outlived its usefulness that it has broken three times since work was begun on the last contract.

With the completion of the new main the city is supplied by two independent lines, either of which will carry the load alone for a number of years to come. They cross railroads and streams on different rights-of-way and it requires two accidents in different locations simultaneously or in quick succession to cause the slightest danger.

A "Made in the U. S. A." exposition is to be held in the Grand Central Palace, New York City, March 6 to 13, for the purpose of popularizing the slogan and to increase American industry and trade.

Bacteriological Standard for Drinking Water Supplied by Common Carriers.

The present article gives the bacteriological standard for drinking water supplied to the public by common carriers in interstate commerce. This standard was adopted by the Treasury Department on Oct. 21, 1914. A chemical standard is under consideration by the same experts, and will be submitted for adoption later on. The bacteriological standard here given is one recommended by a commission appointed for the purpose by the Secretary of the Treasury on Jan. 22, 1913. The commission is composed of the following members: John F. Anderson, chairman; Edward Bartow, Charles C. Bass. S. J. Crumbine, Ed C. Franklin, Henry Hanson, Charles G. Hyde, Ed O. Jordan, Allan J. McLaughlin, W. H. Park, M. J. Rosenau, W. T. Sedgwick, G. C. Whipple, C. E. A. Winslow, W. H. Frost. The following is the standard recommended and adopted:

THE BACTERIOLOGICAL STANDARD FOR WATER.

The following are the maximum limits of permissible bacteriological impurity:

1. The total number of bacteria developing on standard agar plates, incubated 24 hours at 37° C., shall not exceed 100 per c.c. Provided, that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.

2. Not more than one out of five 10 c.c. portions of any sample examined shall show the presence of organisms of the bacillus coli group when tested as follows:

(a) Five 10 c.c. portions of each sample tested shall be planted, each in a fermentation tube containing not less than 30 c.c. of lactose peptone broth. These shall be incubated 48 hours at 37° C. and observed to note gas formation.

(b) From each tube showing gas, more than 5 per cent of the closed arm of fermentation tube, plates shall be made after 48 hours' incubation, upon lactose litmus agar or Endo's medium.

(c) When plate colonies resembling B. coli develop upon either of these plate media within 24 hours, a well-isolated characteristic colony shall be fished and transplanted into a lactose-broth fermentation tube, which shall be incubated at 37° C. for 38 hours.

For the purpose of enforcing any regulations which may be based upon these recommendations the following may be considered sufficient evidence of the presence of organisms of the bacillus coli group.

Formation of gas in fermentation tube containing original sample of water (a).

Development of acid-forming colonies on lactose litmus agar plates or bright red colonies on Endo's medium plates, when plates are prepared as directed above under (b).

The formation of gas, occupying 10 per cent or more of closed arm of fermentation tube, in lactose peptone broth fermentation tube inoculated with colony fished from 24-hour lactose litmus agar or Endo's medium plate.

These steps are selected with reference to demonstrating the presence in the samples examined of aerobic lactose-fermenting organisms.

3. It is recommended, as a routine procedure, that, in addition to five 10 c.c. portions, one 1 c.c. portion and one 0.1 c.c. portion of each sample examined be planted in a lactose peptone broth fermentation tube, in order to demonstrate more fully the extent of pollution in grossly polluted samples.

4. It is recommended that in the above-designated tests the culture media and methods used shall be in accordance with the specifications of the committee on standard methods of water analysis of the American Public Health Association, as set forth in "Standard Methods of Water Analysis" (A. P. H. A., 1912).

In submitting the recommendations above quoted the commission emphasized the fact that the limits defined are recommended with reference solely to the special object of the control of the supplies of common carriers, having in mind that these supplies constitute a special case because of the following reasons:

1. The supplies come from widely diversified and mixed sources.

2. Samples taken from common carriers represent waters stored for various lengths of time under varying conditions.

3. In view of the impossibility of accurately ascertaining the source and history of each supply examined reliance must be placed upon results of laboratory examination to a greater extent than is necessary or justified in estimating the quality of a supply from a known source with a known history.

It is requested that the recommendation of these hard-and-fast limits of bacteriological impurity be not interpreted as minimizing in any way the importance of field surveys in estimating the sanitary quality of water supplies in general. It is always desirable to obtain information from as many angles as possible, and this is, indeed, necessary in order to form an altogether fair estimate of an individual supply.

BRIDGES

Effect of Duration of Mixing on the Strength of Concrete.

The following data on the effect of duration of mixing on the strength of concrete, although by no means exhaustive, will be of interest to engineers and contractors. The need of complete data on this subject has long been felt, and it is hoped that engineering literature will soon contain exhaustive data on this important subject. The data were taken from a paper by H. H. Scofield, presented before the recent meeting of the Indiana Engineering Society.

The hydration of Portland cement and its subsequent "setting up" is at best a topic little understood, although, with perhaps more understanding than ever before, chemists are still investigating what takes place in the interval subsequent to the addition of water to cement, and what are the various conditions affecting it.

Commercially, every engineer and builder is vitally interested in the conditions which affect the hydration of cement. Such factors as the effect of fineness of the cement, amount of water used in mixing, and the amount and kind of mixing itself, together with the placing and treatment of the concrete after the mixing; these are factors which interest every one who is concerned in the production of good and permanent concrete.

The following discussion has to do with the time element in mixing concrete. The desire to make speed—to put another story on a building in fast time, to lay another mile of concrete road in half the time the last one was laid, to build more bridge piers this month than last; these and other allied reasons seem to make it necessary, commercially, to build the so-called efficient mixing plants and to turn out batches of concrete at the rate of sometimes 70 batches per hour. The writer has personally timed the mixer on commercial jobs when operating at this rate of speed. He has even timed a batch mixer on a commercial work when the elapsed time from the introduction of the materials for one batch to the introduction of the materials for the next was 28 seconds. This procedure of thus running a batch mixer nearly continuously is by no means uncommon. It has been stated that the mixing plant for the Lexington Ave. subway regularly operated at 60 batches per hour and frequently reached 70 batches per hour.

The effect of this rapid mixing could probably be minimized if it were known that all other deteriorating influences were absent, but taken in addition to a possible unsound cement, a poor aggregate, "skinned" proportions, excess of water, low temperature, etc., rapid mixing *may* become a very important contributory cause of poor concrete.

The purpose of mixing concrete is two-fold: first, by a thorough stirring-up and abrasion of one particle upon another the solids are properly arranged and mixed; second, by the addition of the water the hydration of the cement should be accomplished. The first, to be effective, must be done without separation of sizes and any fine dust or clay already adhering to the aggregate particles should be abraded away and replaced with cement. The second requires a working of the mass to insure the complete wetting of the cement and the consequent bringing out of the colloidal state upon which the hardening and strength of cement depend.

The complete operation must take some time. The amount of time depends upon many conditions, some of them, of course, being peculiar to the work and to the available materials. The study and tests hereinafter reported are incomplete. They must necessarily be incomplete, because a satisfactorily comprehensive study of the subject involves a large variety of commercial mixers and materials. It would involve a great many changes of conditions for each mixer and each material. Few laboratories are equipped for such a procedure. However, the tests are reported in the hope that they may be of some value in showing the need for thorough mixing of concrete.

SCOPE OF TESTS.

Seven series of compression test specimens were made under different conditions of mixing and duration of mixing. These were tested at the age of one year.

MATERIALS.

The cement used for all series was "Speed" Portland cement, manufactured by the Louisville Cement Co.

The sand and gravel were the usual glacial drift materials found in the deposits near Lafayette, Ind.

The stone was crushed limestone from the "Monon" quarries. The stone was graded between ¼-in. and ½-in. in size.

APPARATUS.

All series were mixed, under various conditions, in a Chicago Improved Cube mixer of 2½ cu. ft. capacity. The mixer was run at the prescribed rate of 26 revolutions per minute.

METHODS.

The stone-sand mixtures were made in the proportion 1:2:4 by volume. The gravel mixtures in proportion of 1:5 by volume. For accuracy and uniformity, the weights per cubic foot of the dry materials were first determined and then the actual quantities for the different series were determined by weight. The weight per cubic foot of the cement was taken as 100 lbs.

Care was taken in placing and moulding the specimens so that as great uniformity as possible would be obtained.

The test specimens were capped with plaster of paris to give absolutely flat bearings, and axial loading was insured by the customary spherical-joint bearing block.

RESULTS OF TESTS.

Tables I to VII, inclusive, give the results of the tests, and show the effect of duration of mixing on the compressive strength and modulus of elasticity of concrete.

The results given in Table I were obtained from 8-in. diameter by 16-in. concrete cylinders, consisting of 1 part cement, 2 parts sand, and 4 parts crushed limestone. The materials were mixed dry for two minutes. Water was then added and the concrete mixed for the length of time noted. The concrete was of medium wet consistency.

TABLE I.—RESULTS OF SERIES A TESTS.

Mark.	Total time of wet mixing, mins.	Compressive strength, lbs. per sq. in.	Initial modulus of elasticity.
1A	1	2,370	3,100,000
2A	4	3,010	3,300,000
3A	15	3,415	3,750,000
4A	30	3,325	3,355,000

Table II gives results of tests of 6-in. concrete cubes consisting of 1 part cement, 2 parts sand, and 4 parts crushed limestone. The materials were mixed dry for one minute; water was added during the next minute, and the concrete was mixed for the length of time noted. The concrete was of wet consistency

TABLE II.—RESULTS OF SERIES B TESTS.

Mark.	Total time of wet mixing, minutes.	Compressive strength, lbs. per sq. in.
1B	1	3,575
2B	4	3,555
3B	6	4,740
4B	10¼	4,770
5B	18	4,430
6B	30	4,040

Table III gives the results of testing 6-in. concrete cubes consisting of 1 part cement, 2 parts sand, and 4 parts crushed limestone. All materials, including water, were added before the mixer was started. The concrete was of very wet consistency.

TABLE III.—RESULTS OF SERIES C TESTS.

Mark.	Total time of mixing, minutes.	Compressive strength, lbs. per sq. in.
1C	1	1,935
2C	2	2,100
3C	4	2,400
4C	8	2,850
5C	18	2,930
6C	30	2,290

The results of testing 8-in. diameter by 16-in. concrete cylinders consisting of 1 part cement and 5 parts gravel are given in Table IV. The dry cement and gravel were placed in mixer; the mixer was then started and water added. The concrete was of dry consistency.

TABLE IV.—RESULTS OF SERIES D TESTS.

Mark.	Total time of mixing, minutes.	Compressive strength, lbs. per sq. in.	Mod. of elasticity.
1D	1	2,780	3,200,000
2D	2	3,100	3,300,000
3D	4	3,370	3,750,000
4D	10	3,585	3,750,000
5D	18	3,720	4,500,000
6D	30	2,845	3,200,000

Table V gives the results of mixing tests on 6-in. gravel concrete cubes. The concrete proportions were 1 part cement and 5 parts gravel. The cement and gravel were placed in the mixer before it was started. The mixer was then started and water added during the first one-half minute. The concrete was of medium wet consistency.

TABLE V.—RESULTS OF SERIES E TESTS

Mark.	Total time of mixing, minutes.	Compressive strength, lbs. per sq. in
1E	½	2,230
2E	1½	2,345
3E	3½	2,640
4E	10	2,890
5E	20	2,540
6E	30	2,655

The results of mixing tests on 6-in. concrete cubes consisting of 1 part cement and 5 parts gravel are given in Table VI. In this case the concrete was of very wet consistency. The gravel and cement were placed in the mixer before it was started; the mixer was then started and water added during the first one-half minute.

TABLE VI.—RESULTS OF SERIES F TESTS.

Mark.	Total time of mixing, minutes.	Compressive strength, lbs. per sq. in.
1F	½	1,900
2F	1½	1,890
3F	3½	1,990
4F	10	2,580
5F	20	2,200
6F	30	1,980

Table VII gives the results of tests of 6-in. concrete cubes consisting of 1 part cement and 5 parts gravel. The cement, gravel and water were added as in Series F tests. The concrete was of very wet consistency.

TABLE VII.—RESULTS OF SERIES G TESTS.

Mark.	Total time of mixing, minutes.	Compressive strength, lbs. per sq. in.
1G	½	2,015
2G	1½	2,020
3G	3½	2,100
4G	10	2,560
5G	20	2,450
6G	30	2,390

By referring to the foregoing tabular data it will be noted that for all series the maximum strength and the maximum modulus of elasticity are obtained when the materials have been mixed from 10 to 18 minutes. The difference in strength between that at 10 or 18 minutes mixing and that at ½ or 1 minute mixing is given in Table VIII.

TABLE VIII.—DIFFERENCE IN STRENGTH FOR VARIOUS SERIES.

Series.	Per cent difference in strength between 10 or 18 minutes mixing and ½ or 1 minute mixing.	Condition of concrete.
A	44.	Mixed med. wet
B	33.6	Wet mix
C	51.5	Very wet mix
D	35.6	Dry mix
E	29.4	Med. wet mix
F	36.	Very wet mix
G	27.	Very wet mix
Av. (all series).	36.7	

CONCLUSIONS.

The value and accuracy of laboratory tests lies in the fact that more constant conditions may be maintained. All variables, except that which it is desired to study, may be more nearly ruled out than under commercial conditions. Although the concrete tested in these series is much stronger than the average of commercial concrete it is reasonable to expect that the same relation would hold in both cases.

It is evident that as far as these series are concerned there is little difference in the strength of concrete, whether mixed ½ minute or mixed 2 or 3 minutes. Some mixers would show greater differences than others. It is seen, however, that by mixing 8 or 10 minutes a marked increase in the strength of the resulting concrete is attained. For economic reasons this fact may or may not be of use commercially.

Instructions of the Pennsylvania State Highway Commissioner to Bridge Companies.

The accompanying letter has been addressed to bridge companies doing work for second-class townships in Pennsylvania by the Pennsylvania State Highway Commissioner. There are many bridge companies in the state which furnished bridge plans directly to the supervisors before the bureau of township highways was created. It was for the purpose of informing these companies of the standard requirements of the bureau that the letter was written:

Act. No. 440 of General Assembly, approved July 22, 1913, provides that "no contract for the repair or construction of any township bridge or culvert shall be valid unless such contract is in accordance with the standard plans prescribed, or unless the plans, specifications and estimates have been prepared or approved by the State Highway Commissioner."

The following information relative to the design of township bridges or culverts will enable the bridge companies to bring their plans to conform with the standards of the Bureau of Township Highways:

(1) Contracts, specifications and plans should be made in quadruplicate on the companies' own forms, and when signed, should be transmitted to the Bureau of Township Highways for approval.

(2) All contracts should be made out in full.

(3) Design requirement:

General.—The aim of this department is to make all bridges as nearly permanent as possible. To this end I-beam spans should have all metal, except the pipe rail, encased in concrete and truss spans should preferably have concrete floors. Concrete floors should have a protection of 6 inches of gravel and earth.

Materials.—Material, unit stresses, details of design, and workmanship shall conform to the specifications of the American Railway Engineering Association of 1910.

Loading.—Three classes of loading will be used (see Table I).

TABLE I.—CLASSES OF LOADING.

Class.	I-beam spans.	Floor system for trusses.	Trusses. 40-ft. span. Lbs.	50-ft. span. Lbs.	60-ft. span. Lbs.	70-ft. span. Lbs.	100-ft. span. Lbs.
"A"	15-ton roller	15-ton roller	180	150	125	110	100
"B"	12-ton roller	12-ton roller	160	130	110	90	80
"C"	10-ton roller	10-ton roller	140	110	95	80	70

Class "A" loading is to be used for bridges that are near cities and towns and on main thoroughfares.

Class "B" loading is to be used for bridges that are in well-settled agricultural districts.

Class "C" loading is for use on bridges in remote and thinly-settled districts.

Painting.—In riveted work the surfaces coming in contact shall be painted before being assembled. Before leaving the shop all steel, except that which comes in contact with concrete, shall be thoroughly cleaned and given one good coating of pure raw linseed oil.

After erection all exposed steel shall receive one coat of red lead, 85 per cent pure, and two coats of white lead and zinc white, in pure linseed oil without turpentine or dryer.

Specifications for Waterproofing Solid Steel-Floor Railroad Bridges.

The following specifications cover the design, materials, and manner of applying the waterproofing of railroad bridges with solid steel floors. Up to the present time the specifications in use have been tentative, being based on the best information obtainable. It is thought, however, that there are certain principles—more or less fixed—which may be lost sight of by the inexperienced designer, the chief object of the author being to state specifically what these principles are believed to be. The specifications, which are open to discussion, were abstracted from a paper "The Waterproofing of Solid Steel-Floor Railroad Bridges," by Samuel Tobias Wagner, in Proceedings, American Society of Civil Engineers, Vol XL., p. 2945. They are not intended to cover the design of the structural work, but to call attention to those details which should be borne in mind by the engineer when designing a structure which is to be waterproofed.

EXPLANATION OF SPECIFICATIONS.

The following explanation is offered for introducting certain features in the specifications:

The waterproofing of solid-floor railroad bridges is undertaken for two reasons: (a) To protect the metal from corrosion due to the alternately wet and dry condition of a ballasted floor; and (b) to prevent the water, which is absorbed by the ballast and given off slowly, from dripping on a street beneath.

A reasonable depth of girder makes a stiff structure and aids in making it water-tight. There can be little doubt that, in all designs, the primary object should be to provide such details as will remove the water from the bridge in the quickest possible time and by the shortest route; and further, in case of the possibility of the water being held on the bridge for any considerable time after a storm, to design the height of the waterproofing so that it will be above the highest water level. There are many places where the ballast will become very dirty in time, and at such localities this detail is important.

It is also considered inadvisable to throw all the water off the bridge at its ends, over the back-walls. It is very difficult to design at this point a satisfactory detail which will prevent water from forcing its way back over the back-wall and down the face of the abutment, even though the drainage back of the abutment is specially good. It is much better to collect the water on the deck of the bridge, take it below the floor by inlets and down-spouts, and discharge it below the floor on the ground, or into a sewer (if in a city). Such inlets can be made so as to be accessible from below for cleaning, and, with ordinary care, can be made satisfactory as far as leakage around them is concerned. To carry the water away quickly there should be a number of these inlets on any bridge of considerable extent.

In the case of deck structures the waterproofing details are simple, the principal questions to be settled being the type of waterproofing to be used and the durability of the materials. The application of the waterproofing—whatever kind may be selected—is not difficult.

In a half-through structure the conditions for waterproofing are at their worst. If the top of rail is near the top of girder it is generally advisable to carry the waterproofing over the girder and encase its entire top in concrete.

The finish of the waterproofing against the web of a half-through girder, the top of which is 3 ft. or more above the top of rail, is one of the most difficult problems to be solved. In some cases it is the practice to carry the waterproofing nearly if not all the way up to the top of the girder, and protect it with a considerable thickness of concrete, but, generally, it is finished up against the web not far above the level of the top of rail. This finish, if done satisfactorily, will make a good piece of work of the structure as a whole, provided the detail in respect to water running over the back-walls is guarded against. It is believed that riveting a flashing angle to the web does not provide a satisfactory detail, as it is impossible to make it continuous on account of stiffeners and gussets. Placing a pocket of ductile, adhesive mastic (which will not harden in cold weather) as a joint between the waterprofing layer and the web is believed to give the best results, and in case of the deterioration of this asphalt, the detail is in a place where repairs can be made without interfering with traffic. The question of interference with traffic in making waterproofing repairs is one that is giving many railroad bridge engineers serious concern, and is leading slowly, but surely, to much more elaborate, effective, and expensive systems, in order that repairs may be postponed as long as possible. It is possible to make the proper kind of pure asphalt, unmixed with foreign matter, adhere to a clean surface of metal or concrete, and thus secure a tight joint. It has been found advisable to protect this pocket of asphalt with a layer of concrete to prevent the ballast, which may be carelessly thrown against the girder, from cutting into it.

As to materials to be used for the solid bridge floor, it is believed that, after the question of durability is disposed of—as one of the most important items—the most durable material, which can be shown to possess adhesion and ductility at low temperatures, and at the same time be sufficiently hard to prevent running at maximum exposure temperatures, is the most desirable—say, temperatures generally between 0° to 200° F. Higher melting points are undesirable for a number of reasons, and should not be used. The most critical time to test a bridge floor is during melting snow, and cracks which may develop at that time are sure to be channels for water.

Whether felt, fabric, or asphalt mastic shall be used is a debatable question, and it will depend somewhat on conditions. If hard pressed for head room in depth of floor construction the use of asphalt mastic is recommended, and, although it is generally considered an undesirable material, it is believed that, with proper natural rock, proper flux, and careful mixing and placing, first-class results can be obtained, if the pure asphalt seal is used against the metal.

Felts or fabrics, of course, contain organic matter, and, if not entirely covered with asphalt, are subject to disintegration by "rotting." It would seem, however, that if properly prepared and laid, these materials should form a very satisfactory membrane—more satisfactory, as far as elasticity is concerned, than the mastic. A felt of inorganic material —asbestos—has all the proper qualities, from the standpoint of durability. It is generally laid in combination with a layer of treated burlap to give it additional strength. Practice sometimes protects asbestos felt with asphalt mastic instead of brick or reinforced concrete. This is probably allowable with asbestos felt, but should never be used with any of the other felts. Experience shows that hot mastic, placed on a layer of felt, or fabric treated with asphalt, will draw the asphalt out of the felt and incorporate it as part of the mastic.

Specifications.

PART I. DETAILS OF CONSTRUCTION.

1. *Depth.*—The depth of steel or concrete construction shall be such as to allow a sufficient distance from top of rail to top of steel or concrete floor for proper waterproofing, and protection from the cutting action of the ballast. Under ordinary conditions, a depth of from 3.5 to 4.0 ft. from top of rail to clearance line below is sufficient.

2. *Drainage Grade.*—Provision shall be made for grades of at least 1 per cent on the floor of the bridge to remove water promptly. Where this cannot be done in the steelwork, cement concrete, with a minimum thickness of 2½ ins., shall be placed so as to drain the water to the inlets.

3. *Inlets.*—Cast-iron inlets shall be set at proper places in the floor and provided with movable top grates. The down-spout from each inlet shall be provided with a trap and clean-out, which shall be accessible from below the bridge. The down-spout shall be of wrought iron, and connected to a sewer or arranged according to local conditions.

4. *Details of Steelwork.*—Where two longitudinal girders meet over a column, the end stiffeners shall be placed with the outstanding leg toward the center of the girder, and the girders shall be connected with ⅜-in. plates on each side of the web. A plate shall also be placed covering the joint on the top flange.

5. Stiffening angles on the outstanding edges of gusset plates in half-through or through girders shall be terminated below the level of the waterproofing, the gusset plates shall be heavier, and shall be placed from 10 to 12 ft. apart.

6. Where the top of girder approximates the same height as top of rail, the waterproofing and protection shall cover the entire top of the girder.

7. The apron-plate from the steel floor over the back-wall shall be provided with a curb angle against which to finish the waterproofing, and to this angle shall be riveted a vertical plate to prevent dirt from collecting under the apron-plate. The apron-plate shall be anchored to the back-wall.

8. *Waterproofing — General Design.*—On top of the prepared surface of the concrete shall be placed either of the following:

(1) One or more thicknesses of felt or fabric, of quality and applied as specified hereafter, together with proper protection.

(2) Asphalt mastic at least 1½ ins. in thickness, of quality and applied as specified hereafter.

9. *Felt, Burlap, or Fabric.*—When waterproofing of this kind is to be used, either of the following types shall be adopted:

(1) From four to six layers of felt.

(2) One middle layer of treated burlap, with four layers of felt.

(3) One layer of felt, two layers of burlap, and two layers of felt.

(4) One middle layer of treated burlap, and two layers of asbestos felt.

(5) Either one or two layers of treated cotton-drill fabric.

10. *Protection of Waterproofing.*—After the completion of the felt or fabric waterproofing, the entire surface shall be covered and protected by one of the following methods:

(1) Straight, hard-burned brick laid flat, with joints filled either with waterproofing compound or cement grout. Waterproofing compound should only be used as a filler on flat or nearly flat surfaces.

(2) A layer of cement concrete from 2 to 2½ ins. thick, with wire reinforcement.

(3) A layer of about 1½ ins. of asphalt mastic used only on top of asbestos felt. It is believed that no protection is necessary for the asphalt mastic.

11. *Special Drainage Over Protection.*—On top of the protection coat, and outside the line of the ties, a line of half-round cast-iron pipe, 6 ins. in diameter and perforated frequently, shall be placed to collect the water and convey it to the inlets.

PART II. PREPARATION FOR WATERPROOFING.

12. *Preparation of the Steel.*—All openings in the steelwork shall be thoroughly closed, either by caulking with burlap dipped in hot asphalt, or by the use of sheet metal sufficient to maintain the concrete base before applying the burlap and asphalt.

13. *Preparation for Waterproofing Materials.*—Wherever called for by the plans, the decks of the bridges shall be protected with 1:3:5 concrete, with ¾-in. stone or gravel, mixed as specified hereafter, finished with a 1:2 mix of cement mortar ½ in. thick, troweled to a smooth surface on top, as shown. This concrete shall be allowed to dry thoroughly so as to prevent the formation of steam when the hot waterproofing materials are applied.

14. All vertical or sloping surfaces of concrete or steel shall be thoroughly cleaned of dust, dirt, loose particles, paint, and grease. The use of a hand-bellows is recommended for cleaning loose dust and dirt from the surfaces. For cleaning paint and grease from the steel and freshening the surfaces of asphalt, where a junction of old and new is to be made, or where a pocket of pure asphalt is used against the girders and the felt or mastic, gasoline shall be used, either by swabbing the surface with it, or by pouring a small quantity over the surface to be cleaned, and setting fire to it. The use of a blow-lamp is also recommended.

15. These surfaces shall then be painted with two coats of approved asphalt, diluted with gasoline. The materials of the first coat shall be proportioned so as to give a brownish tint. The second coat shall have a larger quantity of asphalt.

16. Both coats of paint shall be thoroughly applied and worked into the surfaces, so as to give a uniform coating of the asphalt.

17. Paint shall not be applied to damp concrete or steel. The painting shall be done immediately in advance of the application of the waterproofing materials and before dust has had time to collect.

18. If the concrete is damp before the waterproofing is applied, the surface shall be first covered with a 2-in. layer of hot sand and allowed to stand for from 1 to 2 hours, after which the sand shall be swept back, uncovering sufficient surface to begin work, and the operation repeated over a new surface.

19. *Concrete Proportions.* — The cement concrete shall be proportioned by measurement of volumes. The volume of a barrel of cement, 376 lbs., shall be assumed to be 3.6 cu. ft. The sand and stone shall not be packed more closely than by throwing, in the usual way, into a barrel or box at the time of measurement.

20. *Cement.*—Portland cement shall be used, of the quality specified by the American Society for Testing Materials.

21. *Stone.*—The stone shall be clean, hard, crushed stone, or pebbles, to be approved by the chief engineer, and shall be composed of the whole run of the crusher, from ¼ in. to ¾ in. in size, screened of dust and particles less than ¼ in. in greatest dimension.

22. *Sand.*—The sand shall be clean and sharp, and shall be composed of grains graded from "fine to coarse," screened to reject all particles of a greater diameter than ¼ in. It shall be free from foreign matter, and subject to the approval of the chief engineer.

23. *Care of Sand and Stone.*—Sand and stone, when delivered on the work, shall be dumped on platforms and not on the ground.

24. *Hand Mixing.*—When mixed by hand, the cement and sand shall be first mixed dry and made into a mortar. The stone shall be spread on a suitable floor to a depth of about 6 ins., thoroughly wetted, and the mortar evenly spread over it, care being taken that the stone of each batch is mixed as to size. The whole mass shall then be turned over four times and raked, to secure complete and uniform mixture. If the contractor desires to use some other method, he shall submit it for approval. Should the mixture be permitted to set before placing or tamping, it shall be removed and not used. Hand mixed batches shall not be larger than 1 cu. yd. in volume.

25. *Depositing.*—All concrete shall be deposited as the chief engineer shall direct. It shall be of such consistency that when dumped in place it shall not require much tamping, and shall be laid with a view to be an aid to the water-tightness of the structure, and not merely a support for the waterproofing materials. All showing surfaces shall be troweled to a smooth, hard surface.

26. In cases where concrete haunching against girders is called for by the plans, forms shall be used, and the concrete shall be of a wet consistency.

PART III. MATERIALS AND APPLICATION.

Waterproofing Felt or Fabric and Asphalt.

27. *Materials.*—On the prepared surface, apply the specified number of layers of approved saturated and coated felt, with a finished surface, and weighing about 14 lbs. per 100 sq. ft.

28. The bids shall be based on the use of the type of felt specified in paragraph 27, but additional alternate bids will be considered, based on felts or fabrics other than these, which may be approved by the chief engineer. In the event of such alternate bids being made, the bidders shall present with them sufficient data as to the methods of manufacture, quality of materials, and references to places where such felts or fabrics have been used, giving dates of application.

29. All materials shall be delivered on the work in their original packages, and properly branded.

30. The acceptance or rejection of an asphalt shall rest with the chief engineer, and shall be based on the requirements stated in paragraphs 31 to 37.

31. The asphalt used shall consist of fluxed natural asphalt, or asphalt prepared by the careful distillation of asphaltic petroleum.

32. It shall contain, in its refined state, not less than 98 per cent of bitumen soluble in cold carbon disulphide. The remaining ingredients shall be such as not to exert an injurious effect on the work.

33. When 20 grammes are heated for 5 hours at a temperature of 325° F., in a tin box 2½ ins. in diameter, they shall not lose more than 2 per cent by weight, nor shall the penetration at 77° F., after such heating, be less than one-half of the original penetration.

34. The melting point shall be between 150° and 190° F.

35. A briquette of the solid bitumen having a cross section of 1 sq. cm. shall show ductility at 40° F., and at a temperature of 77° F. shall show ductility of not less than 20 cm., the material being elongated at the rate of 5 cm. per minute (Dow moulds).

36. All tests shall be conducted according to methods approved by the chief engineer.

37. The penetration indicated herein refers to the depth of penetration in hundredths of a centimeter of a No. 2 cambric needle, weighted to 100 grammes, at 77° F., acting for 5 seconds.

38. *Application.*—All flashing and reinforcing around inlets and other places specified shall be carefully executed.

39. Waterproofing shall not be done in wet weather, or at a temperature below 32° F., without special orders from the chief engineer. The felt shall be laid shingle fashion, the first two layers longitudinally and the last three transversely to the center line of the bridge, where five layers are called for, and as specified in detail in other cases, and shall be carried up the haunching and made secure against the girder in a satisfactory manner, or as shown on the plans. The flashing against vertical or inclined surfaces shall be in accordance with the directions of the chief engineer, if not indicated. The first layer of felt shall not be cemented to the floor of a steel bridge, except around the drain outlets. On an arch bridge, the first layer shall be cemented to the top of the arch. At no point shall there be less than the specified number of thicknesses.

40. As the hot asphalt is spread, the felt shall be immediately rolled into it and rubbed and pressed over its surface, so as to eliminate air bubbles and insure thorough sticking. One mopful of the asphalt shall not be spread over more than 1 sq. yd. of surface at one mopping. Not less than 2.5 to 3 gals. of asphalt shall be used on 100 sq. ft. of a single layer of felt. The top layer shall also be mopped and the work done so that the layers shall be one compact mass.

41. The finish of the waterproofing against the girders or concrete shall be made with a pocket of pure elastic asphalt of the quality specified in paragraphs 31 to 37, except that the melting point shall be between 140° and 150° F., the ductility at 40° F. shall be at least 3 cm., and the adhesive qualities shall be satisfactory to the chief engineer.

The surfaces with which this material comes in contact shall be dry, absolutely free from dust or grease, and, previous to its application, shall be covered with a thin paint made by dissolving the asphalt in gasoline, as specified in detail in paragraph 15.

42. Particular care shall be taken to make a tight joint around gussets, stiffeners, and the ends of girders.

43. Care shall be taken to prevent injury in any way to the waterproofing by the passing of men or wheelbarrows over it, or by throwing any foreign materials on it.

44. After the waterproofing course has been completed, the horizontal surfaces shall be protected, as shown on the plans, by a course of straight, hard-burned and dense brick, laid flat in a bed of 1:3 cement mortar, with full joints. There shall be not less than ½ in. of mortar between the felt and the bricks. The brick shall not increase in weight more than 10 per cent when immersed in water for 7 hours.

45. The haunching, and about 18 ins. in width of the horizontal surface adjacent to the haunching, shall be protected, as shown on the plans, by about 2½ ins. of 1:3:5 concrete, reinforced with No. 8 and No. 10 wire cloth, electrically welded, having a 3x8-in. mesh.

46. Every care shall be taken to insure satisfactory and thoroughly water-tight joints between the main layer of waterproofing and the girders; and special attention shall be given to stiffeners, gussets, etc. The waterproofing shall also be carried down over the back-walls to below the elevation of the bridge seat, as shown on the plans, or as directed.

47. Rolls of felt shall be stored on end, and not laid on their sides.

48. Waterproofing shall be done only by experienced and expert felt waterproofers.

Natural Rock Asphalt Mastic.

49. *Rock Asphalt Mastic.*—Wherever called for by the plans, the decks of bridges shall be waterproofed with natural rock asphalt mastic, as specified in paragraph 50.

50. The cement concrete, prepared as specified heretofore, shall be waterproofed with asphalt mastic equal in quality for the intended purpose, as to ingredients used and resistance to water, to the following specifications, and be approved as such:

Sicilian rock asphalt mastic	60 parts
Clean, sharp, graded grit and sand to pass a sieve of 8 meshes per inch	30 parts
Asphalt as specified in paragraphs 30 to 37	10 parts

These proportions shall be varied when required by special conditions on the work.

51. The mixture shall be made at the site of the work, it shall be heated to a temperature of from 250 to 300° F., and shall be stirred until all the ingredients are thoroughly incorporated. It shall then be spread and thoroughly worked, to free it from voids, and shall be ironed to a smooth surface with smoothing irons, if so directed. All mastic shall be applied in two coats, making the total thickness shown on the plans. The two coats shall break joints, and the mastic shall be distributed evenly. Where the thickness of the concrete plus mastic is less than 2¼ ins., the full thickness shall be made up of asphalt mastic.

52. All mastic delivered on the work shall be properly branded. Waterproofing shall not be done in wet weather, or at a temperature below 32° F., without special orders from the chief engineer.

53. Pockets of asphalt shall be placed against all metal, and mastic along girders, around stiffeners, gussets, etc., as specified in detail in paragraphs 14 to 18, inclusive, and paragraph 41.

54. Great care shall be taken around expansion joints, drain pipes, and similar places, where a separation may take place.

55. After the mastic is laid, it shall be mopped with pure melted asphalt, and the surface shall be spread with a layer of clean, coarse sand, to harden the top.

56. The pockets of asphalt placed against the girders, stiffeners, and gussets shall be protected, as shown on the plans, by about 2½ ins. of 1:3:5 concrete, reinforced with No. 8 and No. 10 wire cloth, electrically welded, having a 3x8-in. mesh.

GENERAL CONDITIONS

57. *General Conditions.*—The furnishing and erection of the steelwork for the bridge to be waterproofed will be executed under a separate contract, and the riveting will be completed, the erection finished, and the steel floor cleaned up, ready for the waterproofing, before the work on this contract is begun. In addition to the foregoing, the contractor shall make a final cleaning of the steelwork before the work of waterproofing is begun.

Waterproofing of Counterweight Pits for Bascule Bridge.

Contributed by E. R. Whitmore, City Engineer, Port Huron, Mich.

During the spring of 1913 the city of Port Huron, Mich., completed a double-leaf bascule bridge to carry its principal business street across the Black River, the total length of which is 140 ft. and the clear channel width for navigation 70 ft.

Concrete counterweights were used to balance the dead load, and, as the bridge floor at the center of the bridge is only 15 ft. above low water level and the concrete counterweights are very massive, the bottoms of the counterweights are about 6 ft. below low water level when the bridge is open. The pits into which the counterweights drop are of reinforced concrete, the face wall (adjacent to the river) being 21 ins. thick and the back walls and floor only 12 ins. thick. The specifications for the work called for the use of a patented integral waterproofing compound, and this was used in the lower portion of the first pit. The contractor, however, had failed to procure a sufficient quantity of the waterproofing compound, and when the supply ran short, rather than delay the work, he was authorized to place the remainder of the concrete in this pit without the waterproofing compound, but was required to use sufficient cement to overfill considerably the voids in the aggregate. The other pit was waterproofed in the same manner, merely by the use of additional cement, without any waterproofing compound. The concrete was deposited wet, but not so wet as to cause the water to separate from the aggregate.

These pits have remained absolutely free from seepage, under a head of water of from 6 to 9 ft. The cost to the contractor for the additional cement was considerably less than the cost of the waterproofing specified

SEWERAGE AND SANITATION

The Prevention of Odors at City Refuse Disposal Works.

The disposal of city refuse, unless conducted in a proper manner, is likely to cause conditions under which offensive smells or odors are created and maintained. The present article, which is from a paper by Rudolph Hering, D. Sc., before the Sanitary Section of the American Public Health Association at its latest annual convention, examines into this fact more closely than has been done heretofore. It leads to some helpful conclusions and indicates improved ways and means for the prevention of the odor nuisance.

City refuse when delivered at the disposal plant may cause, in its raw state, offensive odors, chiefly after the beginning of the putrefaction of some of its parts. The odors here discussed relate only to those which are associated with the final disposal of refuse. They can be suppressed at once by subjecting the refuse on arrival to a proper treatment by any of the well established methods.

The different parts of a city's refuse are enumerated as follows: Garbage, dead animals, night soil, stable manure, street sweepings, ashes and rubbish.

All of these parts can be treated and finally disposed of by incineration. Garbage and dead animals can be treated by their reduction to grease and fertilizer. Or, garbage, dead animals, night soil and manure, can be buried as a final disposition. Manure, street sweepings, ashes and rubbish can sometimes be satisfactorily disposed of by dumping, and garbage sometimes as food for pigs.

CLASSIFICATION OF ODOR

The odors which may arise in connection with these various methods of treatment may be classed in two groups.

First.—Odors from the escape of pure gases which are soon converted into other gases that are not offensive. For instance, sulphuretted hydrogen persists in an offensive condition so long as it is concentrated or not decomposed, but when diluted in a sufficient quantity of air it is altered into other inoffensive compounds.

The general remedy for eliminating such odors, therefore, is either the discharge of the gases into an air current sufficiently great to get a quick dispersion and dilution, or the passage through a medium which produces a chemical destruction by fire, or through a disinfecting chamber, or by a dispersion into and a dilution by a sufficiently ample current of water. A disappearance of odorous gases by dilution in the atmosphere is generally quite rapid.

Second.—The odors from vapors, which are the gaseous forms of substances which normally exist either in liquid or solid form, and which, in the case of an incinerator, are frequently accompanied by extremely minute particles of solid matter or dust. For instance, we may refer to the odors from the vapors and dust particles which arise from a chimney and persist until they can be sufficiently diluted and the odor from them has become unnoticeable. Their disappearance by decomposition in the atmosphere, if it takes place at all, is extremely slow.

The remedy is substantially as above, namely, a quick discharge and dispersion in a sufficiently large air current if in an open country, or a passage through fire or through a disinfecting air chamber, or by dispersion and dilution in a sufficiently large current of water.

THE PREVENTION OF ODORS IN VARIOUS DISPOSAL METHODS.

For the prevention of odors it is of first importance that all solids or liquids causing them are removed as quickly and as thoroughly as is financially practicable. It is further important that the odorous gases and vapors are removed by natural or artificial ventilation, with the aid of furnace heat, blowers or air jets, or by a discharge into the atmosphere in a manner to effect a thorough dispersion and dilution.

Ordinary ventilation does not remove the vapors which are held at solid surfaces by absorption. A jet of compressed air frequently played against the interior surfaces of the buildings and against the clothing of attendants, will remove this source of odor. Odorous solids and liquids, from which the molecules carrying the odor are detached and rise up into the air, should not be long exposed about the works.

Special care should be taken, when the atmosphere is moist and warm, to suppress the odors about the works, because under this condition our olfactories are most sensitive to odors.

The tiring of the sensation of smell when continually active, forms some excuse for neglecting to keep the plants wholly inoffensive. It would be well, therefore, to establish reasonable rules, so as to control the suppression of odors and to enforce the rules even if men about the plants do not feel the necessity therefor.

It is most convenient now to discuss the odors as they relate to each of the above enumerated parts of a city's refuse, and in doing this I shall adopt the reverse order which was given above.

Feeding—Feeding garbage to pigs should be prohibited unless the garbage is delivered fairly fresh and without offensive odors. No decomposition sufficient to produce putrefaction of any part of the garbage should be allowed to have taken place. Slight odors of kitchen waste, such as we perceive at the collection can, are neither injurious nor objectionable, nor can there be objection to the odors of the first decomposition perceived when parts of the garbage have turned sour. Unless fed before putrefaction has begun, garbage should be disposed of in other ways.

Dumping. In order to discuss odors arising from the dumping of stable manure, street sweepings and ashes, we should discriminate between the several parts.

Stable manure, if put on fields and utilized or dumped on vacant grounds, may cause the familiar odor which according to the locality may or may not be objectionable. In the former case dumping should not be continued and old manure dumps should be completely covered with a few inches of ashes or earth.

Street sweepings, if dumped on vacant ground, should also be treated in this same manner, although the odors are generally not objectionable.

Ashes do not have offensive odors, but cause objection only from the dust which is raised by dumping and by winds.

Burial—The burial of garbage, dead animals, night soil and manure, is an efficient method of at once preventing all offensive odors. It is the oldest and most common method used for disposing of all such organic waste matter which cannot be more profitably treated in other ways.

Reduction—The reduction of garbage and dead animals is practiced in many large cities of our country. Of all treatments this one has produced the most objectionable odors, although it is neither difficult nor very expensive to prevent them.

These objectionable odors are due partly to the delivered garbage when it is temporarily stored at the plant until treated, partly to the fumes produced during the treatment, partly to the exposed tankage and partly to the exposed liquids discharged from the digesters and grease separating tanks.

To prevent the creation and maintenance of these objectionable odors, the works should first be kept scrupulously clean. The operation should then be so arranged that the freshly delivered garbage can be placed into the digesters within a very short time and best at once, and not be exposed in the open until it gets foul.

The gases and vapors arising in an ascending air current from the digesters, as well as from the presses, naphtha tanks, and wherever odors from the cooked garbage may be generated, should be caught in hoods closely placed, of sufficient size and proper shape, and discharging into pipes of diameters properly proportioned to carry away the respective amounts of odorous air ascending from each hood. The draft into the hoods and the circulation in the pipes is best effected by a blower of ample capacity.

The odorous air thus collected from all places where it is formed should be delivered at the best place for treatment. This place is generally below the grates of the furnaces connected with the operation of the works, where it can be passed through the fires by forced draft and be thoroughly purified by intense heat. If the quantity of this air is too great for serving the regular furnaces, an additional special furnace may be built to cremate the excess in quantity, as the complete destruction of the causes of all this odorous air is important. Or, the objectionable air may be discharged into the rear pass of the boilers which may sufficiently eliminate the odors. Practically all of the objections that have been made to the installation of garbage reduction works has been caused by the foul odors frequently emanating from them.

Another method of purifying this odorous air is by passing it through a disinfecting chamber, which method, however, is generally less efficient and more costly.

A noticeable improvement is often gained by making use of a compressed air jet to occasionally aerate the interior walls of the building in which garbage reduction is effected and the surfaces of all aparatus within the same and even the clothing of the attendants, which has been known to retain the odor for hours.

The foul liquids from such plants should at once be discharged into and carried away by a sewer pipe and disposed of as sewage.

Incineration—Incineration can dispose of all classes of city refuse without exception. It is a method by which all classes when thoroughly mixed can have the odors of all parts completely destroyed which may otherwise create a nuisance.

To accomplish this end, it is necessary to incinerate the refuse at a high temperature, nominally at least 1,250° F., so as to guarantee the sufficient combustion of all organic matter and thereby to remove all sources of odor. Burning at a low temperature is apt to leave some of the organic matter only partly destroyed, and in this incompletely destroyed condition some of it emits a strong pungent odor.

To guarantee the prevention of a nuisance from refuse incinerators it is, therefore, necessary to have high temperature furnaces, which allow of the escape from the stack of chiefly carbon dioxide, if the combustion is complete, and monoxide if it is less so, but sufficient to prevent offense.

When the combustion is perfect there is no visible discharge from the stack. When smoke is seen to escape, it furnishes evidence that unburnt matter may also be discharged. Most of this matter will be organic, because of its lightness, and it is probable that it will have an offensive odor which can be perceived where the fumes strike the ground or a window. This fact has caused frequent complaints to be lodged from inhabited areas to which these fumes had drifted. Minute and even invisible particles of solid and partly burnt organic matter are quickly dissolved and decomposed in the air, as is the case with gases. They drift and may travel a long distance as invisible clouds.

A pungent burnt garbage odor was recognized by myself on one occasion at a distance of over a mile from the stack discharging objectionable smoke, with a very faint wind blowing from the stack to the point of observation.

In order successfully to incinerate refuse in high temperature furnaces so that no odorous smoke will escape, it is necessary to use forced draft and to regulate carefully and intelligently the fires so that the combustion is at all times perfect and that no odorous smoke will escape.

To prevent odors about the plant, no garbage should be stored longer than a day before it is incinerated, although an offense from mixed refuse does not arise as soon as from garbage alone as generally delivered at a reduction plant. It is generally wise to arrange hoods and ventilating pipes in the furnace building to receive and carry the air, which may have become somewhat foul from contact with the refuse, to below the furnace grates and used with forced draft, so that the intense heat of the fire will thoroughly purify it.

At incinerators as at reduction works it is advisable to keep incinerating works scrupulously clean. No refuse should be left scattered about. Dust from the final clinker and ashes should be properly controlled and the floors of the buildings should be swept or washed daily. The walls of the buildings, the tools, clothing, etc., should be given, as often as found desirable, a blast from nozzles supplied with compressed air.

Attention to the above mentioned facts and to the conclusions drawn therefrom should prevent all offensive odors at refuse works, whichever of the best methods of disposal may be employed.

Suggestions on the Operation of Small Sewage Treatment Plants.

The following suggestions for the proper operation of small sewage disposal plants, where expert supervision cannot be afforded, are from the report of the committee on sewerage of the Indiana Engineering Society. The members of the committee are: Charles Brossmann, chairman; J. C. Diggs, and H. W. Klansman.

Plain Septic and Imhoff Tanks.—As the purpose of such tanks is mainly for the separation and retention of the suspended matter to as great a degree as possible, the tanks should be kept in such condition that this will be accomplished, otherwise efficiency will be impaired. To get the best results large accumulations of septic sludge should be avoided when they cause violent ebulition and a consequent carrying over of the sludge to the filters. The sludge should be removed when necessary.

In using Imhoff tanks the sludge should not be allowed to get above the depositing slots at the bottom of the settling chamber.

Large and unusual flows through the tank, such as storm water flows, should be diverted, especially in plain septic or sedimentation tanks. The removal of suspended matter should be as complete as possible, as the less of this matter reaches the filter beds the less trouble there will be in operation. Sludge should be blown off when possible at regular intervals, or at time of high water, unless provision is made for sludge drying.

In the event that there is no stream large enough to carry off the sludge at high water, then a sludge bed, well underdrained, should be constructed and the sludge run on to this bed, allowed to drain and then renewed afterward. Settling chambers of Imhoff tanks should be kept free of sludge, and in some cases where the slope of the hopper bottom is not steep enough the sludge should be pushed down through the slots or otherwise removed.

In some Imhoff tanks sludge mats are likely to form on the top surface of settling chambers and it will usually be found better to clean this mat off at intervals.

The effluent from tanks of any kind should be examined at regular intervals. If solids are carried over it is likely to cause trouble in the syphons, and in the case of contact beds the sludge, if carried over in quantities, will clog the bed in time.

Contact Filters.—The main trouble with contact beds is the tendency toward clogging. Contact beds should not be overworked and should have stated periods of rest. It is impossible not to get some matter carried over from the tank, but this can be taken care of in a way to cause the least trouble, and to catch most of the material before it works into the beds. Proper and complete underdrainage will assist greatly in getting rid of accumulations, but it is safe to say that few contact beds are very thoroughly underdrained. Too little regard is usually given to good underdrainage and proper bottom construction to contact filters.

In operating contact filters they should be filled by dosing; the sewage should then stand for several hours, usually about two hours. At the end of the contact period they should be automatically discharged and should have a suitable resting period of at least six to eight hours. Should the beds become clogged the stone must be removed and cleaned or new stone placed.

Sand Filters.—The sand filter is not so liable to trouble as the contact bed, but it goes without saying it should be kept as free as possible from material that will clog. When ponding occurs the bed should be raked about ¼ in. deep. The bed can be allowed to dry and the top skin will peel easily and can then be raked off. Slopes around filters should be sodded so that clay or dirt will not get into the sand and clog it.

Where the sewage is discharged by distributors into the bed it will be found advantageous to place large gravel or broken stone at such points, so that the sand will not be washed out or scoured.

Low spots on the sand area should be kept filled so that the sewage will flow level and all parts worked as uniformly as possible. In freezing weather the surface of the filter should be furrowed.

In conclusion operators who are not getting proper results out of their plants, or if they notice unusual conditions, should notify the State Board of Health, with a view toward getting things in proper shape.

Methods Employed in Sampling at Experimental Sewage Treatment Plant at Chicago Stockyards.

In Engineering and Contracting of Jan. 13, 1915, we published an article outlining the recommended procedure in disposal of wastes from the stockyards and Packingtown in Chicago. The present article describes the methods employed in taking samples for analysis at various points in the sewage treatment experiment station handling the liquid industrial wastes from the stockyards and, like the matter given in the former article mentioned, is taken from the report recently made to the engineering committee of the Sanitary District of Chicago.

METHOD OF SAMPLING.

In all routine sampling composites were made of 125 c. c. portions taken every hour. For special tests the procedure was changed to meet conditions. Owing to the wide variation in strength of the day and night sewage, two separate samples covering the heavy day and the weak night sewage were analyzed. Table I indicates the sampling schedule for the crude sewage. Weighted averages to cover the 24 hours were also made.

TABLE I.—SAMPLING SCHEDULE FOR CRUDE SEWAGE.

Date		Day sewage.—		Night sewage.		Remarks
From	To	First sample.	Last sample	First sample.	Last sample.	
Oct. 1, 1912	Jan. 1, 1913	8 a. m.	7 p. m	8 p. m.	7 a. m.	Daily
Jan. 1, 1913	Feb. 1, 1913	7 a. m.	10 p. m.	11 p. m.	6 a. m.	Daily.
Feb. 1, 1913	Jan. 1, 1914	8 a. m.	10 p. m.	11 p. m.	7 a. m	Bi-daily.
Jan. 1, 1914	Date	No samples	grit chamber effluent only.			

Up to Jan. 1, 1913, one composite covering the entire 24 hours was taken for the grit chamber and tank effluents. Thereafter "day" and "night" samples were taken for all devices, allowances being made in the tank samples for the nominal detention period in each case. After Jan. 1, 1914, no samples of crude sewage were taken, as the grit chamber effluent was practically identical in composition. Daily samples of the various effluents were taken up to Feb. 1, 1913, and after that bi-daily composites were made. Sunday samples were, however, kept separate and were omitted after Jan. 1, 1914.

The method of taking samples for the biologic oxygen consumption tests were as follows:

Up to May 1, 1914, two samples of crude sewage and of the effluents from each device were taken daily, the sewage samples being collected at 9 a. m. and noon or 1:15 p. m. and the effluents with proper allowance for the nominal detention period. Subsequently, samples were collected every two hours throughout the day (8 in all) and incubated. At the end of 10 days, the samples were mixed and the residual oxygen determined for the composite samples. In this way, much more representative results were obtained. Determinations were made on Monday, Wednesday and Friday every other week and on Tuesday and Thursday of the alternate weeks

Samples of sludge and scum for analyses were taken from the tanks, either when cleaned, or at stated intervals when cleaning was infrequent. Sludge samples were collected by lowering into the sludge mass a bottle attached to a stick and plugged by a stopper. The stopper was then withdrawn by a cord, allowing the sludge to flow in without catching any of the supernatent liquor. A number of samples at various depths were always taken to insure representative composites.

METHOD OF SLUDGE AND SCUM MEASUREMENT

Sludge was measured *in situ* in the tanks by the method devised by Mr. H. B. Hommon at Gloversville, N. Y. A wide-mouthed bottle, with stopper in place, was attached to a calibrated rod and lowered into the tank to a definite depth. The stopper was withdrawn allowing the bottle to fill. The bottle was then lifted and examined. This operation was repeated until the sludge line was closely located. This method was not wholly satisfactory, as it partly ignores the consistency of the sludge other than is visual. In cleaning the Dortmund tanks where the sludge was not entirely drawn out, the amount removed as calculated from the difference between measurements before and after cleaning was much smaller than would be supposed, due to the stirring and thinning of the sludge in the process of withdrawal. The residual sludge doubtless compacted again slowly after cleaning was completed, but the net result indicated a smaller accumulation of sludge than was actually secured. This tendency was more marked for tanks frequently cleaned and probably accounts largely for the lower average sludge accumulation noted for one tank, the time rate probably being somewhat higher. In the spring of 1914, samples of sludge were taken from the tanks both before and after cleaning, so that variations in moisture content could be traced and correction made.

Scums were ordinarily measured by running onto a sludge bed and noting the depth, or if small in amount, a calibrated can or barrel was used.

Meters Must be Sealed.—The Board of Public Utility Commissioners of New Jersey decided that it is not only the right, but the duty of a water company to seal all meters and to examine and test them whenever necessary. A consumer refused to permit the Lakewood Water, Light & Power Co. to test or seal his meter, and the company refused to supply him with water.

ROADS AND STREETS

Power Road Machinery With Special Reference to Hauling and Earth Road Grading.

The substitution of power machinery for hand labor in road construction and maintenance is one of the marked developments of the past decade. In a paper before the Missouri State Engineers' Association N. De-Wind, 904 Karpen Bldg., Chicago, discussed a number of the fundamental requirements of road machinery and his paper is given here.

Power driven road machinery is naturally divided into two classes, the one for preparing the road materials, and the other for handling the material on the road. In the first class, probably the most interesting power driven machines at the present time are those connected with the mixing and preparation of asphalt macadam surfaces. Under the same class come machines for preparing rock. The second class, that for handling the material on the road, is of deeper interest because it offers the greatest field for improvement at the present time.

EARTH ROAD GRADING.

One of the most remarkable phases of power driven machinery that is being developed today is the effort to revolutionize road grading. Up to a few years ago, horse graders, wheeled scrapers and such implements were considered up-to-date methods. Today, we have reached the point where those methods are certainly out-of-date, if not obsolete, owing to high cost of operation. The traction engine and the heavy grader have come to stay. At the present time, the development has been along the lines of building these graders on the same model as the horse drawn machines, but suitable for applying large agricultural traction engines to doing the work.

Looking into the future, I am inclined to prophesy that this is only a step towards another development. The road grader of the future, in my opinion, will be a more complicated machine. In fact, grading will only be part of the functions of the machine, as it seems to me that there is no reason why the trimming and finishing of the road bed should not be done by a machine combining different appliances for excavating the bed, forming the shoulders, grading the contour, and removing excessive earth.

Types of Combination Machines.—A step in this direction has already been taken by one firm. I refer to a machine self-propelled, by a gasoline motor, that can construct prairie roads, and discharge the earth at either side of the machine as desired. The machine is suited for plowing, grading or loading the earth into wagons without any adjustment or without stopping its operation. The wagons can be loaded at either side, the conveyor for loading the wagons being reversible.

One of the fundamental objections to a self propelled road grader is the fact that the engine power is confined to the service of that machine and not readily accessible for other purposes, whereas with the ordinary traction engine, the engine power is available for other purposes when not hauling graders, and therefore appeals more readily under present conditions of road making to officials and contractors.

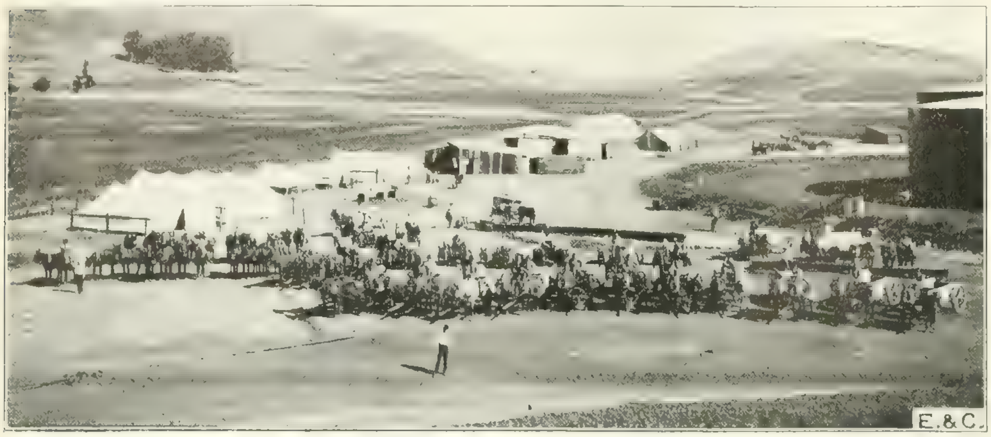

Fig. 1. Grading Camp in California.

The earth handled by this force, which includes about 80 mules and 40 men, could be handled by 8 traction engines and about 25 men.

Another development carried out by another firm is a combined roller, grader and drag hauled behind a traction engine. If I may be permitted to criticise this machine, I would say that the fundamental objection to it is that the rolling is imperfectly done, the lack of concentration of weight and the inability of the roller to cover the entire tracks of the grader being the reason.

Another firm has combined a traction engine with grader blades attached. No criticism can be made regarding the work done with the exception that the grader blades are pushed in front of the machine and not pulled and the traction engine, to a certain extent, mars the work done by the grader. This machine also has the same objectionable feature as the first, that it involves the investment of too much money for only one operàtion in the road building process being accomplished.

Another interesting development on the power road graders is the attempt to render them more useful by adding a scarifier attachment. These scarifier attachments have proved successful to a certain extent. I might say thoroughly successful so far as earth and gravel road beds are concerned, but I don't believe that any road grader with a scarifier attachment will ever be developed to successfully work on a hard macadamized surface or a road bed of similar hardness. There is a lacking in concentration of weight which again points us to the need of a self-contained, self-propelled road making machine. I might quote in support of this the success which has attended the attachment of scarifiers direct to heavy power driven rollers. This form of attachment has been undergoing a process of development by English road roller builders for some years and has been taken up in this country with some re-modeling to suit our conditions. I am merely quoting it as a proof that concentration of weight is a necessity for severe scarifying and this concentration is not likely to be obtained by any large sized grader that is hauled by an independent engine.

Motor Trucks.—One of the more recent developments in power grading and one that we are following up with considerable interest is the attempt of some of the heavy motor truck manufacturers to use their trucks for hauling graders. Many of the grader manufacturers have been surprised at the tremendous power these trucks have developed, so much so that some of the traction engines will have to look to their laurels so far as pulling power is concerned.

While, no doubt, everything is being done in re-designing these motor trucks for this new application, I am inclined to think that this is not a very sound development. The problem of hauling material is a very serious one in itself, and it will not do to prejudice their design as hauling machines to make them more adaptable for road grading.

Conclusions.—At the present time great efforts are being made towards producing more perfect road grading power driven machinery; these various steps in progress have been taken from many different directions, but we are all still very far from having the perfect combination machine that seems to be the ideal of all road builders.

While we are all striving for and we all hope to obtain an ideal machine much has already been accomplished. It is quite remarkable what power application to road machinery has already done, not only to improve the methods, but to reduce the cost of construction. The more we can reduce operating costs, the more we can invest in the first cost of the machine that effects that saving. A great many of our road builders are not giving that side of it sufficient consideration when they are deciding their purchases. The machine that costs the least in actual dollars and cents is not always the cheapest machine to buy when the results are considered.

One of the strongest incentives to adopting power driven machinery is the increasing cost of operation by other methods. The construction of earth roads by traction engines has been forced to the front by the higher cost of securing teams more than for any other reason. It is a notable fact that the more progressive and more prosperous the farming regions of this country become, the harder it is to obtain teams to do road building at reasonable prices. In many parts of the South, where farms are small and the farmers not so well to do, grading by horses is still strongly in evidence. Teams and men can be rented by the road authorities on very reasonable terms, as many of the farmers are very glad to make out expenses by devoting their teams and their time to this work.

POWER HAULAGE OF MATERIALS

Engines.—The greatest development in traction engine haulage of road graders has taken place in the states of Iowa, Missouri, Nebraska, Kansas and the Dakotas, where the farms are large and very prosperous. Touching upon the question of hauling road material by power, to which I have already referred as a serious problem, it is evident to all road builders that there is nothing adds so much to the cost of the road as the transportation of the material and there is no question that confronts the road builder that involves more chances of making a mistake. There are many conditions which must be investigated thoroughly. What is the comparative cost of hauling with horses? Are the roads and grades suited to power hauling? Will they stand the increased demand on their wearing qualities? Will the cost of fuel and maintenance of the engines in that locality compare with cost of hauling by horses?

Power road haulage of material was used in Europe before it was adopted here, and while it was developed there under entirely different conditions, we should not hesitate to learn and profit by some of their experiences and mistakes. The first developments took place in England, where the traction engine and train of wagons were adopted with more or less success. This form of haulage however, was under criticism and popular disapproval before the road builder had time to develop its use, owing to the roads having so quickly suffered by the use of traction engines for industrial purposes. Throughout England and many parts of Europe, the smaller factories are not located on railroads and do not have the railroad switching facilities obtainable in this country. Many of these factories are located several miles away from railroads and are dependent upon the use of the public roads for the haulage of their raw material, the delivery of their finished products and the bringing in of their coal and other supplies. You will therefore see that road haulage was forced on them as a means of existence. It only took a few years for the excellent roads in England to be threatened with destruction by the increasing use of traction engines and heavy wagons. Special legislation was enacted to control and restrict their use and special taxation was resorted to in an effort to make them pay for the damage they did to the road. This had the effect of compelling the factory development of the country to seek direct connection with the railroads and curtailed power road haulage to some extent.

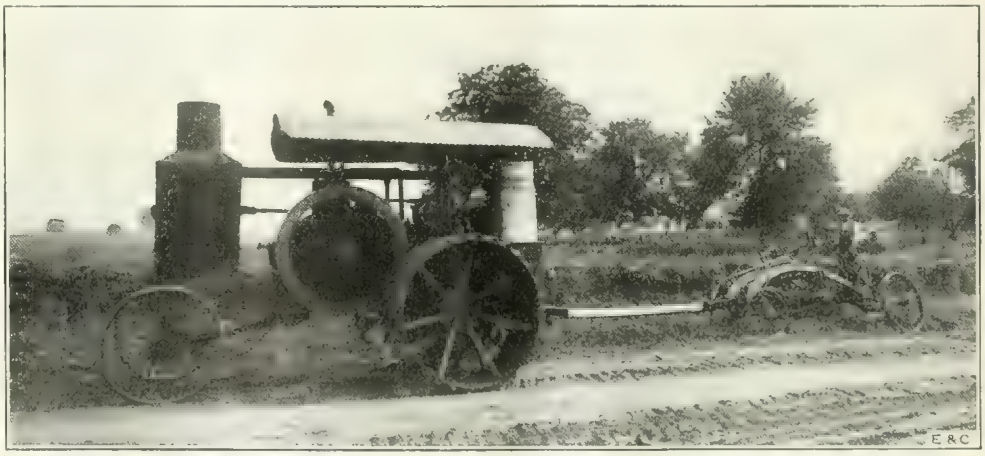

Fig. 2. Heavy Engine Grader Operated by Traction Engine and Two Men.

To secure the same results 10 horses and 4 men would be required.

Motor Trucks—Then the motor truck was developed, first of all operated by steam and later by gasoline. It is a curious thing that damage to roads never was so serious when traction engines were used as it became when the motor truck of the heavy type was adopted. The first English motor trucks were limited to 5 tons empty weight. The earlier designs had steel shod wheels like traction engines. Practically the entire load of 4 to 6 tons was put on this one set of wheels, and you will readily see that a comparatively small diameter of wheel with from 8 to 10 tons load on the one axle would certainly do more damage than a traction engine train with perhaps not more than 5 tons on each axle.

The heavy truck was therefore, proclaimed a road destroyer. Then came another phase—the small traction engine with one or two trailers was introduced. These were less severe on roads than the steel shod motor truck, but were not as economical as the larger traction engines. However, they ran them faster, as the law permitted them to run up to 7 or 8 miles per hour. There was not, however, a sufficiently rigid law on the kind of tires these small tractors and trucks could use, and consequently the roads again failed to stand this power propelled traffic. It was then that the road authorities recognized that roads would have to be built differently to suit the modern traffic, and not compel the traffic to suit the roads. The increase of motor cars assisted in forcing this question to solution and modern specially treated road surfaces are the result.

Conclusions.—We can learn from this experience that there is a great deal in making your roads to suit the traffic, but it is still more important to see that the traffic is borne on the right style of wheels, and not leave it entirely in the hands of the vehicle manufacturers to turn out whatever sort of machine they please. It is really their interest as much as the road builders to see that this is carried out.

If power haulage in this country is to be a success, it is imperative that vehicles are reasonably regulated in their design, weight and speed to suit the roads that modern road builders are capable of constructing. It is also imperative that the roads be built by skilled men and with foresight, so as to carry such self-propelled traffic that the community is likely to adopt.

MIXERS AND CRUSHERS AND OTHER ROAD MACHINERY.

The power driven mixers for drying stone, sand and heating bituminous binders are coming well to the front in city road construction. The power street cleaner, which not only sweeps but picks up the dirt, is also a recent development that is being gradually perfected. The power driven road oiler is a machine that is destined to interest country road builders in the near future, as we are all recognizing that our macadam roads can be preserved and made to stand more severe traffic by adopting the penetrating system of using oil. Power driven street sprinklers are also being used in the larger cities with considerable economy, and are likely to be still further developed as the problem of keeping horses in large cities becomes more aggravated. The power driven road roller has also been highly developed in recent years. The use of the internal combustion engine using gasoline or kerosene has not only lengthened the possible hours to be got out of a roller in each day's work, but it has also cut down the cost of operation, and by eliminating the problem of supplying coal and water in country districts it has greatly benefited the country road builder.

In the preparation of rock, there have been rapid strides made in the past few years. The rock crushing business has been naturally growing, not only from the demand for road material, but also by the introduction of concrete for so many new purposes. Rock drills are also undergoing considerable improvement both in compressed air and steam, and an interesting novelty in this line is the introduction of a gasoline driven rock drill, which for portability is likely to appeal strongly to the country road builder, who wishes to use such a machine at different points along the course of the road. In the large permanent quarries throughout the country, very large gyratory crushers have come into favor owing to their economy in handling the stone just as it is blasted from the quarry face. This in turn has opened up a new field for the steam shovel, which is a prominent feature in many of the larger quarries today.

The Purchase of Asphalt and Asphaltic Cement on the Bituminous Basis.

The following discussion of the advantages of purchasing asphaltic paving cement on the bituminous basis was presented as a paper before the recent Philadelphia meeting of Section D of the American Society for the Advancement of Science by W. H. Broadhurst, chemist, Bureau of Highways, Borough of Brooklyn, New York City.

To those familiar with the nature and composition of asphalts and asphaltic cements, the advantages from an economic standpoint of purchasing these materials on the bitumen basis is obvious. The bitumen, or carbon-bisulphide-soluble content of an asphalt, being the cementitious material which binds the mineral aggregate of an asphalt pavement or bituminous concrete together in a compact mass, it follows that, without giving consideration to the character of the insoluble material, or whether the same improves the value of the asphalt as a paving material or is deleterious, the greater the percentage of the insoluble material, the less the efficiency of the asphalt in respect of the number of square yards of roadway per ton of asphalt a given asphalt or asphaltic cement will lay. Hence to place all asphalts in competition on an economically sound or even basis, the same should be bought on the basis of the contained bitumen. Specifications for the purchase of asphalt should therefore be drawn outlining the requirements, first as to quality and secondly as to quantity of contained bitumen, instead of merely requesting bids for refined asphalt, or asphaltic cement, which is a very prevalent custom today with many municipalities operating municipal asphalt repair plants and state highway commissions purchasing asphaltic cement for state roads.

TABLE I—STATISTICS OF ASPHALT PURCHASING BY YEAR

Year.	Kind of asphalt.	Tons of refined asphalt furnished.	Minimum percentage of bitumen named in bid.	Price bid per ton of asphalt.	Corresponding price per ton of bitumen.
1907	Bermudez	900	—	$24.80	....
1908	California	300	98	23.50	$23.979
1909	California	600	98⅝	23.50	23.857
1909	Texas .	800	99½	20.00	20.100
1910	California	600	99½	23.80	23.919
1910	California	200	99½	22.98	23.095
1911	California	1,600	99½	22.15	22.261
1911	Cuban	100	81	10.00	12.345
1912	Mexican	1,300	99½	15.25	15.326
1912	Mexican	700	99½	15.25	15.326
1912	Mexican	300	99	19.75	19.949
1913	Mexican	1,500	99 7/10	18.75	18.806
1913	California	250	99½	18.74	18.834
1913	Mexican	250	99½	17.20	17.286
1914	Mexican	1,600	99 6/10	15.00	15.060

In purchasing refined asphalt for the municipal asphalt repair plant in the Borough of Brooklyn, City of New York, the principle of purchasing asphalt on the bitumen basis was adopted in 1908 and has proved satisfactory in all respects. The clause adopted, governing the bitumen content, was as follows:

"*Basis of Bidding*—The price bid must be the price per ton of 2,000 lbs. of refined asphalt and shall include the containing package.

"For the purpose of comparison of bids and as a basis of awarding the contract, each bid must name the minimum percentage of 'bitumen soluble in carbon bisulphide' which the proposed grade of asphalt contains, and the price per ton of asphalt shall be calculated to the corresponding price per ton of bitumen, from the percentage of 'bitumen soluble in carbon bisulphide' thus named and the contract shall be awarded on that basis. For example, an asphalt of $20 per ton bid, containing a minimum percentage of 90 per cent of bitumen will be rated at $22.22 per ton of bitumen."

Table I. shows the kind of asphalt supplied, the minimum percentage of bitumen named in the bid, and the price bid per ton of asphalt, by the lowest bidder, for supplying refined asphalt to the Borough of Brooklyn under the above specification since 1908, and also for the year 1907, when the specifications did not call for awarding the contract on the bitumen basis.

The following summary shows the prices bid at one letting in 1913 for furnishing refined asphalt, together with the kind of asphalt proposed to be furnished, and probably fairly indicates the prices at which the various grades of refined asphalt could be furnished at that time:

Kind of asphalt.	Minimum percentage of bitumen named in bid.	Price bid per ton of asphalt.	Corresponding price per ton of bitumen.
Bermudez	95	$27.25	$28.684
Trinidad .	56	21.80	38.928
California ..	99 7/10	19.49	19.548
Mexican ..	99 7/10	18.75	18.806
Mexican ..	99 8/10	21.50	21.543
"Hydrolene"	99 5/10	22.05	22.160
California .	98	21.55	21.989
Mexican	99 9/10	21.74	21.761
Texas . .	99 5/10	21.15	21.252

It will be observed from the above summary that on account of the comparatively low price at which residual or oil asphalts can be supplied, the "Lake" asphalts, or natural asphalts, from the standpoint of cost cannot seriously be considered as competitors. Residual, or oil asphalts, vary markedly in character, and the output from a given source of supply often varies widely in quality and in uniformity of grade, or penetration; hence, the specification should be drawn rigidly in respect of quality and uniformity of product.

In purchasing asphalt or asphaltic cement on the bitumen basis, any attempt at adulteration of the natural product by the addition of fine sand, clay, etc., is very thoroughly discouraged. It should be kept clearly in mind, however, that although refined asphalt or asphaltic cement is the material which is bought and paid for, the price paid per ton of asphalt should be regulated by the percentage of contained bitumen, so that fundamentally it is bitumen which is paid for. The specification should therefore state that "any asphalt delivered which falls more than — per cent below the minimum percentage of bitumen named in the bid, may be rejected, or may be accepted subject to the conditions hereinafter specified," and further, that "all asphalt accepted shall be paid for on the following basis":

"*Basis of Payment*—Payment shall be made for the number of tons of asphalt delivered, except that, in case the percentage of bitumen of the asphalt of any shipment falls below the percentage of bitumen named in the bid, a deduction in payment shall be made on the following basis.

"The total weight of bitumen delivered in any such shipment, shall be calculated from the net weight of asphalt delivered and the average percentage of contained bitumen, as determined by the average of the analyses of samples of said asphalt by the Laboratory of the Bureau of Highways. Said total weight of bitumen delivered, as thus determined, shall be subtracted from the minimum weight of bitumen which should have been delivered, calculated from the net weight of asphalt delivered and the minimum percentage of bitumen named in the bid. The difference, or shortage of weight of bitumen, shall then be multiplied by such a price per ton of bitumen as found by dividing the bid price per ton of asphalt by the average percentage of bitumen actually found by analysis. The amount thus determined shall be deducted from the amount which would become due as calculated from the bid price per ton of asphalt and the weight of asphalt delivered.

Payment will then be made to the contractor on the weight of asphalt delivered, at a price per ton, as determined with the deduction if any, as above provided."

For example, assuming 1,500 tons of refined asphalt have been delivered, the figures named in the bid being,

Minimum percentage of bitumen named in bid.	Price bid per ton of asphalt	Corresponding price per ton of bitumen
99½	$19.90	$20.00

and again, assuming the actual percentage of bitumen found by analysis to be 95 per cent, the shortage of weight of bitumen would be 67.50 tons, which multiplied by $20.947, the price per ton of bitumen found by dividing the bid price $19.90 by 95 per cent would give $1,413.92, the amount to be subtracted from the amount which would have become due had the percentage of bitumen named in the bid been maintained in the material delivered.

This in effect provides a penalty on a sliding scale for the contractor who fails to maintain the standard of percentage of bitumen of the material he proposed to deliver.

It might not infrequently happen that circumstances required the immediate acceptance of deliveries of asphalt which meet the specifications as to quality but fall below the minimum bitumen content as named in the bid. In such cases, the requirements as above given adequately provide for such contingencies.

An Example of the Improvement of a Section of Lightly Travelled Country Road Using Funds Limited in Amount.

On secondary roads the problem of providing a satisfactory surface for traffic resolves itself frequently into the skillful use of inexpensive materials found nearby. The total expenditure per mile is limited and the problem becomes that securing the best surface with the funds available. A method of attaching such a proposition was outlined in a concrete manner in a paper by S. P. Hooker, state superintendent of highways of New Hampshire, presented before the American Road Congress.

STATEMENT OF THE PROBLEM.

Given a country highway as it now exists and the proposition that for 10 miles of this road there is only available the sum of $25,000, what can we do to render this really an improved road, which under proper maintenance will take care of the traffic upon it? A preliminary survey may show that a portion of the road is in a low lying level section without proper ditches where at present the natural tendency of the road is to act as a sort of drainage canal for lands adjacent to it. The soil itself consisting partially of leaf mold containing a large amount of humus and which if used as a cultivated field would produce good crops.

The next portion may consist of a sand and gravel formation, containing boulders and on a grade of from 5 to 8 per cent, rolling over elevations and down into hollows and gullies and eventually working out into clear deep sand.

Succeeding this may be a hollow from which you rise upon a side hill cut through a clay bank. Here you face the proposition that the clay is of such a nature as to practically absorb all the water and where your drainage condition is most difficult to handle.

Your last section may be through ledge of native rock or large boulders, the soil slightly covered with either hard pan or sand and upon grades which easily wash under the annual rain falls.

On almost all country roads several of these conditions will ordinarily appear, while of course it is an exaggeration that they will all occur within the 10-mile stretch.

Confronted with these conditions it seems to me to be absurd to attempt a standardization of such a highway in order to economically work out your problem. You must use the material which is comparatively local and the treatment of each section will be different.

DESIGN FEATURES

Road problems may be roughly divided into four sub-divisions, and their order of importance is about as follows; drainage, alignment, grade and surfacing.

It is unfortunate that to most people the latter is more important, while relatively it is of far less importance than the other three. The surfacing material is frequently considered paramount and the settling of the question as to whether you have a bituminous road, penetration method or mixing, a concrete road, or a pavement type is the main subject of discussion and with far more attention given to it, than in my opinion it rightly deserves.

Your drainage, alignment and your change of grade are permanent features. The surfacing can never be permanent. I have sometimes wondered whether a bond issue to be paid for by posterity should ever be expended on any feature that is not permanent.

Concededly, surfacing of all kinds will require not only constant maintenance but rebuilding. With the essentials fully attended to it is surprising how the surfacing may be maintained at a comparatively small cost. I believe that it is as necessary for us to turn our attention to the economic side of the road question as to the scientific. A highway must have an economic road rental, as well as a fixed road maintenance and wherever the actual cost plus its maintenance exceeds its rental value we are wasting money in building too expensive a road. We must so adjust the scales that our costs are such as to provide a roadway for the traffic at the least possible expense.

Assuming a small apportionment available for the entire mileage needing improvement the economic question is what plan will you adopt for the treatment of such a highway. Will you practically complete this 10 miles with your money or will you build 3 miles of the higher type of roadway and leave the rest unimproved? This seems to be the attitude adopted by most highway departments. They standardize their plans and specifications and are content with the small mileage of what they are willing to say is the best construction and they dislike extremely to build for small cost what they term an inferior type of road. I believe this is a serious economic error and in most sections a road infinitely better than has previously existed may be built at a comparatively small cost to the great betterment of the roads in general and to the great help of the inhabitants of a State.

As far as automobile traffic is concerned, I am sure that many of the inferior types of road are far more satisfactory to them in general than the highest type. Your autoist cares little for a short section of the best possible road if at the end of it he plunges into what he is pleased to call an impassable road for three-quarters of the distance. I believe the development of roads in the future will be along the line of more mileage and less cost and that this is the proper trend of development.

IN UNDRAINED COUNTRY.

The width of the present highway must first be taken up and in general standardized for the ordinary traffic, probably a width of 21 feet between ditches is the most satisfactory standard and considering that this should be accepted as the width of the road, you are next confronted with the alignment and drainage.

In all probability the alignment will be comparatively easy over your level fertile section, but the drainage on this section will be your principal problem. Here in general you must first provide by deep ditching for reducing the water level of the surrounding land and by deep ditching I do not mean the ordinary ditch from which the crown of your road rises, but in many instances a ditch which acts to a considerable extent as a drainage canal.

You must provide culverts at all points where the drainage may be taken away from the road at every accessible point, and however level you may consider the plain or plateau as a whole, you will doubtless find a large number of places by which the water will be conveyed entirely away from the road and bother you no more.

In most instances the grading material obtained from the ditches, though seemingly of very inferior quality, may be used to raise the general grade of your road and if kept dry by the side ditches will compact and make a fair subgrade.

Your next essential is in some way to obtain upon such raised grade a sufficient quantity of metal of some kind to prevent the cutting through of your road surface from water which falls upon the road or in flood seasons cannot be entirely carried away by your ditches. On my plan this may be obtained from either fields, stone fences or even drawn from section two, which has an entirely different soil. In some places it would be necessary to practically lay this stone as telford. In other places it is enough to simply dump it in the road and only partially place it by hand labor. In many places where a roller is available this may be the method and the stone simply forced into the soft material which you have excavated from the ditches and which has not as yet thoroughly dried out from the service rendered by the ditches.

Now what shall be applied as your surface material? In many places you will find that along or adjacent to the road there are hills or hummocks which contain soil not properly either hard pan or clay, but in many places a combination of each containing considerable metal in the shape of either pebbles or fractured stone, and having obtained your bottom through drainage and the addition of stone so that you are confident your sub-base will be practically dry, you may apply 10 inches of the material containing a small amount of metal and by the use of road drags and road hones bring this first into section and next into a smooth hard surfacing, which will prove satisfactory in all weather for traffic, provided it has constant attendance and is repeated after every rain dragged with the ordinary road drag. The drag removes every slight rut which may be started and does not allow the water to settle through your weak upper surfacing. The maintenance must be not intermittent, but constant. You may find that you still have a somewhat slippery upper surface in which case it will be necessary to add an inch or two of your gravel or sand from section two. You will find that this will only require from 3 to 6 yards of your gravel surfacing per 100 feet and while it may be at a considerable distance from the improvement, it will not add materially to the cost.

Your surfacing upon such a type of road will require practically 2,000 yards per mile and if the material is from different banks along the roads your cost will not exceed 20 cts. per yard. It is then perfectly feasible over this section to build such a highway, including the raising of the grade from 1 to 2 ft. at a cost of not more than your estimated limit of $2,500 per mile.

HEAVY GRADING ON A SANDY SOIL

On section two, as I have imagined it, you have a problem of grading, rather than of drainage. That is, the soil will readily dispose of your water, but you must reduce the grades to a reasonable gradient and with a sandy material provide some method for compacting the road. The first to consider then is what shall be your maximum grade.

I confess that in this class of construction I proceed backwards, like a crab, rather than attempting to dictate an absolute gradient. That is, I take the heaviest grade and see to which per cent I can reduce this with a reasonable amount of money, instead of saying arbitrarily that a 4 per cent grade is the maximum, I figure how much it will cost for a 4 per cent, how much less for a 5 per cent and what the saving would be, should I allow it at even a 6 per cent grade.

We will say that I have found that I may reasonably reduce the grade on this section to 5 per cent. This I establish as a maximum and the other grades are brought to this maximum.

There will doubtless be considerable blasting on the large boulders to do on this section in order to properly widen your road, because the ordinary country road has no established width. In cutting your grades you will usually find that a considerable portion of the material which you have excavated in reducing the grade makes good surface material and almost your entire expense will be the shaping of your roadway and your drainage.

As I have imagined it, however, as you approach the end of this section you have run through your gravel and into what is practically sand. Here the gravel that you have on the other end will not properly compact or pack so as to make a suitable road surface and you will have to build practically a sand-clay road. I have not had good success with the sand-clay roads, unless I have practically telfordized the same by making the sub-base largely of metal.

In my treatment of this particular part of section two, I should endeavor from the gravel pits used on the first part of it to obtain the small boulders sufficient to build the entire bottom of the road to at least 6 inches in thickness of such pebbles. These I should fill with sand up to the top of the metal, then put on at least three alternating sections of clay and sand repeating until I had my road at least 10 inches thick, harrow each section as it is built up, seeing that the top surface is of sand rather than of clay. This portion of the section, as I advise building, will doubtless cost much more than the sum per mile that you have expended upon the gravel portion, but together they should leave your general average within the limit.

SIDE HILL REQUIRING UNDERDRAINAGE.

Section three, consisting largely of grade, is almost entirely a drainage proposition and it will be very necessary to practically tap the water coming from the side hill near the surface or originating within the road. You may find it necessary in many instances to run short drains for the express purpose of tapping the water holes, which come up in the road bed proper and it will doubtless be necessary on the inside of such a road to lay a side drain the entire length of every grade. A ditch should be dug on the upper side of your road to a depth of at least below frost line, a foot of sand being placed in the bottom and then an open drainage tile laid to as perfect a grade as possible and your ditch filled in with sand seems to be the most satisfactory way of cutting off this water.

Having shaped your clay road which is a comparatively easy matter as such a road will retain its section and may be practically worked with a road machine and then covered with, not to exceed 2 ins., of sand and gravel harrowed in as thoroughly as possible, though it is somewhat difficult upon a clay road to get the sand to work into it at first and the further application during wet weather of at least 2 ins. more, will ordinarily give such a road a most desirable surface. The only caution being that you must not apply the sand in large quantities at a time, but must expect to renew this surface frequently during the first two years.

LEDGE AND BOULDER EXCAVATION

We have assumed that we have now come to the ledge and boulder section and that all material must be drawn from a considerable distance to make a satisfactory road. Here without question, the most feasible plan is to use a macadam roadway. The putting up of a local crusher and the macadam method of construction may enable you to build at a less cost than would the use of the uncrushed material.

Frequently, however, on such sections there is a great difficulty in getting sufficient water to properly flush a water bound macadam road. You may obviate the use of large quantities of water by the use of bitumen but this adds greatly to the cost of your road.

Wherever macadam is used you may retain the same 21-foot section, though 15 feet should be the extreme width of the metalling. This will take 2,600 tons per mile of stone and assuming the use of 2¼ gals. of bitumen per square yard, your added cost will be something over $2,000 per mile. If water is fairly available, you may build your water bound road and apply one-half gallon per square yard of bitumen as a cover coat at a cost of about $650 per mile, which will reduce the cost of your road for light traffic about $1,500 per mile. Unless there is considerable trouble about getting your water therefore I should recommend the use of water bound macadam with the blanket coat.

You must consider also the added cost of maintenance upon your macadam road as compared with the cheaper forms, so that personally I should hesitate about using macadam whenever there is a possibility of using the cheaper surfacing.

MAINTENANCE.

Constant continuous maintenance is necessary upon all the types of roads that are built. It is indispensable, however, that upon the surfaces of the cheaper type of roadway the maintenance be both continuous and intelligent.

A road of what may be called natural surfacing, if left for even a week during the summer season without attention loses all its features of a good road. It must be constantly patrolled, all holes in it which have worn must be filled, all weak spots which develop must be repaired within a few hours after discovery or your road will so rapidly degenerate that it is useless as an "improved" road.

The higher types of roadway may be left for varying periods of time without attention and while this results in the end in being a more expensive method of treatment it is only a loss of money, you still have the road which may be repaired, but if you attempt this sort of treatment upon your cheap surface you eventually lose your highway entirely.

If the dust nuisance upon your cheaper road becomes intolerable it may be alleviated greatly and practically removed by the application of light bituminous oils or tars. The objection of this treatment, however, being the tendency on the part of a patrolman to allow the road to get out of section by neglecting to drag it after every rain, as he does not wish to destroy the skin coating on top, which is left after the treatment.

My experience is that a patrolman with a horse and cart, an efficient drag or hone and the willingness to work will keep in almost perfect condition from 5 to 7 miles a cheaply constructed roadway, at an approximate cost of from $175 to $200 per mile.

Given the same mileage of the higher types of road he will require a helper, a much larger equipment and if working upon bituminous roads probably not less than $150 per mile for material in the way of bitumen, crushed stone, etc.

My average cost of maintenance upon the higher types of road, including the use of a blanket treatment once in two years, will not be less than $500 per mile, and in many instances it will greatly exceed this. On the expensive road also you are constantly facing the fact that within a reasonable number of years you must resurface at a cost approximating $6,000 a mile, while upon your cheaper road, if properly patroled, you will find that your surface material is thicker than it was at the time the road was built and has been in practical perfect condition during the entire period.

Methods for Determining the Melting Points of Asphalts.

One of the most important qualities that asphaltic binders must possess is a well defined melting point. This characteristic is of special importance in connection with the selection of binders for use under different climatic conditions. A paper by J. G. Miller and P. P. Sharples before the American Society of Testing Materials outlines a satisfactory method of making melting point tests.

The methods for the determination of the melting points of coal-tar pitches have been practically standard for a number of years. What is known as the "half-inch cube method in water" (S. R. Church, "Methods for Testing Coal Tar and Refined Tars, Oils and Pitches Derived Therefrom," Journal of Industrial and Engineering Chemistry, Vol. 3, No. 4, p. 227; April, 1911) is the recognized standard for the determination of the melting point of pitches of a melting point below 170° F. The attempt has been made to adapt the method to higher melting points by substitution of a cotton-seed oil bath for the water bath, but the results have not been wholly satisfactory. The same methods applied to asphalts have not proved satisfactory owing to the low range of temperatures within which the method is adaptable; also because some asphalts have a specific gravity below that of the liquid bath.

TABLE I.—COMPARISON OF HALF-INCH CUBE METHODS.

Method.	Bath.	Apparatus.	Size of beaker, cc.	Temperature at start, deg. Fahr.
Oil-bath, Barrett Mfg. Co..........	Cottonseed oil	One beaker	600	60
Hubbard	Air	Two beakers	Air, 300 Cottonseed oil, 800	77
Air-bath, Barrett Mfg. Co..........	Air	Special copper oven	....	Normal

Note.—In all methods the specimens are ½-in cubes, and are suspended at a height of 1 in from the bottom of the apparatus; the suspending wire is of copper, No. 12 B. & S. gage; the rate of heating is 9° F. per minute; and the melting point is taken when cube touches the bottom of the apparatus.

Hubbard (S. R. Church, "Dust Preventives and Road Binders," p. 351, John Wiley and Sons, 1910) has proposed a method which removes the difficulties encountered, both for the higher melting point, coal-tar pitches and for the asphalts. The method, however, has not been widely adopted, and the asphalt manufacturers quote melting points by the ring-and-ball method.

In the laboratories of the Barrett Manufacturing Co. a method (S. R. Church, "Methods for Testing Coal Tar and Refined Tars, Oils and Pitches Derived Therefrom," Journal of Industrial and Engineering Chemistry, Vol. 5, No. 3, p. 195; March, 1913) similar in principle to Hubbard's method has been adopted. This also obviates the difficulties encountered in determining the melting point of hard coal-tar pitches and asphalts by the "half-inch cube" method.

Tables I and II show the results of tests of the half inch cube method and the ring-and-ball methods.

The great discrepancies observed between the melting points as determined by the ring-and-ball method in the above-mentioned laboratories, and the melting points given by the companies furnishing the asphalt, led to an investigation of the method. It was found that the method as employed in different laboratories differed essentially in details, especially in the dimensions of the apparatus and the rate of heating. As the rate of heating is known to give wide variations in results, the different methods were made comparable by adopting the widely used rate of 5° C. per minute. The results with different asphalts by the different methods are given in Table III

The necessity for standardizing the ring-and-ball method is very clearly shown by the comparison of the results from the apparatus of the Chicago laboratory of the Barrett Manufacturing Co. and that of the Standard Oil Co. The very surprising difference of 25° F. was brought out, which is as much as the difference between the Hubbard method and the ring-and-ball method of the Standard Oil Co.

It is also to be noted that the cube methods cannot be compared with the ring-and-ball method even by the introduction of a factor, since the relative difference depends on the kind of asphalt.

In Table IV is shown the effect of using a heavy wire in the half-inch cube method.

CONCLUSIONS.

The experience with the methods in the laboratory seems to indicate:

1. That the oil-bath method is inapplicable to asphalts, owing to their solubility in the oil;
2. That the Hubbard modification of the cube method gives concordant results and is a dependable method for check results;
3. That the ring-and-ball method has certain advantages for ease of laboratory manipulation, especially for low melting point asphalts;
4. That if the results by the ring-and-ball method are to be made comparable, every detail of the apparatus and method of testing must be specified.

TABLE II.—COMPARISON OF RING-AND-BALL METHODS.

Method.	Size of ring (brass). Diameter, in.	Depth, in.	Thickness, in.	Size of attached wire, in.	Diameter of ball (steel), in.	Bath.	Size of beaker.	Amount of liquid.	Distance of ring from bottom, ins.	Rate of heating, per minute.
Barrett Mfg. Co., Chicago Laboratory	11/16	⅝	1/64	5/32	⅜	Glycerin for high M. P., water for low M. P.	600 cc	400 cc	1	Water—5° C. Glycerin—7° C.
Barrett Mfg. Co., Philadelphia Laboratory	⅝	⅜	⅛	....	¼					....
Standard Oil Co. and Atlantic Refining Co.	⅝	¼	3/32	1/16	⅜	Water or oil	3 in. diam.	2 in.	1	10° F.
Gulf Refining Co.	⅝	⅜	3/32	....	¼	Glycerin	200 cc	Two thirds full	1½	5° F.
U. S. Asphalt Refining Co	⅝	¼	3/32	*	⅜					....

*Adjustable support.

Note.—The melting point in all cases is taken when ball touches bottom of apparatus; the temperature at the start is not given. At the Chicago laboratory of the Barrett Mfg. Co. the liquid is stirred.

TABLE III.—COMPARISON OF MELTING POINTS OF HARD, MEDIUM AND SOFT ASPHALTIC MATERIALS.
All results in deg. Fahr. Rate of temperature rise in all cases = 9° F. or 5° C. per minute.

Material.	No. 1, ½-in. cube, cotton-seed oil method.	No. 2, Hubbard, air-bath method.	No. 3, Barrett Mfg. Co., air-bath method.	Difference between Nos. 1 and 2.	Difference between Nos. 2 and 3.	No. 4, Chicago Barrett Mfg. Co., ring-and-ball¹ method.	No. 5, Standard Oil Co. and Atlantic Rfg. Co., ring-and-ball¹ method.	Difference between Nos. 4 and 5.	Difference between Nos. 4 and 2.	Difference between Nos. 2 and 5.	No. 6, Chicago Barrett Mfg. Co. ring-and-ball² method.	No. 7, Standard Oil Co. ring-and-ball² method.	No. 8, ½-in. cube in water.	Difference between Nos. 6 and 7.
Atlantic Rfg. Co., Phila. asphalt	292	277	262	15	15	280	260	20	3	17				
Atlantic Rfg. Co., asphalt	263	250	236	13	14	255	235	20	5	15				
Parolite from Standard Oil Co	...	250	239		11	...	225			25				
Hydrolene, Sun Co	...	194	187		7	...	175			19				
Taxes asphalt	246	230	214	16	16	237	212	25	7	18				
Oxidized flux oil	...	160	155		5	181	161	20	21	1	178	160	178	18
"D" grade asphalt		144	140		4	158	139	19	14	5	146	131		15
Chicago mixed asphalt	...	124	118		6	133	117	16	9	7	128	113		15
Flux oil	...	115	107		8	112	105	7	—3	10	109	97		12
Flux oil	...	108	101		7	107	100	7	—1	8	105	94		11

¹Glycerine bath used.
²Water bath used.

TABLE IV. — EFFECT OF USING A HEAVY WIRE IN THE HALF-INCH CUBE METHOD OF TESTS FOR ASPHALTS.

Material and method.	Melting point, deg. Fahr. No. 12, B. & S., 0.0808 in. diam.	No. 12, Stubbs, 0.109 in. diam.	Difference.
Atlantic asphalt, Hubbard air-bath method	250	254	4
Soft asphalt, Hubbard air-bath method	134	135	1
Medium asphalt, Barrett Mfg. Co., air-bath method	196	197	1
Hydrolene, Barrett Mfg. Co., air-bath method	187	191	4

Short Course in Highway Engineering, Cornell University, Ithaca, N. Y., Feb. 15-20, 1915.—A series of practical, instructive lectures will be given covering the fundamental principles of highway engineering. Practical highway engineering experts will discuss the most recent practice and developments of each type of road construction and maintenance and the erection and care of highway structures. These lectures will be illustrated by photographs and moving pictures. Each lecture will be followed by an informal discussion, thus affording, to all attending, an opportunity to discuss any points of particular interest. An important feature of this road work will be a question box in which anyone may deposit questions which will be taken up by the highway engineer best fitted to deal with each topic.

This meeting will be attended by a number of engineers of the New York State Highway Department, by County Superintendents, and by many others interested in highway work.

It is felt that this course will present an excellent opportunity for those attending to exchange experiences and thoroughly discuss many subjects of interest. The association with many others interested in the same kind of work will be of great value. The course should be of assistance to many who have been compelled to specialize in the construction of certain types of roads, in giving them an opportunity of obtaining the latest ideas in regard to other types.

The laboratories of the College of Civil Engineering are equipped with machinery for testing road materials. The staff will be glad to explain the machines and the methods of testing, and if desired will give demonstrations.

Everyone interested is cordially invited to attend. There will be no fees charged for the course. Reservations can be secured at either the hotels in Ithaca, or at private houses. More detailed information can be obtained by writing to the College of Civil Engineering, Cornell University, Ithaca, N. Y.

Cost of Caring for Trees in Newark, N. J.—The work of planting, caring for and removing trees in the city of Newark, N. J., during the year beginning July 1, 1913, and ending June 30, 1914, as given in the 27th Annual Report, consisted of trimming 1,904 trees, spraying 10,699 trees, removing 153 trees, planting 109 trees, cementing 8 trees, digging 109 holes, installing 84 stakes and guards and treating 14 trees. Service was also rendered for private work on lawns and trees and to companies having overhead wires on the public streets, for which charges were made, as follows:

Wire companies supervisor	$144.00
Spraying lawns and trees	6.25
Cementing trees	34.50
Removing trees	35.75
Furnishing and planting new trees	266.68
	$487.18

The cost of the tree service for the year was as follows:

Salary of forester	$1,200.00
Labor and teams	1,576.74
Tools	11.22
New trees (175)	129.61
Woven wire	21.69
Iron guard	2.50
Lumber	12.61
Paint	11.60
Chemicals	35.79
Zinc	8.02
Expense of forester to nursery	5.00
	$3,014.78

Meeting of Michigan Good Roads Association, Grand Rapids, March 9-12, 1915.—The seventh annual meeting of the Michigan Good Roads Association will be held on the 2nd floor of the Coliseum Annex in Grand Rapids, Mich., from March 9-12, 1915. An exhibition of road machinery and appliances will be held in connection with the meeting. About two-thirds of the space is selling at 20 cts. a square foot, the remainder at 15 and 25 cts. Speakers of national reputation will appear on the program and the officers state they are determined to have the meeting both interesting and well attended.

American Institute of Architects to Design Bridges.—The American Institute of Architects, through its president, Mr. R. Clipston Sturgis, of Washington, D. C., has offered to the Lincoln Highway Association its services in designing appropriate arches, bridges and tablets for use along the route.

An experiment is being made in Montevideo, Uruguay, with the so-called "Durax" system of street paving. A contract has been closed for laying 5,000 sq. meters of Durax in that city, materials to be shipped from Norway. Briefly, this pavement consists of small stone blocks laid in diagonal courses or in concentric interlocking segments of circles. It is known in Germany, where it is in common use, as "Kleinpflaster."

Engineering and Contracting

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The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Cement Block Machinery.—A manufacturer of cement pipes, artificial stone, etc., in Mexico, wishes to receive catalogues of machinery for making cement blocks. No. 15376.

Steam Hammer.—A business man in Italy desires to be put in touch with American manufacturers of steam hammers. He now has a demand for two steam hammers, one of 3 tons and the other of 7 tons size. He solicits catalogues, prices, etc., for hammers which are not now represented on the Italian markets. No. 15377.

Automobiles and Motor Trucks.—An American consular officer in Central America reports a possible market for automobiles or motor trucks. He transmits the names and addresses of two business firms in his district which may be in the market for motor trucks. No. 15385.

Dredging Machinery.—Copy of detailed report relative to opportunity for American firms to bid on dredging machinery may be had on application to Bureau of Foreign and Domestic Commerce. No. 15359.

Cement, Iron Work, Steel Tubes.—Specifications in Spanish may be seen at the office of the Bureau of Foreign and Domestic Commerce and its branch offices for the cement, iron and steel work, etc., needed for the construction of a waterworks plant in a South American city. No. 15361.

Chemicals, Metals and Wire.—A foreign government contractor and manufacturers' agent wishes to secure, immediately, exclusive agencies and quotations for commodities to be used in the manufacture of dynamite and powder; oleo stearin for candle manufacturing; iron plates, tin plates, steel rails, and steel plates for shipbuilding, etc. No. 15360.

Paper Mill Machinery.—Russian firm wishes the names and addresses of manufacturers of machinery and all necessary appliances for a mill producing paper for newspaper purposes. The paper is to be made from aspen and fir wood. It is explained that it is desired to equip a mill capable of producing about 2,160 short tons per annum. Correspondence should be in Russian, German or English. No. 15402.

Lead and Brass Working Machinery.—Latin American company is being organized for the manufacture of lead and brass tubing and lead and brass plates and seals. A representative of the proposed company states that he wishes to receive catalogues from American manufacturers of machinery for this kind of work. It is stated that cash will be paid for the machinery, which is needed immediately. Correspondence should be in Spanish. No. 15408.

Brick Machines.—A business man in Russia wants names and addresses of American manufacturers of machines, or devices for pressing brick. No. 15392.

Cotton Mill Machinery.—Business man in South America wants catalogs, prices, etc., on machinery for a cotton mill. No. 15386.

Woodworking Machinery.—Foreign firm wants names and addresses of American manufacturers of woodworking machinery. Correspondence should be in Russian, French or German. No. 15389.

Rakes, Hoes, Etc.—An import firm in Latin America desires to secure a line of rakes, hoes, lawn mowers, and general gardening implements. This firm wishes to represent on a commission basis. Correspondence is preferred in Spanish. No. 15394.

Rolling Stock.—The Siamese Royal Railway Department will receive bids, until June 1, 1915, for the supply of 40 bogies with axles and wheels, and 20 frames with vacuum brakes, footsteps and end railings complete for 20 bogie carriages without carriage bodies. Sealed tenders should be forwarded to L. Weiler, director general of the Royal Railway Department, Bangkok, Siam. Copies of forms of tender, specification and drawings are for sale at the Siamese Legation, Washington, D. C.

INDUSTRIAL NOTES

The Bucyrus Co. has been awarded the contract for a third dipper dredge to be used in the Panama Canal. The two large dredges, the Gamboa and the Paraiso, at present at the canal, were also built by this company. The Bucyrus Co. has received lately an order for three steam shovels and a dragline excavator to be used in the coal mines of the Southern Manchuria R. R.

Ceresit Waterproofing Co. of Chicago has established its New York office at 101 Park Ave., in the Architects' Bldg. Space has also been taken with the Architects' Samples Co. where the products made by the Ceresit Waterproofing Company are exhibited in a way tending to demonstrate their merits and with a view to giving the architect and his client the information required in deciding upon the proper materials to use. Mr. R. E. Clarke is the New York manager.

The Jones & Laughlin Steel Co., Pittsburgh, Pa., announces that it will no longer depend upon Russia, India and Germany for its supply of manganese. Since the war started in Europe the company has developed manganese deposits in Brazil and at present is operating its Aliquippa furnaces with ferro manganese brought from Brazil. One of the 500-ton furnaces was started Jan 18 on the supply that has accumulated during the last three months. The daily capacity in manganese is about 100 tons. The company will not sell this manganese but will use all of it at its own works. The manganese now being used at Aliquippa is said to be of the highest percentage of purity in the commercial field. The Jones & Laughlin company makes the announcement that with this South American supply it is in an easy position for the future in steel making. It is not likely the company ever again will look to the old sources of manganese supply. In the Pittsburgh district the price of manganese has jumped since the war began. It was selling at $38 a ton at the seaboard but when war broke out this price rose to $150 a ton. The alloy since has declined to about $75. It is predicted by Pittsburgh manufacturers that since the war has checked the shipment of manganese the trade will never be recovered by English and German shippers, as the ore found in Brazil, Chile and other parts of South America is of as good quality as the European product and can be produced much cheaper.

NEW CATALOGUES

Lead Wool.—Paper, 6x9 ins.; 4 pp., United Lead Co., 111 Broadway, New York City.

Describes an economical method of laying cast iron pipe, using Ulco lead wool. Illustrated.

Irrigation Meters.—Paper, 8½x11 ins.; 22 pp. Builders Iron Foundry, Providence, R. I.

Bulletin No. 132 describes a special Venturi meter for measuring irrigation water, and explains in full the installation, operation, recording devices, etc. Illustrated.

Water Softeners.—Paper, 8½x11 ins.; 4 pp. L. M. Booth Co., 58 Hudson street, Jersey City, N. J.

Circular containing views of a number of installations of Booth Water Softeners and several letters relative to operation and effectiveness under varying conditions.

silos.—Paper, 6¾x10 ins.; 44 pp. The Canton Culvert & Silo Co., Canton, Ohio.

Zyro metal silos, made of anti-corrosive, galvanized sheets are shown in this catalogue, and their construction described in detail. No-Co-Ro metal, the material of which these silos are made, is also described and its qualifications discussed.

Concrete Mortar and Plaster Mixers.—Paper, folder. The American Cement Machine Co., Inc., 1006 to 1030 Johnson street, Keokuk, Iowa.

Specifications and prices of Boss Mixers. Shows the various styles and engine, hopper, discharge chute, hoisting attachment, etc.

Trench Excavators.—Paper, 8¾x11¾ ins.; 32 pp. The Parsons Co., Newton, Ia.

A large and handsome catalogue showing views of actual operations of the Parsons trench excavators, and describing their design, construction and operation. Introduces two new types of the machines for water, gas and small trench construction.

Stump Cutter.—Paper, 8½x10¾ ins.; 4 pp. Moore Rotary Stump Cutter Co., Inc., 213 Hennen Building, New Orleans, La.

Brief history of the invention, and description of operation of the Moore rotary stump cutting machine, and an account of the saving in by-products from resinous woods which results from the use of this machine.

Concrete Mixers.—Paper, 6x9 ins.; 40 pp. The Knickerbocker Co., Jackson, Mich.

Describes the 1915 Knickerbocker line of concrete mixers, showing the various styles of Knickerbocker batch mixers and Coltrin continuous concrete and mortar mixers, with their equipment, and giving tables of capacities, etc., and diagrams showing design.

Steel-Bound Concrete Curb.—Paper, 6x9 ins.; 12 pp. Steel Protected Concrete Co., Real Estate Trust Building, Philadelphia, Pa.

Describes Wainwright steel-bound concrete curb, and combined curb and gutter. Shows the use of Wainwright galvanized steel corner bar in this construction and in concrete steps and columns.

Structural Concrete Buildings.—Paper, 9x12 ins.; 12 pp. Turner Construction Co., 13 Broadway, New York City.

Bulletin No. 14, under the title of "Spending the Owner's Money," explains the form of contract used by the company, the system of purchasing materials, labor, contractors' equipment, etc.; describes the work done by the contract and estimating, engineering, construction departments, etc., and shows views of structures erected by the company, with brief notes as to type, size, time required, etc.

CATALOGUE REVIEWS

Asbestos Protected Metal.—Paper, 8¼x10¾ ins.; 32 pp. Asbestos Protected Metal Co., 100 Main street, Beaver Falls, Pa.

Bulletin No. 54, with the title of "Asbestosteel for Roofs and Walls," is devoted to the special use of asbestos protected metal in connection with concrete for the construction of roofs and curtain walls, a type of construction which is called "Asbestosteel." Asbestos Protected Metal is the keynote of this construction and the composition and qualities of that material are explained.

Asbestos Protected Metal, being made up of sheet steel, asphalt, asbestos and a special white waterproofing, serves as the self-centering form for the concrete, which is again reinforced by steel. The methods of roof and wall construction are explained in detail, and a number of photographs are shown of structures in which it was used.

The properties of this type of roofing are described, reports of load tests, specifications and tables on weights, sizes, size of purlins, etc., are given.

Asbestosteel lath for walls and ceilings, Asbestosteel for stucco walls and interior walls, Asbestosteel for coal bin construction and for gutters is described and elaborately illustrated by photographs and diagrams. Views of construction work under way, the finished work, interior and exterior appearance, and special applications are presented.

CURRENT NEWS

The Doings of the Week.

A steady improvement in the condition affecting constructive operations has been shown during the past week. There has been a continued growth of optimism regarding the financial and industrial situation. An outstanding feature of the week was the Government's foreign trade statement for December showing an excess of exports of $132,000,000. This is the largest excess ever reached in December. Western railroads continue to show substantial gains in traffic, the increase being mainly in industrial tonnage. Increasing activities are reflected by the augmented volume of payments through the banks. Increased orders for steel, iron and equipment have been an important feature of the past few days. In the construction field there has been considerable activity. Two large railway contracts were placed and there are reports that several more important pieces of work in this line are now being figured on. Municipal work continued to show an increase in the number of projects reaching the call for bids stage. Some notably large projects in other fields are now being advertised and bids were opened on a number of good sized undertakings. In the iron and steel trade there has been marked improvement over last week. Mill operations are increasing and in the Pittsburgh district plants are now operating at about 60 per cent capacity. Rail orders placed recently are for small amounts, but on the other hand the carriers are buying freely of track supplies such as spikes, bolts and angle bars. Pipe manufacturers are increasing their business and numerous substantial contracts from municipalities and gas companies have been placed in the last few days. The National Tube Co. secured an order for an oil pipe line requiring 40,000 tons of steel. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Jan. 20 were as follows:

Finished Iron and Steel.	Jan. 20.	Jan. 13.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Pittsburgh........	1.17½	1.17½
Iron bars, Pittsburgh.........	1.15	1.15
Iron bars, Chicago..........	0.97½	0.97½
Steel bars, Pittsburgh........	1.10	1.10
Steel bars, New York........	1.26	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York......	1.26	1.26
Beams, etc., Pittsburgh......	1.10	1.10
Beams, etc., New York.......	1.26	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh......	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.80
Galv. sheets, No. 28, P'gh....	2.75	2.75
Wire nails, Pittsburgh.......	1.55	1.55
Cut nails, Pittsburgh.........	1.50	1.50
Fence wire, base, P'gh.......	1.35	1.35
Barb wire, galv., P'gh........	1.95	1.95

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railways.—Prospects are now excellent that some real old-fashioned activity in the railway construction field will be started about March. There is good reason to believe that a number of big jobs will be taken up about that time. One of the largest contracts placed since the outbreak of the European war was let last week. This called for about 28 miles of double track between Charlottesville and Orange, Va., for the Southern Ry. C. W. Lane & Co., Atlanta, Ga., and the Morrow Contracting Co., Atlanta, secured the work, which calls for an expenditure of about $1,500,000. Engstrom-Hosford Co., Northfield, Minn., have taken the grading contract for 85 miles of work on the Van Horn & Valley Ry. in Texas, for which Runquist & King, Duluth, Minn., are the general contractors.

Roads and Streets.—A considerable amount of municipal paving work, mostly in small jobs, is being advertised. A few highway jobs of fair size also are ready for estimates for construction. Road District No. 1 of Reeves County, Texas, is calling for proposals for 65 miles of machine grading and 30 miles of gravel surfacing; Ramsey County, Minnesota, is asking bids on macadam construction to cost about $80,000; King County, Washington, opens proposals Feb. 11 for grading about 30 miles of road, the estimated cost being about $150,000. The paving and road contracts let recently include the following: Enterprise Paving & Construction Co., Cleveland, at $83,449 for 20,000 ft. of brick road for Ohio State Highway Commission; Thogmartin & Gardiner, Fort Scott, Kan., a $76,250 paving job for the city of Sulphur Springs, Tex.; Brehon Bros.' Construction Co., Cincinnati, O., an $87,797 asphalt paving contract for the city.

Bridges.—No particularly large bridge undertakings appear to have come up for advertising during the past week. A considerable number of smaller structures, however, are ready for bids. In Illinois alone 10 small reinforced bridges are being advertised. Iowa counties are calling for proposals for supply of various materials for culvert and bridge construction, including corrugated culverts and cement. One of the large improvements on which bids were opened last week was a section of the new Hanover St. bridge at Baltimore, Md. The McLean Contracting Co., Baltimore, at $108,867, was the low bidder.

Drainage and Irrigation.—Several fair sized drainage contracts are now being advertised. In Koochiching County, Minnesota, bids will be opened Feb. 4 for four judicial ditches, the total length being 209 miles and the estimated cost $660,000. The Fabius River Drainage District No. 3, of Missouri, is asking proposals on 500,000 cu. yds. of channel excavating; the Borah Drainage District of Wayne County, Nebraska, opens bids Feb. 4 on 101,839 ft. of main and lateral ditches requiring 617,000 cu. yds. of excavation. Beltrami County, Minnesota, awarded contract for two judicial ditches to cost $35,000 and $77,825.

Waterworks and Sewerage.—In both the waterworks and sewerage fields a considerable number of contracts are now being advertised. In New York City the President of the Borough of the Bronx is calling for bids on an exceptionally large concrete sewer undertaking, and the Passaic Valley Sewage Commissioners, Newark, N. J., are asking proposals on important contract for the main intercepting sewer. The Tampa Water Works Co., Tampa, Fa., opens bids Feb. 15 on 206 ft. x 125 ft. x 20 ft. reinforced concrete reservoir; Joliet, Ill., opens bids Feb. 1 on a similar structure to cost about $20,000.

Rivers and Harbors.—A fair amount of Government river and harbor work reached the call for bids stage last week. The U. S. Engineer at Boston, Mass., opens proposals Feb. 18 for dredging in Chelsea Creek, Boston Harbor; the U. S. Engineer at Cleveland, O., is calling for bids for dredging in Toledo Harbor, O.,; the U. S. Engineer at Savannah, Ga., is asking bids for furnishing and placing stone for raising jetty at Savannah Harbor. The Coastwise Dredging Co., Norfolk, Va., was low bidder for 2,000,000 cu. yds. of dredging for Baltimore, Md.

Low Prices on Drainage Work.

Low prices and many bidders have been features of recent drainage lettings in Western states. A couple of weeks ago a judicial ditch in Polk and Norman Counties, Minnesota, was let at 9 cts. per cubic yard for the excavation. This is said to be the lowest price obtained in the state for some years. The road construction from the dirt thrown up from the ditch was bid in at $125 per mile. The ditch and its laterals have a total length of 37 miles. In all 11 bids were received on the excavation, the next lowest being 9¼ cts. per cubic yard; the others ranged up 17 cts. per cubic yard, while the figures on the road leveling ran up to $195 per mile. At a recent 1,650,000 cu. yd. letting in Otoe and Johnson Counties, Nebraska, the entire excavation was awarded at 7 cts. per cubic yard. Of the total yardage in this district 1,050,000 cu. yds. were included in the main canal. This is to have 10-ft. bottom width at the upper end, increasing to an 18-ft. bottom at the lower end. Side slopes are to be 1 to 1 and there is to be a 15-ft. berm. A 3 ft. by 5 ft. sub-channel is to be dug in the bottom of the ditch. The engineers estimated the cost of the excavation for the main canal at 8 cts. per cubic yard. The bids received ranged from 8.2 cts. to 5.33 cts. per cubic yard. There were 13 bidders on the work, and five of these submitted prices under 7 cts. per cubic yard on the principal part of the improvement. An interesting feature of this particular letting was the submission of bids by several contractors who heretofore have engaged mainly in railroad and grading work.

Over Due Construction.

Two weeks ago bids were asked on a notably large bridge job in a Pacific Coast state. The bonds for this work were voted in 1912 but were not sold until late last year. This improvement is but one of many that have been held in abeyance by the financial conditions that have prevailed during the first two or three years. Many undertakings, particularly those of irrigation districts and utility companies, originally proposed for construction in 1912, 1913 and 1914, have been held up because it was impossible to finance them. For the greater part of this work the engineering has been done and the plans and specifications prepared. All that remained was to secure the necessary money and to call for bids. It now seems likely that many of these projects will be financed in the next few months and that this long overdue construction will be offered to contractors. This is one of the things that makes for optimism regarding the outlook for the present season.

Liability Insurance in Ontario.

The Workmen's Compensation Commission of the Province of Ontario, Canada, judging from its insurance rates, is taking no chances. It has fixed the assessment for workers engaged in steel construction on high buildings at $7 per $100 of wages paid. This is an increase of $2.28 over the rates of liability insurance companies on similar work. The commission's rates for shop work are $2 per $100 of wages, as compared with liability company insurance of 42 cts. per $100. This increase in rates is rather a serious matter to the larger structural steel construction companies. They, however, have entered no protest owing to the assurance of the commission that there will be a readjustment of rates based on the first year's experience.

Bond Sales Over the Counter.

A noteworthy record was made by Philadelphia last week. In a single business day $5,000,000 of city, 30-year, 4 per cent bonds were sold over the counter. The issuance of baby bonds, securities of small denominations, and their sale to local investors is a comparatively recent development of municipal financing. Most of the cities that have tried it have found the demand for the bonds exceeded the supply. With the return of the municipal bond market to its normal condition, it will not be necessary for cities to retail their securities. The plan, nevertheless, furnishes a municipality an opportunity of securing necessary funds when it cannot obtain them in the usual way.

BRIDGE CONSTRUCTION IN ILLINOIS.

Bids Asked on 10 Concrete and 1 Steel Structure.

Quantities and Details of Constructional Features.

The large amount of highway bridge construction being undertaken at present in Illinois under the direction of the State Highway Department and the superintendents of highways of the various counties offers many opportunities to contractors specializing in small undertakings of this kind. During the past week notices of calls for bids for 11 small structures were sent out. Of these 10 are to be reinforced concrete bridges, six of them being located in the same county. Some details of these improvements are given in Table I.

The Jerome Black and Lewis bridges are to be built in Cornwall Township, Henry County, the nearest railroad station to the work being Atkinson. The present bridges are wood and are 16 ft. and 80 ft. in length. The low water flow is dry and 1 ft. deep; high water 7 and 10 ft. deep. The average depth of excavation is 9 ft. and 17 ft. in loam and clay, and is to extend about 4 ft. and 5 ft. below stream bed. Piles probably will be required at site of the Lewis bridge. Green timber for falsework may be cut near the sites of both bridges. It is reported Mississippi River gravel can be had f. o. b. station at about $1.70 per cubic yard. James H. Reed, Cambridge, O., is County Superintendent of Highways.

The Manlius bridge will be constructed in Manlius Township at a point about 5½ miles from the Rock Island Ry. station at Sheffield, Ill. The Gold bridge will be installed in Gold Township, about 5 miles from Sheffield. Both structures will be constructed over drainage ditches. At the Gold bridge sand is found 2 ft. below the bed of the stream and continues some distance. Low water is 3 in., but probably will average considerably higher in spring and may reach 6 ft. or 7 ft. in high water. Average depth of excavation is about 13 ft. in clay and loam to 4 ft. below stream bed. Piles probably will be required. The conditions at Manlius bridge are much the same as above, except that the sand begins 2 ft. or 3 ft. above bed of stream and continues 5 ft. or more below bed of stream. Water conditions are about the same as at the Gold bridge. Excavation will be about 13 ft. in clay, loam and sand to 4 ft below stream bed. Piles probably will be necessary. Concrete gravel can be delivered at either bridge site for 75 cts. to $1.25 per cubic yard. F. R. Bryant, Princeton, Ill., is County Superintendent of Highways.

The Dugan bridge is located in Bald Bluff Township, about 5 miles from Little York, the nearest railroad station. The present bridge is a 24-ft. span steel structure on wood abutments. Low water flow dry; high water 5 ft. deep. The average depth of excavation is about 5½ ft. in clay and loam and is to be carried 4 ft. below stream bed to clay foundations. It is reported that gravel may be had f. o. b. station at $1.20 per ton. C. R. A. Marshall, Stronghurst, Ill., is County Superintendent of Highways.

The August Weigand and Wm. Sloan bridges are located in Biggsville Township, being 3½ miles and ½ mile, respectively, from Biggsville, the nearest railroad station. The present bridge at the Weigand site is a 20-ft. span wooden structure; at the Sloan site there is a 40-ft. steel bridge with approaches, on wood abutments. Low water flow at each site is dry; high water flow 4 ft. and 10 ft. Average depth of excavation for Weigand bridge is about 6 ft., in silt and clay; at other bridge it is 8 ft. in gravelly clay. Excavation will be carried about 4 ft. below stream bed at each site to clay foundations. It is reported that stone and sand can be obtained f. o. b. station at $1.20 per ton. C. R. A. Marshall, Stronghurst, Ill., is County Superintendent of Highways.

The Brokaw, Griffith and John Simonson bridges are in Raitan Township, the nearest railroad stations being, respectively, as follows: Stronghurst, 7 miles; Sciota, 7 miles; and Stronghurst, 7½ miles. The present structures are wood on wood abutments, the spans being 20 ft., 24 ft. and 18 ft., respectively. Low water flow dry, 4 ins. and 6 ins.; high water, 4 ft. deep at each site. The average depth of excavation for the three bridges is 5 ft., 5 ft. and 6 ft., respectively, in clay, and is to extend about 3 ft., 4 ft. and 3 ft. below stream bed to clay foundations. It is reported gravel may be had f. o. b. station at $1.25 per ton. C. R. A. Marshall, Stronghurst, Ill., is County Superintendent of Highways.

The largest of the 11 bridges will be a steel structure on reinforced concrete abutments. This will be built in Princeton Township. It will have a 120-ft. span and 18-ft. roadway. The height over all will be 24 ft. The total estimated concrete in abutments and retaining wall is 2,147 cu yds.; reinforcing steel 19,060 lbs.; fill for approach grades, 1,300 cu. yds. The present bridge is a wood and iron structure, 75-ft. span, on steel tubes. Low water flow trace; high water over highway. Average depth of excavation will be 10 ft. in loam and sandy clay and will extend about 5 ft. below stream bed to clay foundations. The nearest railroad station is Princeton, which is 2 miles from the work. It is reported gravel may be had f. o. b. Princeton at $1.05 per cubic yard. Green timber for falsework may be cut near site. The estimated cost of the bridge, including retaining wall and backfill, is $8,530. Bids will be opened Feb. 9 and the work completed by Sept. 1. F. R. Bryant, Princeton, Ill., is County Superintendent of Highways.

TABLE I. CONSTRUCTION DETAILS ON 10 ILLINOIS BRIDGES NOW ADVERTISED FOR BIDS

Name of bridge	Jerome Black.	Lewis.	Manlius.	Gold.	Dugan.	August Weigand.	Wm. Sloan.	Brokaw.	Griffith.	John Simonson.
Span, ft.	22	60	30	14	10	16	40	18	18	18
Roadway, ft.	16	16	20	16	16	16	20	16	16	20
Height over all, ft.	12½	18	14½	13½	16	11	18	10	10	10
Total concrete, cu. yds.	60.5	187.2	86.5	61	67.9	[illegible]	158.7	43.1	43.1	48.2
Reinforcing steel, lbs.	6,790	32,530	11,125	4,900	4,240	3,870	20,548	4,460	4,460	5,230
Distance from nearest railroad station, miles	4½	5½	5½	5	5	3½	½	7	7	7½
Estimated cost	[illegible]	[illegible]	....	....	$1,025	$650	$2,290	$690	$720	$790
Bids opened	Feb. 1	Feb. 1	Feb. 9	Feb. 9	Mar. 2	....	....	....	....	....
Work to be completed	Aug. 1	Aug. 1	....	....	June 15	....	....	....	....	....

STATE WATER SUPPLY IN NEW JERSEY.

Development of Wanaque Water Shed.

Reservoir, Pipe Lines, Etc., to Cost $9,300,000.

Preliminary work and negotiations have been practically completed by the State Water Supply Commission of New Jersey on the two North Jersey plans for the state to furnish water to municipalities. One of these schemes provides for the purchase of the property and rights of the East Jersey Water Co.; the other calls for the development of the Wanaque water shed. In the last annual report of the Commission, from which this note is taken, it is stated the latter plan will be recommended if the municipalities interested will signify their willingness to have the Wanaque River developed and will enter into contracts to buy water from the state. The development is dependent upon all contracting municipalities owning their own distribution systems and purchasing water from the state at wholesale.

The total approximate cost of the Wanaque development is $9,290,750, of which $5,862,000 is for a low level supply of 50,000,000 gals.

per 1,000,000 gals. of amount contracted for ply from an intake just below the outlet of Greenwood Lake at an elevation of 572 ft. The construction of both of these supplies would not be undertaken at the same time. The estimated cost of the low level scheme, providing for obtaining a supply from the river with a dam at Midvale, is as follows:

Diversion rights	$1,000,000
Reservoir	1,149,500
*Pipe line to Patterson	1,800,000
†Pipe line to Newark	1,200,000
‡Pipe line to Elizabeth	260,000
Right of way	40,000
Appurtenances, meters, etc.	75,000
Engineering, etc.	337,500
Total	$5,862,000

*50,000,000 gals per day. †30,000,000 gals. ‡15,000,000 gals.

The detailed cost of the high level supply includes the following items:

Diversion rights	$ 500,000
Intake dam	50,000
Land for intake	2,500
Right of way	5,000
18-in. steel pipe line, 170,000 ft.	2,550,000
Appurtenances, meters, etc.	50,000
Engineering expenses, etc.	266,250
Total	$3,428,750

The law under which Wanaque River water shed development would be carried out provides that the several municipalities desiring to procure a supply from this source at wholesale must advance to the Commission $30,000 for 1,000,000 gals. per amount contracted for daily. In order to provide the Commission with funds for the purchase of reservoir and for the commencement of construction the State Water Supply Commission will issue bonds against this property as the work proceeds in a similar manner as is now the practice with building construction on a large scale. As a further security for these additional bonds the Commission will have contracts with the municipalities for the water desired by them. Forms of contract have been prepared for submission to the municipalities and if these are signed up so that the Commission can see its way clear to finance the work, the project will be undertaken.

The purchase of the East Jersey Water Co. properties, including water rights, filtration plant and distribution systems of Montclair, Paterson and Passaic would require an expenditure of about $9,200,000. Conferences have been held with representatives of the interested cities in an effort to secure unqualified expressions of preference for one of the two plans. It is expected that a decision in the matter will be reached soon.

Railway Valuation by Interstate Commerce Commission.—The Physical Valuation Division of the Interstate Commerce Commission has completed the inventory of the property of five of the railroads of the United States. These are the Texas Midland, operating 125 miles of line; the New Orleans, Texas & Mexico, 287 miles; the Atlanta, Birmingham & Atlantic, 645 miles; the Norfolk & Southern, 907 miles, and the San Pedro, Los Angeles & Salt Lake, 1,100 miles. The next step with regard to these railroads will be the holding of a conference in March by the Director of Valuation of the Commission with representatives of the state commissions interested and the five roads. In April probably the entire Commission will hear arguments on the findings and will attempt to settle the questions at issue in reaching the true valuation of the properties.

DEVELOPMENTS AT FT. McHENRY PARK, BALTIMORE.

Total Expenditure Preposed for 1915 by City $150,000.

Government Building to Cost $550,000 to be Erected.

Plans are under way for the establishment of a new waterside park at Baltimore, Md. The improvement will be located on a part of Fort McHenry Park. This park contains an area of 23 acres and is situated on the eastern end of a peninsula which is directly in the harbor of Baltimore. This peninsular lies between the North and South harbors, the North harbor being usually designated as the "Basin" and the South Harbor as "Spring Gardens," or the main branch of the Patapsco River. The United States Governument having no further use for Fort McHenry for fortification purposes, deeded these 23 acres to the city of Baltimore for park purposes, with the agreement that if at any future time this land should be needed by the Government that the city of Baltimore would return the same. The value of this land has been estimated at about $1,000,000, and it will make a site of a most beautiful park. It is now proposed by Baltimore to spend about $150,000 during the year 1915 in improving the same.

The various boat and rowing clubs of Baltimore have been occupying frontage on the Spring Garden side of the harbor, and one of the first steps taken will be to prepare on the south side of this park an artificial harbor for the boat clubs, offering them inducements to move from their present location to the location of the park. To that end a committee was appointed, of which H. K. McCay, City Engineer, was chairman, to formulate plans for this breakwater. A plan was adopted for a breakwater 1,715 ft. long, with a curve in it, to conform to the pier head-line established by the U. S. Government. This breakwater will consist of a single row of piles. reinforced on each side and on the top of these piles will be put a 6-ft concrete walk. This walk will be furnished with a railing, and at the end there will be a circular pavilion, which can be used as a lighthouse. The walk will be equipped with rings, to which boats can be moored, and with steps, so that parties can enter boats from the same. It will also be equipped with lights, adding a considerable feature to Fort McHenry Park. Between this breakwater and the western end of the park there will be about 2,000 ft. of shore line available for boat-house purposes. It is proposed by the city of Baltimore to move the boat houses to this location, giving them 225 ft. of shore space to each boat house, of which there are four, which will take up about 1,000 ft. of the shore line.

The city of Baltimore will pay all of the expense of moving these boat houses and also will pay for their embellishment, so as to make them suitable buildings for park purposes. The boat clubs are to pay a rental equal to 5 per cent on the expenses, also a 10 per cent sinking fund. It is expected by this arrangement to popularize to a large extent Fort McHenry Park and to make it a truly riverside park. Within this harbor there is also to be established a public bathing beach, under the jurisdiction of the Public Bath Commission of the city of Baltimore.

The U. S. Government has reserved three acres of this park for the erection of a large emmigration detention house, costing $550,000, so that it is expected by the city of Baltimore that not only the moving of the club houses to Fort McHenry Park, but also the erection of the emmigration building, will make this one of the most popular parks in Baltimore.

In addition to all of this, the Government has appropriated the sum of $75,000 for a memorial to Francis Scott Key, author of the "Star Spangled Banner," and it is proposed also to erect at the entrance of the park a memorial gate, design of which has not yet been determined upon.

Water Conservation and Development in New York.

The Conservation Commission of New York in its annual report transmitted to the legislature two weeks ago recommends that the state construct storage reservoirs to conserve flood waters and regulate stream flow. The cost of these reservoirs would be borne in part by the state and the municipalities benefited and in part by owners of water power sites, undeveloped as well as developed. The Commission believes that in order to secure the necessary funds, the valid power of taxation must be invoked and legislation must carry with it the power of eminent domain. It also is considered by the Commission that the development of water powers and their improvement by stream regulation would be construed to be a sufficient public purpose to validate the exercise of the necessary powers of eminent domain and taxation.

For some years the Commission and its predecessor, the State Water Supply Commission, have been working on a plan for the progressive development of the waterpowers of the state under state ownership, control and maintenance. In its recent report the Commission states that all phases of the problem have now been investigated, and it urges that prompt action be taken for the development and utilization of 1,500,000 hp. at present undeveloped and unutilized in the state.

In its report the Commission states that the construction of a reservoir on the Sacandaga River at an estimated cost of $5,000,000 would increase the total low flow water power of the Hudson River at the developed sites below Hadley from 29,490 hp. to 91,300 hp., and at undeveloped sites from 8,885 hp. to 61,500 hp. The scheme of regulation also proposes developments for the Genesee, Black, Oswegatchie and Saranac River.

Large Concrete Sewer, New York City.

Bids are now being asked by the President of the Borough of the Bronx, New York City, on the largest concrete sewer job that has come up for letting in that city for some months. The work calls for the construction of sewers and appurtenances in Pennyfield Ave. between the East River and Chaffee Ave.; Chaffee Ave. between Pennyfield Ave. and Throgs Neck Blvd.; in the latter street between Chaffee Ave. and Barkley Ave., with overflows for Throgs Neck Blvd. and Chaffee Ave. to the East River, and from the boulevard and Dewey Ave. to Long Island Sound. The improvement involves the construction of a considerable amount of large-sized concrete sewer. The engineer's estimate includes the following quantities for this particular feature of the work:

965 lin. ft., 11 ft. 3 ins. by 6 ft. 6 ins.
741 lin. ft., 10 ft. 3 ins. by 6 ft. 6 ins.
790 lin. ft., 9 ft. 6 ins. by 6 ft. 6 ins.
1,605 lin. ft., 8 ft. 9 ins. by 6 ft. 6 ins.
810 lin. ft., 8 ft. 3 ins. by 6 ft. 6 ins.
275 lin. ft., 8 ft. by 6 ft. 6 ins.
590 lin. ft., 7 ft. 9 ins. by 6 ft. 6 ins.
827 lin. ft., 7 ft. 3 ins. by 6 ft. 6 ins.
148 lin. ft., 7 ft. by 6 ft. 6 ins.
565 lin. ft., 6 ft. 9 ins. by 6 ft. 6 ins.
2,132 lin. ft., 6 ft. 3 ins. by 6 ft. 6 ins.
615 lin. ft., 5 ft. 9 ins. by 6 ft. 6 ins.
1,519 lin. ft., 5 ft. 6 ins. by 6 ft. 6 ins.
35 lin. ft., 4 ft. 9 ins. diameter.
[illegible] lin. ft., [illegible] ins. diameter.
36 lin. ft., 45 ins. by 60 ins.
75 lin. ft., 34 ins. by 46 ins.
112 lin. ft., 32 ins. by 44 ins.

The undertaking also calls for several hundred feet of vitrified pipe sewer 12 ins. to 30 ins. in size, 1,415 spurs for house connections and 99 manholes. Other items included in the work are 5,500 sq. yds. slope pavement, 1,500 cu. yds. rock excavation, 4,700 cu. yds. concrete Class B, 170,000 lbs. steel reinforcing bars, 135 M ft. timber, 115 M ft. timber sheeting, 135,000 lin. ft. piles and two overflow chambers. The work is to be completed in 600 consecutive days and the security required is $175,000. Bids for the construction of the sewer will be received until 10:30 a. m., Feb. 2, by Douglas Mathewson, President Bronx Borough, 177th St. and 3d Ave., New York City.

A $55,000 Paving Contract, McKinney, Tex.

A $55,000 street improvement contract is being advertised for bids by the city of McKinney, Tex. The work is to be done for Improvement District No. 2, and includes the following approximate quantities:

Pavement, sq. yds.	25,800
Excavation, earth, cu. yds.	[illegible]
Curb and gutter, lin. ft.	1,482
Curb and gutter, armored radial, lin. ft.	866
Curb and gutter reset, lin. ft.	[illegible]
Curb reset, lin. ft.	528
Curb, lin. ft.	748
Gutter, lin. ft.	1,826
Cement walk, sq. ft.	2,078
Curb and gutter catchbasins	[illegible]
V. S. pipe, 15-in., lin. ft.	310
Special outlet grates and box	2
Pavement (car track), sq. yds.	1,846
Excavation, earth (car track), cu. yds.	375

Bids will be received on sheet asphalt, brick, asphaltic concrete and other classes of pavement. The concrete base will be 5 ins. thick, composed of a mix of 1 cement, 3 sand and 6 broken stone or gravel. For brick pavement the samples of brick must not show a loss of original weight exceeding 24 per cent when subjected to the rattler test. Either cement grout filler or asphalt filler may be used. For the asphaltic concrete the specifications suggest the following grading of aggregate:

	Per cent.
Bitumen	7 to 11
Mineral aggregate passing 200-mesh screen	7 to 11
Mineral aggregate passing [illegible]-mesh screen	18 to [illegible]
Mineral aggregate passing 10-mesh screen	[illegible] to [illegible]
Mineral aggregate passing [illegible]-mesh screen	[illegible]
Mineral aggregate passing [illegible]-mesh screen less than	10

The specifications require that the equipment shall be sufficient to lay at least 500 sq. yds. of asphaltic surface in an ordinary working day. Bids for the work in Improvement District No. 2 will be received by Sims Cameron, City Secretary, McKinney, Tex., until 6 p. m., Feb. 3. Charles Schultz is City Engineer.

Cumro-Harper's Ferry Cutoff for B. & O. R. R.

Now that the Baltimore & Ohio R. R. has completed its Magnolia cutoff there is good reason to believe that one of the next big improvements undertaken by this railroad will be the construction of the new low-grade line from Cumro to Harper's Ferry. In fact it was reported two weeks ago that the contract for the work already had been let to H. S. Kerbaugh, Philadelphia, Pa. The report has not been confirmed as yet. Officials of the railroad have stated that at the present time they did not contemplate any work in this territory. However this may be, it appears practically certain that the cutoff will be started in the near future.

As outlined, the new line will start from a point north of Cumro, crossing the Cumberland Valley R. R. at or near Berkeley Station, and extending thence by way of Greensburg to a point near Swan's Pond. From here the road runs to Shepherdstown and thence to Harper's Ferry. The new line would eliminate many heavy grades. It would be about 23 miles long, which is practically the same length as the present line between Cumro and Harper's Ferry.

Convict Labor and State Quarries in New York.—An appropriation of $10,000,000 for highway construction for 1915 is asked by John N. Carlisle, State Highway Commissioner of New York, in his report to the State Legislature. In his report the commissioner advocates the employment of convicts in getting out stone for maintenance work, and the establishment of a plant for crushing the material. He suggests that state quarries be established on the Hudson River between New York and Albany, where trap rock can be obtained; in the Mahawk Valley near Utica, at a point between Albany and Plattsburg, and at two points in the western part of the state. During 1914 about 500,000 tons of stone for maintenance purposes was purchased by the state.

PERSONALS

Mr. R. D. Johnson, for six years past, hydraulic engineer of the Ontario Power Co. of Niagara Falls, Ont., and Mr. P. Wahlman have opened an office at 60 Wall street, New York City, as consulting hydraulic engineers. Mr. Wahlman was for two years, 1902-1904, superintendent of construction of water works in Sweden. From 1904 to 1907 he was connected with water power development in Sweden and Norway, and for three years following was in the same work in the United States. Since 1907 he has been chief engineer of the Cia. Hidro-Electrica de Tucuman, Argentina.

Mr. M. F. Clements, Assistant Engineer, Northern Pacific Ry., has been placed in charge of the grade separation work at Spokane, Wash., for the railway. The work consists in raising the tracks of the Northern Pacific through the business section of the city and eliminating grade crossings at 20 streets. The estimated cost of the improvement is $3,000,000. Mr. Clements has been engaged in engineering work for the past 15 years and since 1907 has been assistant engineer on construction for the Northern Pacific Ry. Previous to this he was with the Burlington, Cedar Rapids & Northern Ry. and the Chicago, Rock Island & Pacific Ry.

Mr. Samuel N. Polishook has opened an office at 50 Church street, New York City, as consulting civil and economy engineer. Mr. Polishook began his professional career in 1898 as a building mechanic and foreman. From 1900 to 1902 he was engaged in the design of power plants. From 1902 to 1906 he was a civil engineering student at Columbia University, and for three years afterward was engineer and superintendent for an architectural office. During the year 1910 he was foreman on building construction work and in 1911 was designer on New York subway work and also builders' estimator and office manager. Since 1912 he has been examining engineer for the Bureau of Buildings, Manhattan Borough, New York City, which position he now resigns to open his new office.

Mr. Harry G. D. Nutting, public utility expert and engineer, has been appointed manager of the engineering department of the John E. De Wolf Co., Railway Exchange building, Milwaukee, Wis. He will have general charge of the engineering and operation of public utility properties controlled by the company, and report on security issues. He will also continue his private consulting engineering practice. Mr. Nutting was at one time employed by the Fairbanks-Morse Co. as experimental engineer. He was also formerly an engineer for the Wisconsin Railroad Commission, and has since held positions as manager of the Fort Atkinson Municipal plant, district superintendent for the Central Illinois Public Service Co., assistant to the president of the Wisconsin Public Service Co., the Wisconsin Railway, Light & Power Co., the Evanston Railway Co., and consulting engineer to the Berlin Public Service Co.

Mr. M. Roy Thompson announces that he has resumed practice as consulting engineer in Tacoma, Seattle and San Francisco. Mr. Thompson is county engineer of Pierce County, Washington, and is past president of the State Association of County Engineers. He has had a wide experience in various kinds of engineering work. He designed and constructed the Thousand Oaks and other tracts near San Francisco and Regents Park, Tacoma, for Mr. John H. Spring of San Francisco. He has conducted right of way purchases for the Northern Pacific Railway Co. and the appraisal of $5,000,000 worth of that company's properties. As county engineer of Pierce County Mr. Thompson planned and built over $1,000,000 worth of concrete, asphalt, and brick roads, public highways and bridges and has compiled authoritative maps of Pierce County and Ranier National Park. He is an eligible Senior Highway Engineer in the U. S. Office of Public Roads under civil service rules. Mr. Thompson's personal address is Box 933, Tacoma, Wash.

Mr. L. P. Rossiter has been appointed division engineer for the Lehigh Valley Railroad on the Buffalo Division with headquarters at Buffalo, N. Y. Mr. Rossiter has been in railway engineering work since 1899, when he entered the service of the Baltimore & Ohio as a rodman. He rose to the position of assistant division engineer at Pittsburgh for that road in 1902, and the following two years he held the same position at Winchester, Va. From 1905 to 1910 he was division engineer at Pittsburgh. In December, 1910, he became engineer for the Youngstown Construction Co. of New York, and remained with that company until May, 1912, when he went into business in Coleridge, N. C. In April, 1913, Mr. Rossiter became assistant engineer for the Rock Island lines on construction of terminal at Inner Grove, Minn. Since March, 1914, he has been engineer Maintenance of Way at Des Moines and at Manley, Iowa, for the Rock Island.

Messrs. Virgil G. Marani and J. E. A. Moore have formed a partnership under the firm name of Marani & Moore, civil and mechanical engineers, with offices at 702-3 Euclid Building, Cleveland, Ohio. The firm will specialize in fire protection, acting as architects and engineers both for new fireproof buildings and for changing the construction of present buildings so as to reduce the fire risk. For the latter work the firm expects to assume the entire contract of engineering and installation. Mr. Marani was from 1895 to 1906 construction engineer for the Cleveland Gas, Light & Coke Co. For three years following he was engineering superintendent of the Cuyahoga County, Ohio, court house. In 1910-11 he was building commissioner of Cleveland, and since that time has been in private consulting practice, specializing in fireproof building construction.

Mr. Moore was resident engineer at Duluth, Minn., on Ore Dock & Railroad Terminal construction in 1891 to 1894, and for three years following was structural engineer with the Riter, Conley Mfg. Co., Pittsburgh, Pa. From 1897 to 1900 he was chief structural engineer for the Wellman, Seaver, Morgan Co., and for the next seven years was chief estimating engineer for that company. From 1907 to 1911 he was in partnership with the late J. W. Seaver in a consulting engineering business, and since 1911 has been chief engineer for the C. O. Bartlett-Snow Co. Both members of the firm are University graduates in civil engineering, and are members of the American Society of Civil Engineers, the American Society of Testing Materials, the National Fire Protection Association, and the Cleveland Engineering Association.

Mr. A. J. T. Taylor, for two and one-half years president and managing director of Taylor & Young, Ltd., engineers of Vancouver, B. C., has severed his connection with that firm to become managing director of the Taylor Engineering Co., Ltd., engineers and machinery merchants, 412-413 Vancouver Block, Vancouver, B. C. This firm, recently organized, specializes in pumping, power plant and machine tool equipment and already has been retained by a number of industrial concerns in Western Canada, as consulting engineer on pumping and power plant equipment. Mr. Taylor was formerly in 1907 assistant manager of the Schaake Machine Works, and in 1909 was works engineer for Canadian Explosives, Ltd. During the year 1910 he was assistant manager for H. W. Petrie, Ltd., and in 1912 became president and general manager of Taylor & Young, Ltd. Recently he has specialized on the pumping and power plant requirements of Western Canada. Mr. Taylor is an associate member of the American Society of Mechanical Engineers.

CONTRACTORS.

Mr. Louis Lock of Monroe, La., who was recently awarded a $286,000 contract on the water works improvements at Corpus Christi, Texas, a description of which appeared in our issue of Dec. 30, 1914, is proprietor and manager of the Home Heating and Plumbing Co., of Monroe. This company has installed many large heating, plumbing, water works and sewerage systems in various buildings, sanitariums, asylums, and other public institutions in Louisiana and Arkansas, during the past three years, and at the present time is engaged in similar work in Texas. Mr. Lock has had eight years of experience along this line. The present contract includes 15 miles of 22-in. cast iron water pipe, a complete filtering plant, and the installation of the engine room equipment.

OBITUARIES

George Herbert Webster, civil engineer of note throughout Western Canada, died recently at his home in Vancouver. Mr. Webster had long been connected with the engineering staff of the Canadian Pacific Railway, but at the time of his death was in private consulting practice in Vancouver. He was a member of the Canadian Society of Civil Engineers and of the American Railway Engineering and Maintenance of Way Association.

Thomas Coltrin Keefer, C. E., C. M. G., LL. D., one of the most noted pioneer engineers of Canada, died at his home in Ottawa, Ont., Jan. 7, aged 93. Mr. Keefer was born in Thorold, Ont., in 1821, and was educated at Upper Canada College, Toronto. He began engineering work immediately after graduation with the staff of the Erie Canal. Later he was engaged on Welland Canal work, and in 1845 was made chief engineer of improvement work on the Ottawa River. In 1850 he was engaged by the Canadian Government to make a survey of the rapids of the St. Lawrence River. Later Mr. Keefer was engaged in preliminary surveys for the Grand Trunk Railway between Montreal and Toronto. He also prepared plans for bridging the St. Lawrence at Point Saint Charles, was employed on construction of the waterworks systems of Ottawa, Hamilton and Montreal and built Montreal's first aqueduct. In 1874-75 he was chief engineer to the Ottawa Waterworks Commission. He afterwards served for a number of years as engineer to the Montreal Harbor Commission. It was largely due to his efforts that the railroads of Canada made the change from narrow gage track to the present standard gage.

Mr. Keefer was an author of note, having published a number of engineering books and articles. He was one of the founders of the Canadian Society of Civil Engineers and was twice president of that society. He was a member and past president of the American Society of Civil Engineers and a member of the Institution of Civil Engineers of Great Britain. He was commissioner for Canada at the First International Exhibition in London and at the Paris Exposition, at which time he was also elected an officer in the Legion of Honor of France. He was chairman of the Royal Commission on Ice and Floods, member of the International Deep Waterways Commission, and fellow of the Royal Society of Canada, of which he was also president in 1898.

CIVIL SERVICE NEWS

Manager of Municipal Auditorium, Oakland, Cal. Civil Service examination for this position will be held at Oakland, Feb. 15. Salary $3,000 to $5,000, depending on his success in making the auditorium a paying institution. Will have entire charge of the building, consisting of an auditorium and fully equipped theater combined. He will be expected to secure conventions, theatrical entertainments, etc., and to keep the building occupied as much as possible.

The U. S. Civil Service Commission announces an examination for hull draftsman; salary $1,800 per annum; Feb. 24 and 25, 1915.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

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All-Concrete Dams: the Next Step in the Evolution of Masonry Dam Construction.

The large masonry dam was formerly a shell of ashlar filled with rubble masonry. Within a decade this structural type has nearly disappeared. Large masonry dams are now shells of ashlar or of concrete blocks filled with rubble concrete. The change has increased the speed of dam construction three or four times and provides a no less sturdy and enduring structure than the preceding. There is a belief that another change in construction type is impending. This new construction, it is believed, will be all-concrete—no stone will be used except the broken stone coarse aggregate of the concrete—and it is believed that it will reduce further the time of construction.

The sole purpose of placing rubble in concrete is to reduce cost. All charges considered, unless a rubble stone in the dam costs less than would an equal volume of concrete the placing of this stone is not justified. No universal measure can be established which will determine when the use of rubble is economy. The measure is different for each dam. Will, in the specific case, 10 to 30 per cent more concrete cost more or less to produce and place than the same volume of rubble stone will cost to produce and place? In computing these costs all charges must be considered including particularly the value of time gained or lost by using one method instead of another. Plant charges are, however, the ones upon which the decision turns.

A complex—not complicated—plant is required for rubble concrete construction. In the quarry there must be plant for producing broken stone and other plant for producing blocks of rubble. This is the necessity also with the carrying plant from quarry to dam. On the dam the plant must be capable of handling and placing both rubble and concrete or a separate plant must be provided for each process.

Eliminating rubble eliminates all plant required specifically for producing and placing rubble. It permits the selection of any kind of concrete carrying and placing plant that may be best adapted to the requirements. All plant will be devised for the sole purpose of producing and placing concrete. This at least conduces to plant simplicity. Does it conduce also to plant economy?

It is obvious that in replacing the, say 25 per cent of rubble, with concrete, more crushed stone must be produced by a larger crushing plant and more concrete must be mixed by a larger mixing plant. But the carrying plant from quarry to dam need not be of greater capacity nor need the carrying and placing plant on the dam be of greater capacity. Indeed it is almost certain that in both places the same capacity can be obtained with less plant, even if the same kind of plant be used. For example a cableway and a derrick will handle and place per hour more concrete than rubble stone. Likewise a service railway from quarry to dam will transport per hour a greater volume of broken stone than of rubble blocks. Even without change of type of handling plant concrete can be put in place faster than can blocks of rubble. This fact is one of frequently recorded observation, though precise comparative figures are not of frequent record. But the greater plant advantage of all concrete construction comes in another way.

Plant designed solely for handling concrete has the advantage that it has no secondary purpose to fulfill. An inspection of the plant on the dam of any recent large rubble concrete dam demonstrates first that the necessity of handling and placing rubble stone has determined the nature of this plant and second that many of the units of this plant are solely occupied in rehandling operations—in picking up buckets or stones brought almost to place and moving them a few remaining feet to exact position. This is a necessity difficult to avoid if one plant must handle both rubble and concrete. It can be easily avoided if choice is extended to all plants which can handle concrete alone.

By all concrete construction the field of plant selection is broadened. If rubble is to be handled the choice of plant is narrowed to the kinds that will handle both rubble and concrete. If concrete alone is to be handled cableways and derricks and cars are not eliminated from the competition, but belt conveyors, pneumatic conveying and chuting methods are added to the competitors. All of these newer concrete carrying methods have been successfully used in dam construction. They all carry and place in final position without rehandling.

Interest would be added to this consideration could precise comparative figures be given. Without them a convincing argument is difficult. However, it seems possible to assume these facts: Concrete construction permits of simpler plant than does rubble concrete construction. It reduces on the whole the amount of plant required. It permits a wider choice of plant and therefore a more precise fitting of plant to conditions. The construction operations are of one kind: constant repetition gives unusual skill; there is no delay caused from changing operations or from one operation awaiting on the performance of another different operation. All these are advantages. They may not warrant final decision that all-concrete dam construction is economically superior to rubble concrete dam construction but they do indicate a possibility of increased speed and economy which is worth determining.

In 1915 Let There Be More Public Work Than Ever.

When any American city can sell $5,000,000 of 4 per cent bonds at par "over the counter" in six hours, there is slight excuse for postponing public work. Not many cities have the wealth of Philadelphia, whose bonds were thus easily disposed of, and greatly oversubscribed besides, but money seeking safe investment is now so abundant that every municipality of sound credit can raise all funds needed for public improvements. Nor has there been a time in many years when a dollar thus invested would secure so much effective labor and materials.

The manufacturer and the merchant may still hesitate about resuming "full blast," but solely because of uncertainty as to a ready market for the output. But a city having a need of improvements—better pavements, better water supply, better sewerage—has not to wait for a "market" for the better health and the cheaper haulage. Business men in charge of city affairs are not always quick to appreciate the difference between investing in goods that must be sold quickly and investing in a public plant that yields its services over a long period of years. In the latter case low interest rates and low prices for materials will give the maximum of benefit at the minimum of cost to the public.

Is this not an opportune time for local engineering societies to give added publicity to the great opportunity that cities now should seize?

The money scarcity that the war caused six months ago has entirely disappeared. The labor scarcity prior to the war has—unfortunately for laborers——also disappeared. Not in 20 years have there been conditions more favorable for the construction of public works and plants of all kinds. Engineers know this, and realize the great economic opportunity. It is part of every engineer's duty to bring to public attention, as forcefully as practicable, the desirability of building now for the future.

Fortunately most cities are showing no indication of curtailing their normal expenditures for public works. But this, good as it is, is not good enough. There should be an abnormally great amount of public work done this year. Entirely aside from the desire to reduce the number of idle men, we advocate large appropriations for municipal, county, state and federal government improvement. Our advocacy of this rests upon purely economic grounds.

In recent lettings of public contracts, as repeatedly recorded in the current news columns of Engineering and Contracting, the number of bids has been very large and the unit prices have been low. Prices of structural materials will probably not be as low again in ten years as they now are. Laborers are willing to work with vim, and delays from strikes will not occur. For the individual or company having funds to invest in plant construction, 1915 will be a most favorable year.

Doubtless many will be far-sighted enough to act accordingly. The public has no economic reason whatever for failing to act vigorously in adding to the public plant—roads, streets, sewers, water works, irrigation works, drainage systems, etc.

Had there been a period of inflation—a great "boom"—prior to last August, we should not now be urging investment in more plants—public or private. But for seven years the brakes have never been fully off the wheels of progress. The panic of 1907 cut the air pipe and set the financial brakes with a shock. Then came three years of gradual release and slow acceleration. Hardly had industrial momentum reached the normal when the "presidential year" again put the brakes on. The period of uncertainty as to tariff legislation had barely ended when the "great war" began. Also acting as a deterrent to progress in certain lines—notably railway construction—there have been "seven lean years" of hope from relief from extremely radical legislation. In another sense those were "seven fat years," years corpulent with attacks on the rates charged by railway and public service companies.

Looking back upon the period between October, 1907 and August, 1914, we see nothing that remotely resembles either the seven years prior to the panic of 1873 or that of 1893. During those no-panic years, there was an enormous industrial expansion, and at the same time there was a most unsatisfactory currency condition—two features that made inevitable those great panics. Each of those two panics (1873 and 1893) was followed by the failure of thousands of corporations, the closing of banks, the foreclosure of mortgages, the sale of real estate for taxes, and all the sequent phenomena of extreme industrial debility. We need but to contrast those two real panics with the so-called "panic of 1907" to appreciate how slight was the financial illness seven years ago, and how slight the indisposition of the last seven months has been.

Recovery from great and prolonged fever is slow. Recovery from a touch of influenza is rapid. The panics of 1873 and 1893 were the commercial typhoids of those days. All subsequent troubles have been merely commercial spells of "grippe." And we may profitably carry the analogy farther. Just as nearly all municipalities have rid themselves of typhoid epidemics through the scientific sanitation that engineers have effected in the last two decades, so bankers and the government have scientifically eliminated most of the currency troubles and their consequent "fevers."

Other forces have also been active in America tending with equal effectiveness to eliminate conditions leading to severe panics. We refer to the forces that have been so frequently legislated against and so loudly and often unwisely damned—the "trusts," even to the "money trust." One effect of the numerous consolidations of capital in America has unquestionably been to reduce competition. Consider what that entails: First, a greater uniformity of prices and rates of charge; second, higher wages to the average employe; third, curtailment of excessive production; and, fourth, reduction in the number of dollars invested in plant per dollar of annual output.

This last named effect is one not often spoken of, even by the trusts in their own defence. But it has been very evident to those of us who have done appraisal work for many corporations. It means that there has been a steady decrease in duplicate plants, plants built by competitors in excess of probable needs. Duplicate plants have nearly disappeared from the railway and public utility field. We still have, unfortunately, a good many duplicate telephone systems, but the great wastes of capital thus caused by unbridled competition are being steadily reduced. Reduced by whom or by what? by the "trusts," the consolidations of capitalists in each of the industries. While there is no real "money trust," there is certainly a publicity as to projected plants that, coupled with publicity as to earnings of existing plants, serves effectually to close the doors of investment bankers against many an unwise project that would have been easily financed fifteen or twenty years ago.

Whatever may be the defects of a monopolistic system—and there are many—certainly one of them is not overproduction, either of goods or of the plants that make the goods. The days of excessive building of railways, factories, etc., have almost vanished.

It is well to review these and other great changes that have occurred in America since the memorable 1893, for not infrequently business men, harking back to that "Coxey army" period, attempt to forecast similar conditions whenever there is a financial flurry. "History," if bad, "repeats itself" only a few times, and then come changes that make repetition impossible. This is particularly true of great disasters, for the ingenuity of men is aroused by ill fortune to prevent recurrence of it. Ultimately ingenuity triumphs. The great plagues of the middle ages are of the history that comes no more to civilized nations. The great panics have had their last staging. And, let us hope, "the great war" is the final act of the recurring tragedies of its kind.

This, then, is not the time to worry over the histories of '73 and '93, for those histories will have no future parallel. This is the time for every man—and particularly for every engineer—to urge the loosening of public purse strings wherever there are public improvements needed. Such action will be truly economic, and, besides, it will inspire similar action on the part of companies and individuals.

A School for Water Works Employes at San Diego, Calif.

In the introductory paragraph of the article entitled: Field and Office Methods in Connection with the Laying and Repair of Large Water Mains at San Diego, Calif., which was published in our issue of Jan. 13, 1915, it was stated that monthly meetings are held by the officials and foremen of the San Diego Department of Water. We desire here to call special attention to these meetings, to tell of their object and of the success which has attended them, and to commend the holding of such meetings in large water works departments.

The Department of Water at San Diego lays all its pipe, valves and fittings by force account, and also builds its own pump stations, flumes, aqueducts and other works. The valuation of the entire system for the collection, conveyance and distribution of the works is $7,500,000. The distributing system consists of over 400 miles of pipe: the temporary pipe is wrought iron of a minimum size of 2 ins. and the permanent pipe is cast iron ranging from 4 ins. to 36 ins. in diameter. The impounding system consists of four large reservoirs. The department at the present time is constructing a concrete dam, 70 ft. high, by day labor.

To carry on all the foregoing activities several hundred men are employed. As it is the superintendent's aim to have the highest attainable efficiency in the conduct of the affairs of the department of water, he has had periodical meetings with the men for the purpose not only of getting them together and thereby making them better acquainted, but to familiarize each of the various bureaus, into which the department is divided, with the work done and the methods employed by the other bureaus. Thus a study is made of the procedure within the department from the time a request for material is issued until the material is delivered on the ground and ultimately placed in the improvement for which it was ordered. At these meetings the various construction foremen and other employes of corresponding rank in other bureaus read papers in which they record their experiences and the methods they employ in handling the work in their charge.

The results obtained by the meetings have considerably raised the efficiency of the department. The men take a keen interest in the meetings. Good-fellowship is also promoted, as it brings the men and foremen together, thereby oftentimes eliminating imaginary grudges. The superintendent, who is also a member of the City Council at San Diego, has many demands upon his time, and only by means of the meetings here discussed can he get in direct personal touch with the various employes.

The character of the programs of papers presented before these meetings may well be illustrated by the meeting held on Jan. 27, 1915, in the council chambers of the city hall at 7:30 p. m. The names and titles of the officials on the program, at that meeting, and the titles of their papers, were as follows:

Rainfall, Runoff and Catchment, by Rudolph Wueste, Supervisor, Bureau of Conservation.

Durability Test Given Meters, by W. O. Allen, Inspector, Bureau of Engineering.

Accomplishing Results, by G. E. Gabrielson, General Foreman, Pine Creek.

Development Plan for Distributing System, by P. H. Thearle, Chief Draftsman.

Making and Inspection of Hydrants and Fittings, by Nate Van Denburgh, Receiving Clerk.

We believe our readers will agree that less pretentious programs have been offered at the annual conventions of some of the smaller water works associations.

The success of this plan at San Diego naturally leads to the suggestion that it be tried elsewhere. We believe that such meetings could be held to great advantage in the water departments of all cities of a population exceeding 100,000. In many smaller cities the plan might well be tried. For example, to the best of our knowledge, the population of San Diego has not yet reached 50,000. Good managers of water works properties will do well to give careful consideration to this plan.

GENERAL

Determination of Stresses in and Design of Cast Iron Lining for Subaqueous Tunnels.

In rock or self-sustaining ground, the lining of a sub-aqueous tunnel may consist of masonry, brick or concrete. In sand, gravel, disintegrated rock and still more in mud and silt, it is necessary that the lining attain its maximum strength at once before the shield be moved forward; this has led tunnel builders to generally adopt cast iron for the lining, which is made up of rings bolted to one another by means of circumferential flanges and divided up into a certain number of plates or segments bolted together by longitudinal flanges. The number of segments depends on the length of circumference, each segment, in order not to weigh too much, being generally not over six feet long. Each ring consists of a certain number of such segments and of a key, which, being set in from within to close the ring, must have its outer arc smaller than the inner one. This means, of course, that the longitudinal flanges of the segments in a ring are all radial except the flanges of the key and the adjacent sides of the two segments abutting against the key. In a paper before the Canadian Society of Civil Engineers Mr. P. A. N. Seurot presents some of the problems in tunnel lining design and discusses their solution as follows:

The weight of the lining increases rapidly with the diameter; likewise, the moment of resistance of a segment increases with the depth of the flanges, so that, within certain limits and whenever possible, it is advantageous to distribute the metal so as to increase the depth of flanges.

Empirical formulas give the approximate weight of lining; the best of these have been given by Mr. Raynald Legouez (1) and by Mr. Harrold Berridge (2).

Legouez's formulas are: $W = \frac{1}{3} D^2$ for poor or soft ground, and $W' = \frac{1}{4} D^2$ for good or fairly good ground, in which W is the weight of lining, expressed in metric tons, per lineal meter of tunnel, D being the diameter in meters. To reduce these quantities to English measures, these formulæ may be written as follows: $w = 20.713\, d^2$, and $w' = 15.535\, d^2$, in which w is the weight in pounds per lineal foot of tunnel, and d the diameter in feet.

Berridge's formulas are: $W = 11.9 \times H \times R$ for poor or soft ground, and $W' = 9.5 \times H \times R$ for good or fairly good ground, in which W is the weight in pounds per lineal foot of tunnel, H is the hydrostatic head and R the external radius, both in feet.

Table I (see p. 92) gives the actual weights of some tunnel linings compared to the theoretical weights figured according to the above formulas. In the formulas using the hydrostatic head H, the maximum depth between high water and the lowest point of tunnel invert has been used in the calculations.

From Table I it appears that the formulas in which the hydrostatic head is taken in account give results rather too high. This is due, probably, to the fact that the maximum head has been assumed in the calculations, whereas an average head would perhaps be nearer the real conditions, and also because the action of the weight of the ground or of the skin friction has not been deducted from the action of the hydrostatic head.

These formulas were deduced from actual practice, from experience in tunneling through all sorts of ground, and from observations as to the behavior of the lining after erection, common sense and precedents usually fixing the weight of the lining, the thickness of the skin and the depth of the flanges. In a few instances attempts have been made to analyze the stresses in the tunnel ring after it had been so designed; this analysis, however, gives either extraordinary results or merely a sort of moral check on the empirical design. This state of uncertainty is due chiefly to the lack of knowledge of the law of earth pressures and also to the constantly changing conditions of the various strata through which the tunnel is built, as it is not unusual to find at one time four or five different kinds of grounds at the face of the heading, grounds in a more or less fluid state and each with a different angle of repose.

It may be assumed that the lining resists the bending moments due to the loads without being supported by the surrounding ground, or it may be assumed that the lining has only to resist compressive forces, in this case the rigidity of the structure being ensured by the reactions of the surrounding ground.

In the first case it is necessary to determine the external forces, both vertical and horizontal, each element of the surface supporting a hydrostatic pressure calculated by the head of water on the center of gravity of the element and also a column of earth corresponding to the projection of this element on a horizontal plane. The resultants of the horizontal and vertical components are then found and laid off to form a load diagram. In order that there be equilibrium, the loading must be symmetrical on each side of the vertical axis, and, after deformation of the shell due to the loads, the points *C* and *D* must remain on the same vertical plane, and the two lines of thrust at *C* and *D* must be horizontal and act as the reactions of all the horizontal components $h_1 \ldots h_n$ (see Fig. 1). By taking the moments of these components about *C* and *D*, the reactions h_1O, h_nO fixing the pole *O* are found, and a line of thrust may be drawn and the correct line of thrust will be the one along which the sum of the positive bending moments equals the sum of the negative moments.

If it be assumed that the lining has to resist only compressive forces, the rigidity of the structure being ensured by the resistance of the surrounding ground, from Fig. 2, it may be seen that the maximum pressure due to the hydrostatic head takes place at *a* and is equal to *WH* per square foot, when *W* is the weight of a cubic foot of water. The radius *R* being constant, the reaction on the ground is maximum at *b* and is equal to *WH—Wh*. The lining has to resist a maximum compression equal to $WH \times R$, which, divided by the area of cross-section *a* of the metal per lineal foot, gives the unit stress.

$$S = \frac{WHR}{a}$$

The local stresses in the lining, shell and flanges may be determined by assuming that the shell takes a bearing on the circumferential flanges and is subject to a bending moment due to external pressure. In order to determine the value of this moment, it is necessary to admit that the skin of the lining is a straight plane, which is assuming conditions worse than they are.

From the above load *WH* the maximum pressure *p* on an elementary slice of the shell 1 inch square may be found and by calling *l* the length of the ring under investigation (see Fig. 3), the bending moment *M* in the center of the lining, the continuity of which is ensured by the bolting of the circumferential flanges, may be written:

$$M = \frac{pl^2}{24}$$

and if I is the moment of inertia of the slice, *c* half the depth and *S* the stress in the extreme fibre, this stress is:

$$S = \frac{pl^2 \, I}{24 \, c}$$

In the plane of the flanges the moment *M'* becomes:

$$M' = \frac{pl^2}{12}$$

and in the root *r* of the flange (Fig 4), when this section is at a distance *t* from the end, *I''* being the moment of inertia of this section, the moment *M''* is:

$$M'' = M' - \frac{pl}{2} \times t + \frac{pt^2}{2}$$

and the stress *S''*:

$$S'' = M'' \cdot \frac{I''}{c''}$$

In regard to the stresses in the bolts, if the lining is supported by the ground, the internal air pressure during construction is taken as being the only force acting, and the stresses on the longitudinal and circumferential joints are determined, as in the case of cylinders or boilers, subject to internal pressure. If there is no support from the surrounding ground, the stresses in the longitudinal seams are determined by taking the total moment on the shell tending to open or close the upper joint about the bolts or the inside edge of the flange.

The stresses due to the hydrostatic pressure may be determined in some other way by dividing them into four groups, each group consisting of the forces acting on a quadrant of the ring of lining. Figs. 5 and 6 show the location and magnitude of these forces, *L* being the hydrostatic head above the top of the tube, *D* the diameter of the tube, *V* and V_1 the vertical forces, and *H* and H_1 the horizontal forces acting on the upper and lower quadrant respectively, their value being the product of the horizontal or vertical projection of each quadrant, as the case may be, by the respective depth and the weight of a cubic foot of water. Each of these four forces passing through the center of gravity of the shaded portions, it is easy to determine the point of application of each force on the lining, and to compute the lever arms about the vertical and the horizontal axes, and get the bending moments about points *A* and *B*, where these moments are maxima.

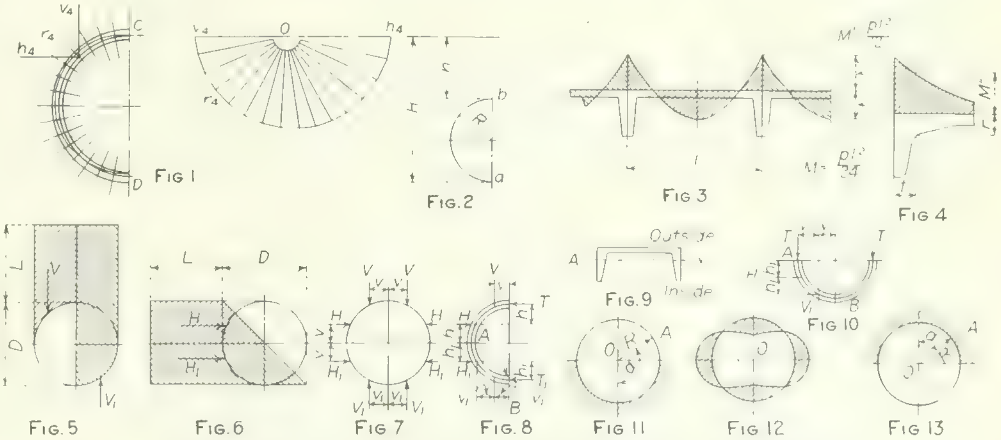


Fig. 1. Diagrams Illustrating Computation of Tunnel Lining.

To find the stresses at point *A*, the tube is supposed to be divided in halves by the vertical axis and the forces and lever arms are shown on Fig. 8. From these the reactions or horizontal thrusts T T_1 are calculated. The moment of inertia *I* of the cross-section (Fig. 9) being found, the moment of resistance of this section taken outside the neutral axis *xx* will be called *R*; the moment of resistance taken inside the neutral axis will be called *r* and the cross-sectional area *a*.

The following may be calculated for point *A*. First, stresses in outside fibre.

The maximum bending moment due to the horizontal forces is:

$$T_1 \cdot h'_1 = RS_1$$

and the compressive stress

$$S_1 = \frac{T_1 h'_1}{R}$$

The maximum bending moment due to the vertical forces is:

$$V_1 \cdot v'_1 = RS_2$$

and the tensile stress

$$S_2 = \frac{V_1 v'_1}{R}$$

The direct unit compression S_3 at point *A* due to the vertical force is:

$$S_3 = \frac{V_1}{a}$$

The algebraic sum of these stresses $S_1 S_2 S_3$ is the maximum stress in the outside fibre at point *A*.

The stresses in the inside fibre point *A* are found in the same way.

To calculate the stresses at point *B*, the tube is assumed to be divided in halves along the horizontal diameter, and the forces acting on the lower half are shown on Fig. 10 and are calculated as above.

Mr. Ch. Birault in a very interesting study, entitled "Calcul des Parois des Souterrains Tubulaires à Section Circulaire," has worked out the following formula giving the value of the bending moment due to the external forces acting on the lining and to the weight of the lining itself

$$M = (pR^2 - \tfrac{1}{2}\, dR^3)\, Z$$

in which *Z* is a trigonometrical function of the angle α made by the radius joining the point of the shell under consideration and the vertical axis (see Fig. 11), *d* being the specific gravity of the surrounding ground, *p* the weight of lining per square meter, *R* the outer radius. The above supposes that the weight of the tube is greater than its buoyancy and the tube rests on the ground immediately under, as shown by the shaded portion of Fig. 11, and, if the values of the moments found in function of *Z* are laid out around the circumference and upon the radii, the resultant curve as shown on Fig. 12 indicates that there is a tendency of the shell to flatten. This flattening is corrected in practice by the introduction of tie-rods which prevent the deformation of the tube during construction and by the breaking of joints, longitudinally, the causes of weakness in each joint being eliminated by the rigidity of the abutting flange.

More frequently, however, the weight of the tube is less than its buoyancy; in this case the shell is pressed against the ground above the tube as in Fig. 13. The upper vertical radius *OA* is then the origin of the angles and the bending moments are given by the formula

$$M = (-pR^2 + \tfrac{1}{2}\, dR^3)\, Z$$

In order that the tube be in equilibrium, and to avoid any upward movement due to the buoyancy, it appears, theoretically, that the weight of the ground above the tube ought to be greater than the difference between the buoyancy and the weight of the tube, otherwise there may be movements in the lining tending to shear off the bolts of the circumferential joints.

The ideal condition is to give to the tube as nearly as possible a weight equal to the buoyancy; this, of course, can only be obtained by either increasing the weight of the cast iron lining or by filling the inside with concrete. When there is equality between these two opposite forces, i. e., weight of tube and buoyancy, the bending moments are equal to zero; in other words, the bending moments due to the weight of the tube and to the hydrostatic pressure are in proportion to the buoyancy.

The above assumption, based on the hydrostatic pressure, is probably the safest to follow, as it eliminates the uncertainty as to the nature of the ground and the angle of repose, both of which are constantly changing, not only along the length of the tunnel, but also at any point on a transverse plane.

If the nature of the ground were known, and if it could be ascertained that its loading upon the shell were symmetrical, the elliptical section, with the major axis vertical, would be better than the circular section; but the elliptical section is ill adapted to hydrostatic pressure. This is another argument in favor of the adoption of the circular section in water-bearing subaqueous tunnels, argument to be added to the practical advantages presented by the circular section in regard to ease and rapidity of erection and to the arguments already mentioned in favor of the circular shield as against the elliptical shield.

Opinions differ, however, as to the value of the hydrostatic pressure or rather of the buoyancy. A few engineers claim that the specific gravity of the ground through which the tunnel is to be built should be taken in consideration and not the density of the water.

TABLE I.—THEORETICAL AND ACTUAL WEIGHTS OF LININGS IN NET TONS PER LINEAL FOOT.

Tunnels.	Diameters ft.	ins.	Theoretical Weights 20.713d²	15.535d²	11.9 HR.	9.5 HR.	Actual weights	Remarks.
Pennsylvania Tunnels	23	0	5.48	4.11	6 64	5.30	4.55	Mud and Hudson silt.
Pennsylvania Tunnels	23	0	5.48	4.11	6.64	5.30	6.06	Black slurry, pile foundations of buildings and river piers.
Old Unfinished Hudson	19	5¼	3.91	2.93	5.32	4.24	3.18	Hudson silt (lining too light).
New Hudson Tunnels	16	7	2.84	2.14	4.53	3.62	2.84	Soft Hudson silt.
New Hudson Tunnels	16	7	2.84	2.14	4.53	3.62	3.17	Black slurry, very poor ground.
East River Gas.	10	10	1.21	0.91	3.86	3.08	1.18	Sand, seamy and disintegrated rock.
Paris Concorde Metropolitan ...	25	6 5-32	6.74	5.05	4.98	3.98	4.53	Sand bottom and fissured rock roof.
Tancarville Tunnel	23	3½	5.62	4.21	5.54	4.42	5.93	Very fine silt. Weight of tube nearly equal to buoyancy. Tunnel not yet built.

This is Mr. Birault's opinion who, in his formulas, gives to *d* the specific gravity of the surrounding ground. Mr. Charles Rabut, a French government engineer, made experiments with a small model of a tunnel of known weight and dimensions placed in a tank filled with mixtures of sand and water, sand, clay and water, etc., in various states of fluidity. The results seemed to show that the vertical upward movements were proportional to the buoyancy and, in each case, to the specific gravity of the mixtures.

These experiments cannot be said to be conclusive, however, because the conditons are entirely the reverse of what they are in reality. In the laboratory, the tunnel was built first and the ground after, and a tunnel driven through virgin soil must surely be subject to a certain resistance from the ground which has attained a cohesion that the several mixtures could not attain, and from the skin friction. This cohesion of the ground and the coefficient of friction cannot be determined, but they undoubtedly oppose the action of the buoyancy and this explains why most tunnels, the weight of which is less than the buoyancy, are perfectly stable.

Records have been kept by Messrs. Jacobs & Davies, during the construction and since the completion of the Hudson tunnels, of the behavior of the tubes. From these observations, it appears that in soft water-bearing silt, there is a vertical upward displacement of the shell, sometimes as great as 3 or 4 ins., during the 48 hours following the passage of the shield; this ascent stops towards the end of the 48 hours and the tube begins to settle down slowly to its original position, this settlement extending over a period of 2, 3 and even 6 months.

These movements may be explained as follows: the lining being erected behind the shield is under air pressure to resist the external forces; this air escapes at the face and through the annular space between the top of the lining and the shield tail; the ground immediately above is more or less disturbed, and the lining, under air pressure, following the line of least resistance, has a tendency to elongate along the vertical diameter and to ascend. Once the shield has been moved forward, however, the silt comes down on to the shell of lining seeking, as it were, the same state of equilibrium in which it was before the disturbance of the shield took place and pushing the tube down until it has come back to its original place.

Other experiments, carried on in the Pennsylvania Hudson tunnels, have shown that, contrary to the expectations of those who most strongly believed in the effects of buoyancy, the tubes descended, or deflected, slightly at every high tide, the range of oscillations being about ⅛ in. for a 5-ft. tide. This proves that the additional weight of water compresses the silt on to the tunnels.

Comment on the Commission-Manager Form of Government.

To the Editors: I have read with a great deal of interest in your issue of Dec. 15, 1914, the editorial "Early Difficulties Encountered Under the Commission-Manager Form of Government."

I have watched this phase of the development of a new type of city government not without some skepticism as to results that would obtain principally for the reason that it seems to me the plan is not in accordance with the principles of efficient organization and management. Specialization is indispensable to the efficiency of any officer; especially is this true in the management of the different departments of a city government requiring diverse and widely differing qualifications from its employes.

The civil engineer seems to be, and probably is, the one professional man who would be most universally qualified to fill all of the positions from pound master and plumbing inspector up to director of the finances of a modern city. However, I have yet to discover even in the civil engineering profession, having followed that profession myself, one who would possess all of these qualifications. In a small town or city we have informally the city manager, as represented in the superintendent or engineer of the local pumping station, who is called upon to look after sidewalk construction, street grading, drainage and sometimes sewer construction, occasionally the police department, everything perhaps, except the medical and legal matters connected with the city or village organization, and he undoubtedly fills all of these positions fairly well and is able to give good satisfaction in view of the limited finances and slight encroachments upon his time necessary to look after these various duties.

With a large city, however, the matter is entirely different and he must depend upon his assistants or the heads of the different departments of the city to look after these matters independently. The real management is shifted perforce from the commission-manager to his subordinates as the heads of departments.

When we arrive at this phase of the situation, the whole matter resolves itself into the question as to whether it pays to have a commission-manager simply to act as a middle man or intermediary between the heads of the different departments and the commission or council itself. In a large city the heads of the divisions or departments must become the real managers, and I doubt if the commission-manager would be able even to read over the reports, estimates, bills, recommendations and other communications necessary in the conduct of a large volume of business for an entire city, which would be transmitted from the heads of the several departments to the commission, to say nothing about digesting or using any discretion in the management or direction of the work under these heads. The human mind has its economical limit of efficiency, the same as any machine, and even if this were practicable it does not seem reasonable that in the case, for instance of the civil engineer, who is a commission manager, that he would be able to direct or use intelligent or expert direction of affairs in the police department, or the legal department, or in the questions of a public library, play grounds, parks, etc., where those who have longer experience in those departments would generally give better results.

The straight commission form of government seems to take care of these questions in a more efficient way. Each man is elected upon his experience and qualifications in that particular line of business, and his attention being confined to a single department, he is able to give it more concentrated attention and more effective management.

In a small town the commission manager, under a non-salaried commission, might be used to an advantage, excepting possibly in the legal and medical departments, but in a large city he simply becomes a middle man or intermediary, and might be able to give some advantageous service to certain departments, in which he has had experience, but would be bound to be at least superfluous, if not a drag upon the other departments.

The question of political preference, it would seem, could be as easily worked under the commission manager form as under the other. In the election of a commission the question of who was to be the city manager would be an issue at the elections, just as under the old ward system, the appointive officers of the council were made subjects of political dictation and pre-election bargains.

That the straight commission form of government is going to work out the better I believe will be the result, perhaps not at first, until the people or the voters are educated up to the point of selecting commissioners specially qualified for the different positions which they are to fill, but eventually when the voters realize that there can be no efficient government under any plan until they choose competent officers and that the entire responsibility is upon the voters themselves, the same as it is upon the commissioners in the management of the several departments of the city's affairs under their charge.

Again the most competent legislative body always is the one composed of the heads of the departments themselves, who are in direct contact with the work and with the people whom the department serves, and who would be better able to understand the necessity of certain laws than any one else could possibly be. It becomes to some extent a fair and reasonable substitute for direct legislation by the people as distinguished from indirect or representative legislation.

However, American cities have caught the spirit of investigation, experimentation and study. They are becoming academic and are dissatisfied with the old ward system, with its inefficiency and mismanagement, and are reaching for better results in civic government. This fact of itself indicates a growing competency of the voters themselves, which must result in better city governments. Perhaps the commission manager plan will be the final result. Yours very truly,

D. A. Reed,
Manager Duluth Water and Light Department.
Duluth, Minn., Dec. 31, 1914.

Method of Constructing Rock Tunnel of 50-Ft. Clear Width, Stockton St., San Francisco.

Contributed by E. G. Tilton, Civil Engineer, San Francisco, Cal.

In order to provide easy gradients throughout its length for the fourth unit of its municipally-owned electric railway system about to be built and at the same time to provide an artery into which some of the flow of traffic now congesting nearby streets can be diverted, the city of San Francisco is regarding the hill portion of Stockton St., which lies within the four blocks between Sutter and Sacramento streets. From Sutter St. on the south to the summit of Stockton St., a little more than two blocks, the present gradients rise to a maximum of 18 per cent; and from Sacramento St. south, to 12 per cent. The maximum gradient on the regrade will be 4.29 per cent. The present summit is about 65 ft. higher than the level of the tunnel floor at a point directly beneath it.

DESCRIPTIVE.

The regrade consists of a concrete-lined tunnel under the deeper portion of the hill and of two open cuts, one from each tunnel portal to the first cross-street beyond. One cut is a block long and the other about half a block. The feature of the improvement which elicits interest is the tunnel, which has a finished width of 50 ft. between walls, a span said to exceed that of any tunnel heretofore constructed.

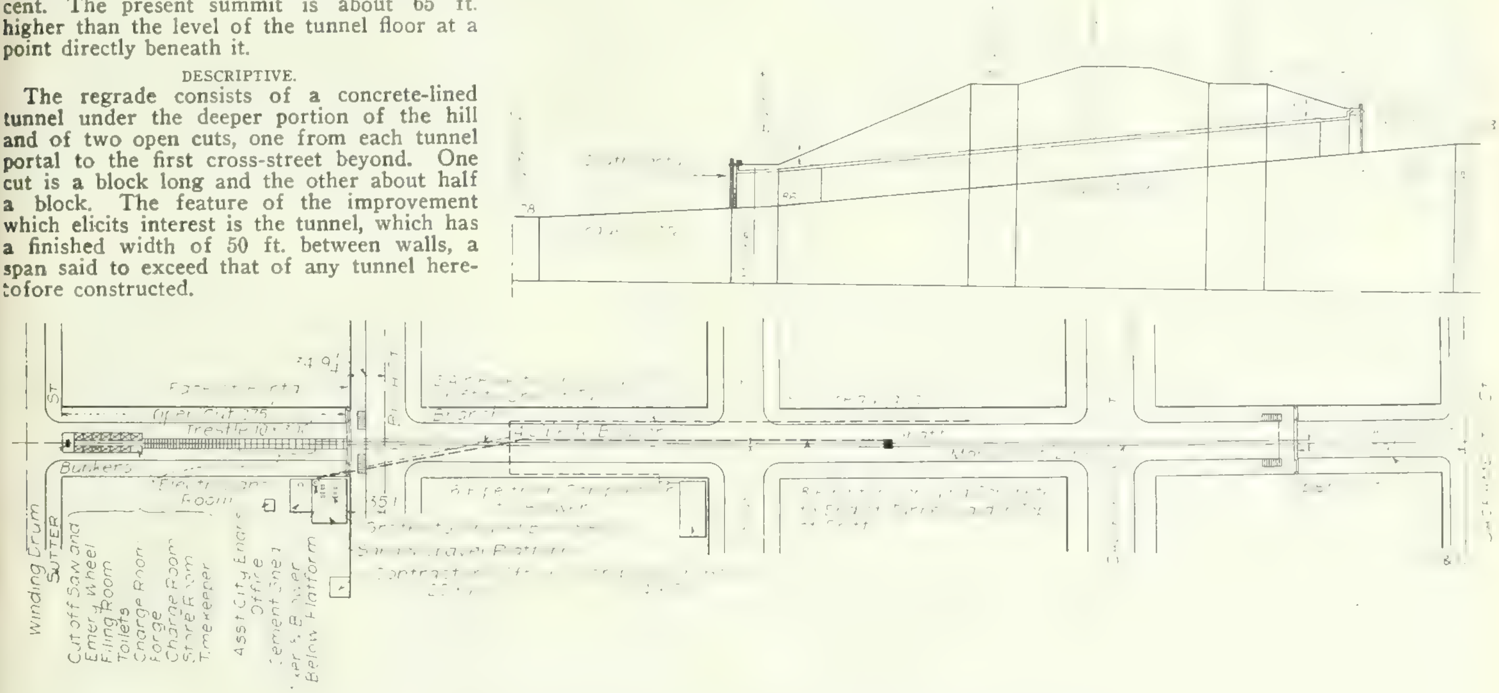


Fig. 1. Profile and Plan of Stockton Street Tunnel, San Francisco, Cal. (Plan Shows Arrangement and Location of Construction Plant.)

The formation of the hill is essentially a clay shale originally deposited in horizontal layers of varying thickness up to several inches, but which subsequent upheavals have distorted or folded or have thrown into angles varying up to the perpendicular and broken into plates and blocky fragments. Mixed with this material is a large amount of clay or decomposed shale. In consequence of being so disarranged and broken, the ground is very weak and has a decided tendency to move where excavations are made in it particularly during the wet season when soaked by rains, which readily penetrate its broken joints and add weight and a lubricant to an already unstable mass.

When the works were planned it was believed that the ground was dependable and that no unusual difficulties would be encountered while tunneling it, but this assumption was found afterwards to be erroneous and as a consequence the methods first determined upon for driving and timbering the tunnel had to be radically modified and the concrete lining had to be made thicker and to be more heavily reinforced to stand severer stresses than those for which the original design provided.

The hill rises very steeply to the west of the tunnel and falls away in the opposite direction. When the tunnel excavation had penetrated it but a short distance, the ground began to move from the northwest to the southeast or at an angle of about 45° with the course of the tunnel. This movement produced so much pressure against the roof timbers as to crush and break many of them and also to throw numerous posts seriously out of plumb. This necessitated frequent replacements or reinforcements of members and all timbering requires constant attention to keep it in proper position and condition. Numerous falls from the tunnel roof have occurred and there has also been a rather general subsidence of the street above, which in some places is as much as 5 ft. Practically all of the lots flanking the west side of the street above the tunnel are vacant and some of them have high retaining walls. Nearly all of these walls have been carried out of position and widely fissured by the movement of the ground. On the east side of the street are several buildings but they suffered but little damage because precautionary measures were taken in time. Pipes, wire conduits and the tracks of a cable car line within the zone affected suffered frequent disarrangement and required much attention.

The two open cuts of the regrade, as called for by the specifications, were extended into the hill beyond the tunnel portals to a point where the cuttting above the outer surface of the concrete lining of the tunnel reached 10 ft. These extensions of the north and south open-cuts were respectively, 62 and 128 ft. in length, and within them the tunnel lining was built in the open and afterwards backfilled to the original street grade. Except in the extensions which were made wider to accommodate the tunnel masonry, the open-cuts of the regrade are 66 ft. wide on the bottom or the same as the original street. They were excavated by steam shovel, the spoil being hauled away in motor trucks to fill in low ground elsewhere. The amount of material taken from these cuts was 12,200 cu. yds. Less than a dozen buildings face the portion of the street affected by the improvement, as those four blocks of Stockton St. including it have been only partially rebuilt since the great fire of 1906. All of these buildings are of modern types of construction, however, with one minor exception. The foundation of most of them, fronting the open-cut regrade, have been extended below the new grade line. In some instances, the difference in level between the original ground floor of a building and the new street grade was sufficient for another story to be built in and advantage was taken of this condition.

The tunnel (Fig. 1) is 911 ft. long between portals and has a clearance width (Fig. 2) of 50 ft. and a clearance height of 19 ft. An additional 20 ft. in width and 5 ft. in height had to be removed to make room for timbering and the permanent concreted lining. It is lined throughout with reinforced concrete masonry of 1 : 2¼ : 4½ mixture. Concrete deposited underground was waterproofed by adding to each cubic yard of the mixture 30 lbs. of hydrated lime; and that deposited in the open was waterproofed with two coats of asphaltum applied to exterior surfaces.

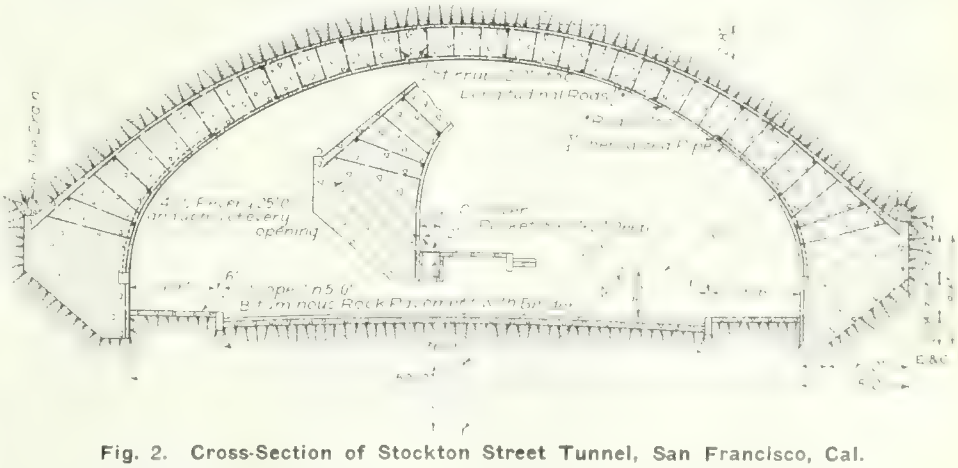


Fig. 2. Cross-Section of Stockton Street Tunnel, San Francisco, Cal.

The intrados of the arch ring is a three-center curve springing from the side walls at a height of 3 ft. above the tunnel floor. The extrados is a simple curve of much larger radius, which is produced to a tangent at a point about two-thirds of the distance between the crown and the outside of the haunches, thence tangent to the outside of the haunches. The ring thickens from 2 ft. 8 ins. at the crown to 8 ft. at the haunches.

Both intrados and extrados are reinforced laterally with 1-in. square steel bars laid at least 2 ins. beneath the surface of the concrete and spaced 12 ins. on centers, and are reinforced longitudinally with ½ in. square bars 6 ft. on centers. Stirrups, ½ in. square on 2 ft. centers, connect the upper and lower lateral ring bars and the longitudinal bars, and all bars are tightly wired together where they intersect. The bars are required to have an ultimate tensile strength of 60,000 lbs. to the square inch and an elastic limit of 30,000 lbs. Both twisted and corrugated types are used.

Drains are provided in the lining on each side, spaced at least 12½ ft. apart, which pass through the haunch and connect with longitudinal tile drains placed 2 ft. below the sidewalks and the same distance out from the face of the side walls. Conduits for lighting wires are also built in the masonry.

The paid-for concrete per lineal foot of lining is 13 cu. yds. This yardage is very much exceeded, however, as the contractor is required to fill with concrete all voids between the outside of the lining and the timber lagging above it. Paid excavation amounts to 48 cu. yds. per lineal tunnel foot. A great excess yardage over this is taken out to make room for timbering. The reinforcing steel runs to 750 lbs. per foot of lining.

A sidewalk 7 ft. wide will be laid on each side of the floor of the tunnel. A double-track electric railway track will be built between the sidewalks and room enough will remain for a wagon roadway on each side between the car track and walk. These roadways will be about 8½ ft. wide. The floor will be composed of a 6-in. concrete base, a 2-in. binder course and a 1½-in. asphalt wearing surface. The finish of the tunnel has not yet been decided upon, but it probably will be cement finish, either applied by hand or by a cement gun.

The portals are of concrete, their exposed surface being finished with white Atlas cement. Their open work parapet walls are built of pre-cast members, except the copings which were cast in place. On each parapet will be two tasteful electroliers. Within each portal are two broad and easy flights of stairs—one on each side of the tunnel—rising from the floor to the street above. Both tunnel and stairways will be brilliantly lighted. The design of the portals is handsome and their appearance is striking.

At six places in the tunnel lateral passageways have been built through its lining to provide access into buildings already erected and to be erected along the street above. These passageways are 7 ft. 6 ins. high by 5 ft. 6 ins. wide with the floor level of each corresponding with that of the tunnel sidewalk opposite.

CONSTRUCTION METHODS.

Three drifts were first driven through the length of the tunnel and all were timbered. One of them, 6 ft. 3 ins. x 6 ft. 1 in. inside of the timbered measurement, was located at the crown of the tunnel section; and of the others, 5 ft. 10 ins. x 6 ft. 2 ins., also inside measurement, one was built at each corner at floor level. The positions of all are shown in the drawings of Fig. 3 which illustrates the method of timbering. Car tracks were laid in the three drifts and muck was hauled out through the lower ones. At the highest parts of the hill and on the tunnel center line a 7x9 ft. inside measurement shaft was sunk for ventilation. Sometimes it is utilized as a passageway through which timbers are lowered to the workings below.

Following the completion of the drifts, the excavation of the segment of the tunnel wherein the concrete lining was to be built was begun at each end of the tunnel. But little advance had been made, however, when it was discovered that the square-set system of timbering being used was ineffectual in the moving and heavy ground which had been developed, it was therefore abandoned in favor of the crown-bar system, which has been employed since. At the same time it was decided to increase by 14 to 24 ins., the thickness of the tunnel lining and to double the amount of its reinforcing steel. In consequence of thickening the masonry lining and of the substitution of the crown-bar method of timbering, which requires more headroom, the section for the excavation of the segment had to be made larger by an average of 3 ft., measured outward, than was at first intended. The roof of the crown drift had to be excavated 2 ft. higher than it had been built and its floor lowered 1 ft. or to a newly-fixed elevation of the top of the bench or core. This explanation will elucidate the note "present location" which appears under the first diagram of Fig. 3.

When the crownbars were placed, a clearance of 3 ins. was left between them and the line of the extrados of the tunnel lining to allow for any spring or settlement of the bars. In a number of instances, however, the heavy load brought upon them by settlement of the ground above has so crushed the bars at their post bearings or deflected them to such an extent between bearings, that their undersides have been lowered below the bottom of the clearance line or within the space to be concreted. Where this happens it is feasible sometimes to scabble off the encroaching portion of a bar, but in many cases the settlement is so excessive that the bars have to be removed and 6-in. steel I-beams substituted for them, the beams being some 8 to 10 ins shallower than the crown bars.

The concrete lining is built in successive sections or rings about 12 ft. long each, and progresses as rapidly as excavation of the segment ahead provides room for it. Clear 3x6-in. Oregon pine lumber surfaced on four sides and laid on 6-in. I-beams, bent to conform to the shape of the tunnel and spaced 4 ft. on centers is used for the bottom form or the form next to the soffit. The I-beams are carried on longitudinal stringers, which in turn are supported by blocks and posts which rest on the bench or the tunnel floor. The inner end of a ring section previously cast serves as a form at that end for a succeeding ring section to be cast against. At the inner end for a new section a bulkhead form is built extending from the bottom form up to the roof of the tunnel excavation and is made tight where it meets any timbering. To this form at about 16 ins. above its bottom, is attached another form for the purpose of producing throughout in the end face of the ring a 6x6-in. recess which provides a key for the next ring. The rings are joined together also by longitudinal reinforcing bars except at expansion joints which are spaced from 30 to 75 ft. apart.

After forms are built, all wooden stulls within the compartment are removed one by one and permanent stulls made of 4-in. standard steel pipe filled with concrete are substituted for them. The compartment is then cleared of rubbish, swept and drenched with water and made ready for the reception of concrete. The permanent stulls are set on wooden blocks 2 ins. thick, which are removed while the soffit form is being stripped and the pockets left by the blocks are later filled with cement mortar. Concrete is propelled by compressed air under 100 lbs. pressure to any part of the tunnel through an 8-in. pipe laid from the mixer which is situated a few yards outside of the south portal. This method of delivering concrete is found to be more economical and satisfactory than would be its conveyance by cars or barrows. The pipe is carried to the tunnel bench on a light trestle and thence on blocks laid upon the bench floor at a height of a foot below

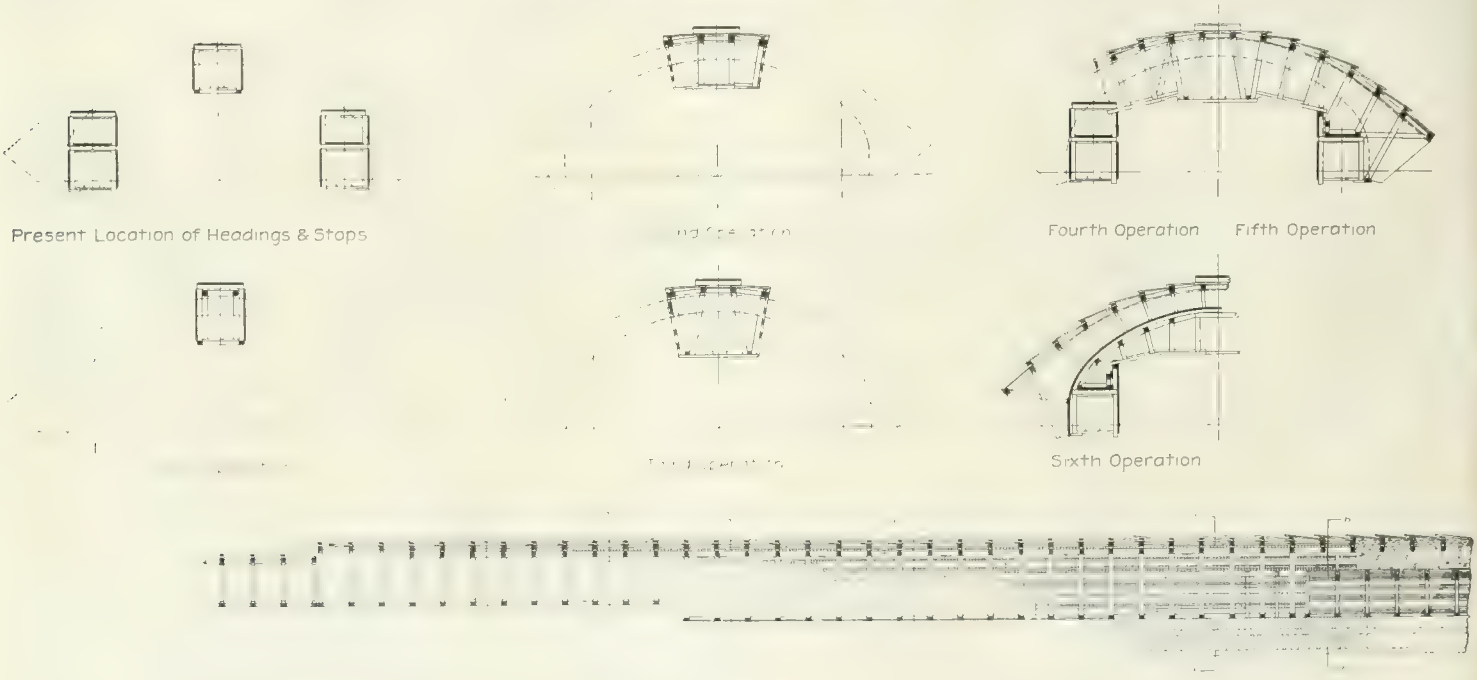
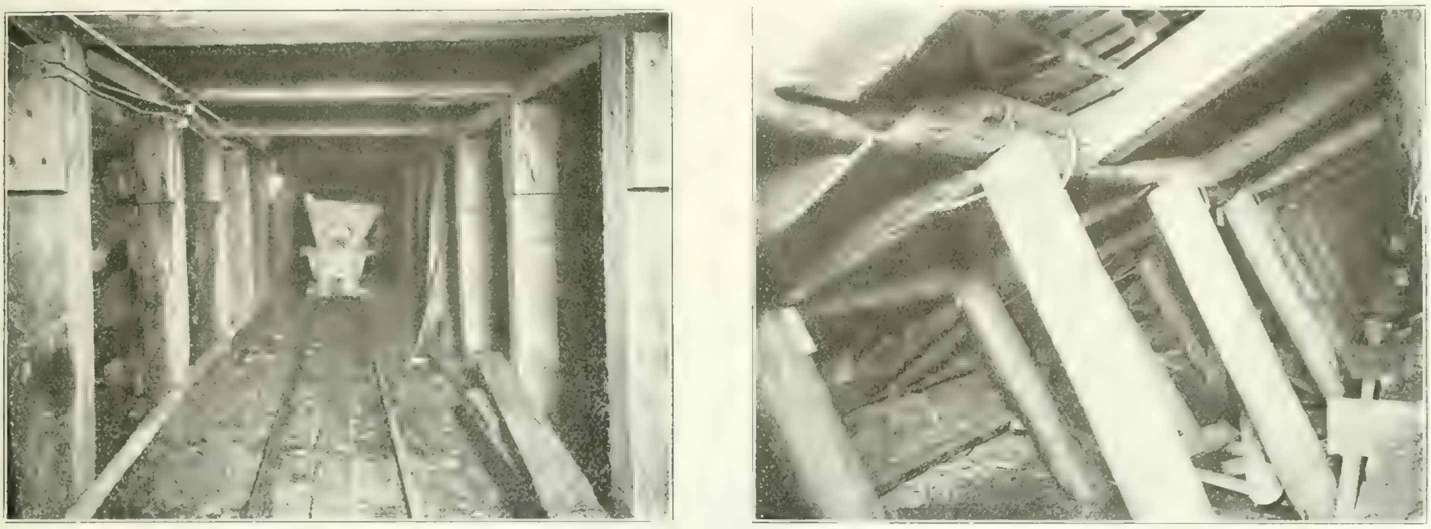
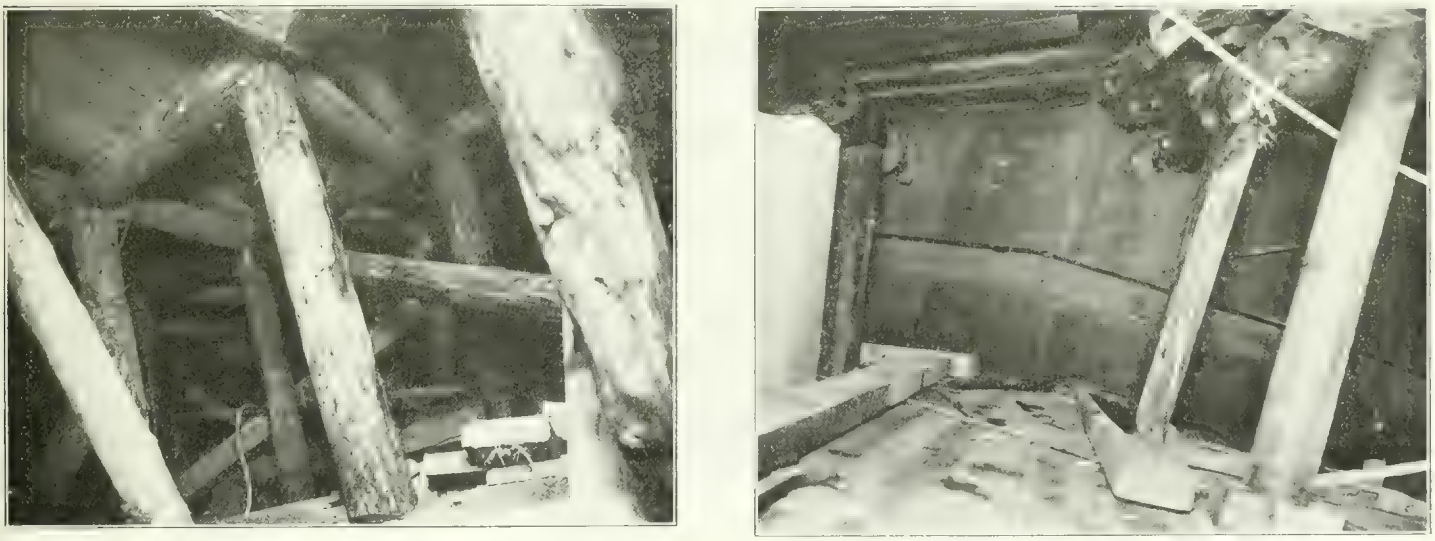


Fig. 3. Diagrams Showing Sequence of Construction Operations, Stockton Street Tunnel, San Francisco, Cal.

the bottom of the form I-beams. By riser and elbows it is continued into the compartment of the section to be cast passing through the bulkhead form at the inner end of the compartment. Concrete is delivered in a continuous stream and from the point where discharged by the pipe flows by gravity into any part of the section being cast. Men are stationed within the compartment on each side to work the concrete with tamping bars with the object of releasing any imprisoned air. The compartment is quite low in places but there is sufficient room for men to operate in. Inspectors oversee their manipulations through small openings in the bulkheads, which openings are tightly closed when the concrete reaches their level. When the compartment becomes so filled that insufficient space remains in which men can labor further, the men leave it. All openings are then made tight and the compartment is filled to the roof with concrete forced in under 100 lbs. pressure. After 30 days the bottom form is removed. The concrete is dense and of excellent quality. About eight hours are required in which to cast a section and once casting is begun, it is continued uninterruptedly until completed.

The core in the tunnel is left for the purpose of supporting the timbering during construction and will not be removed until the tunnel lining is completed. Then it will be excavated by an air-driven steam shovel, the spoil loaded directly into motor dump-trucks and hauled away to distant dumping grounds. Muck from the segment is passed down to the floors of the stopes above the side drifts. From there it is dropped into dump cars standing on tracks in the drifts below. These cars, in trains of eight, are hauled by electric


(a) Side Drift Timbering, Truck and Muck Car (b) Timbering at Corner of Haunch


(c) Timbering Between Crown and Haunch. (d) End Form for Ring of Lining.

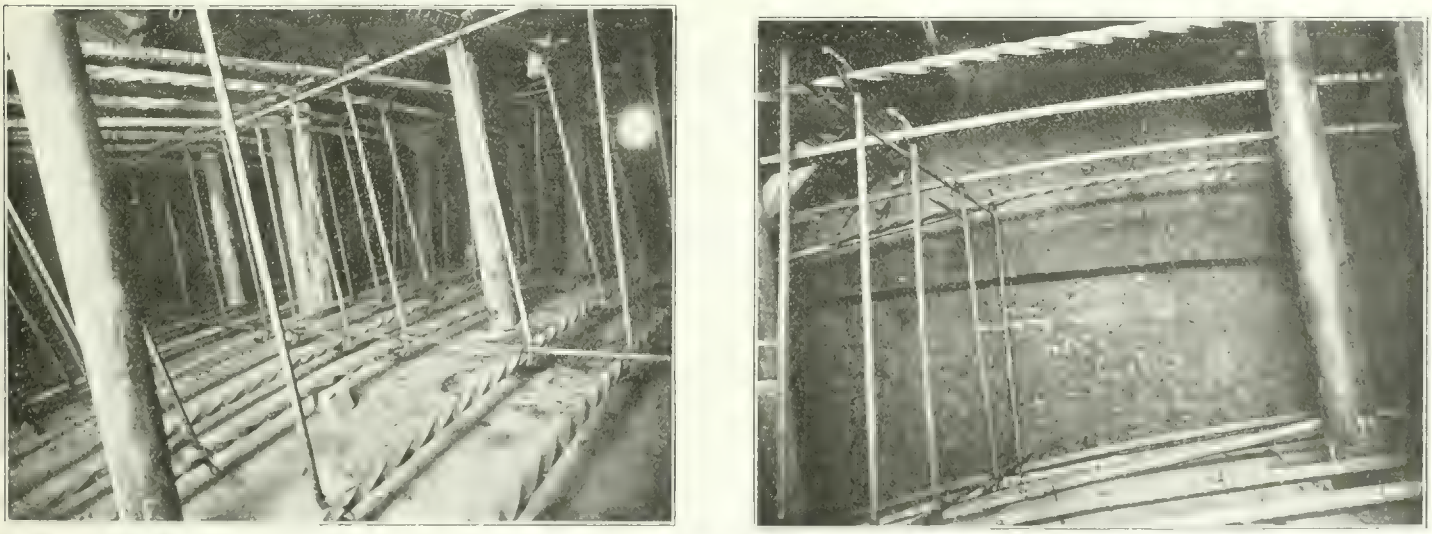

(e) Centering and Reinforcement Ready for Concrete. (f) End of Lining Ring with Dovetail

Fig. 4. Views of Stockton Street Tunnel Workings at Different Construction Stages.

locomotives out of the drifts and up a trestle incline to a bunker containing 14 eight-yard pockets fitted with gates and spouts, which stand at the extreme south end of the south open-cut regrade. From the bunkers it is carried away in motor trucks. The gradient of the incline is 4½ per cent. A single locomotive with an eight-car train cannot successfully negotiate it and has to be assisted with a cable which is operated by a 36 HP. motor-actuated hoist or winding drum located at the outer end of the bunker platform. The incline carries a single 2-ft. gage track.

CONTRACTOR'S PLANT AND LAYOUT.

The plant of the contractor is ample and its layout (Fig. 1) is convenient. The compressor which furnishes compressed air to the rock drills in the tunnel, to the blacksmith forge and for the purpose of propelling concrete through a pipe from the mixer to where it is used in the tunnel, is a two-stage, class J, Ingersoll-Rand machine with a capacity of 1,200 cu. ft. of free air per minute at 100 lbs. pressure. It is belt driven by a General Electric 240 HP. A. C. motor run with current at 440 volts, currents being supplied by an electric company. Its air receiver is 11 ft. long by 4 ft. 9 ins. diameter. From the receiver a delivery pipe carries the air to the concrete "blower," located at the mixer. At about midway of its length a branch is taken out which extends to the drills in the tunnel. In the compressor house, situated on the hill above and about 100 yards from the south portal, is also a Stanley 35 HP. A. C., 400 volt motor which runs another motor used as a generator for converting the alternating current supplied into direct current for operating the mixer, locomotives, cut-off saw and hoist. The mixer is a Foote No. 7 of 1 cu. yd. capacity, driven by a 15 HP. motor. It is established about 50 ft. from the south portal just off the regrade right of way, at an elevation of 5 or 6 ft. above the grade. Just above and opposite the opening in the mixer is a sand and gravel measuring box with a short spout leading into the mixer. Above and adjacent to the box are four large bins, one for sand and the others for three sizes of gravel; and from each bin to the measuring box extends a delivering chute. Cement is delivered to the men at the mixer in bags through a chute leading from a cement warehouse above. When a batch of concrete is mixed it is dumped by means of a movable spout from the mixer into the "blower," which is sunk into the ground immediately in front of the mixer with its top level with the surface. The blower is Horne's patent and has a capacity of 1 cu. yd. It is a steel cylinder about 6 ft. high by 3 ft. in diameter, its lower third being a truncated cone. At its lower or outlet end, 8 ins. in diameter, it is connected to an 8-in. outlet or delivery pipe through which the concrete is discharged. Its upper end is headed. A 2-in. diameter inlet air pipe is tapped into the side of the blower just below its head. In the head is a 15-in. circular hole or hatchway filled with a hinged lid having a gasket on its under side. Attached to the lid is a device for closing it tightly to prevent the escape of air when it is admitted for the purpose of blowing the concrete through the pipe. Near the bottom of the conical end is tapped another pipe 1 in. in diameter. Through this pipe a stream of compressed air is admitted while the blower is being loaded and blown, its function being to keep the concrete agitated so it will not settle in mass and choke the outlet pipe. When a batch of concrete is dumped from the mixer into the blower, the lid of the blower is fastened down, the air turned on and the entire charge is blown out of the far end of the delivery or discharge pipe in from one to two minutes—depending upon the distance from the blower to the delivery point. A batch contains 3⅗ cu. yd.

Above the concrete mixer and at the level of and abutting against the street which crosses the tunnel back of the portal, is a 4-in. plank platform 40x50 ft. square, a portion of which rests on stringers supported by bents set on the slope of the open cut. All sand and gravel is delivered by motor trucks upon this platform. In it are gratings through which, as needed, sand and gravel are shoveled into bins beneath. Abutting against the south side of the platform and at a 3-ft. lower level is a 24x40-ft. closed-in cement storage shed from the floor of which a chute leads to the mixer. Near this shed stands the office of the city's assistant engineer in charge. Conveniently located nearby and facing the street is the contractor's office, a building about 20 ft. square, also conveniently situated with reference to the works.

In a shed beneath the deck of the trestle approach to the bunker is a motor-driven saw for cutting wedges, lagging and other tunnel timbers, except stulls which are sawn to length by hand. This saw is kept very busy. Its motor also drives an emery wheel for sharpening edged tools. Two changing rooms, a time-check office, forge, supply storehouses, electrician's room and toilets are also below the incline floor.

For hauling muck trains, two 36-HP. electric locomotives made by the Baltimore Locomotive Co. are used. They take their current of 250 volts by trolley from an overhead wire. The 2-ft. gage, 1¼ cu. yd. steel muck cars, 18 in number, are of the Kopel design modified somewhat in its dumping arrangement. Their boxes are 6 ft. by 3½ ft. with sides flaring inward towards a concave bottom about 14 ins. wide. The drills employed in the tunnel excavation are four Ingersoll-Rand, Sargent, 3½-in. and twelve Hardsocg Wonder drills. Electric drills were tried but they were not adopted.

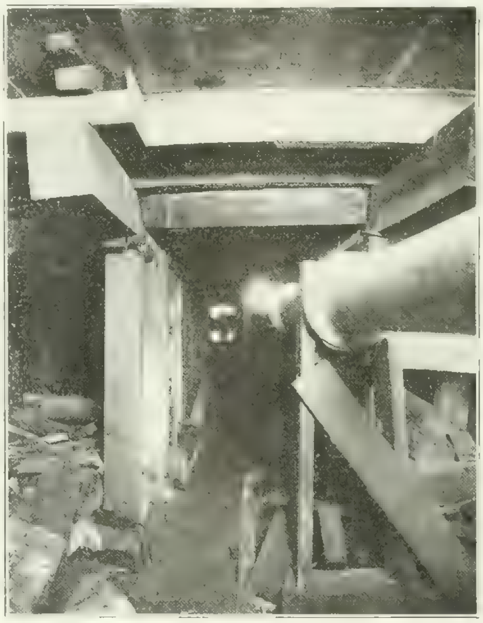


Fig. 5. Method of Supporting Centering and Pipe Through Which Concrete Is Blown.

Much of the timber and all the reinforcing steel and contractor's supplies are delivered upon the south open-cut regrade within the space not occupied by the trestle which extends down its center, and the timber is worked up and the steel bent there. Except that it is contracted in width this yard is convenient. Car tracks are laid throughout its length and into the tunnel. The timbers used for stulls and crown bars are delivered and cut to length at both ends of the tunnel and at the shaft also, but the north end affords the most room. Owing to the treacherous character of the ground and the great width of the tunnel, an enormous amount of timber is required.

The steam shovel used for excavating the open-cuts and which will be used for removing the core of the tunnel, is a Marion No. 20, 1½ cu. yds. capacity. Eight four-yard motor trucks are employed hauling away muck and five for fetching in sand and gravel.

Under the contract the regrade was to have been finished this June, but progress has been so retarded because of bad ground that three or four months more time will be required. Its construction was contracted for in a bulk sum, therefore there are no unit prices which can be given here. Its cost, exlusive of land damages and engineering supervision and including extras for increased concrete and steel used because of the thickening and strengthening the tunnel lining will be about $430,000. The contract includes paving and repairing Stockton St. over the tunnel, but does not include the lighting system for the tunnel. All material is furnished by the contractor and is inspected and tested by the city.

The work is being done by the Board of Public Works and is under the direction of M. M. O'Shaughnessy, City Engineer. The assistant engineer in charge is L. F. McAfee. The contractor is Jacobsen-Bade and K. G. Lundstrum, whose engineer is L. F. Gardetz.

For municipal employes and for employes of contractors engaged on municipal work, a city ordinance fixes the term of eight hours as a day's work and $3.00 as the minimum wage to be paid therefore.

For insurance against claims arising from injuries to his employes, the contractor pays to a casualty company as a premium, a sum amounting to 12¼ per cent of his pay roll. About 400 men are employed on this contract. Practically all of them work in one of two shifts and the remaining few in a third shift.

Ancient Block of Concrete at Cement Show.—A cube of the first concrete made by the old French Panama Canal Co. in 1886 has been received in Chicago for exhibition by the Universal Portland Cement Co. at the Eighth Annual Chicago Cement Show, beginning Feb. 10, in the Coliseum.

Although the old concrete was formed in blocks like cut stone and not made monolithic as in all the later construction, its endurance under severe weather conditions is remarkable. The materials used were a Portland cement, Bohio rock and Panama Beach sand.

In quoting the specifications under which this concrete was made Col. Goethals says: "The Bohio rock is volcanic agglomerate of rather low specific gravity and medium hardness, but very resistant to atmospheric weathering. During severe 'northers' the breakers have, sometimes, been strong enough to roll the blocks upon the beach." The French records of the contract of 1886, under which these blocks were made, contain the following specifications:

> "Stone to pass through a ring 0.06 m. diameter, and to be washed and screened to eliminate all particles smaller than 0.02 m. diameter. The cement mortar to be composed of 800 kgs. of cement to 1 cu. m. of sand. These materials to be mixed dry upon a wooden platform under a roof, and water to be added by means of a sprinkling hose, taking care to use only as much water as may be necessary to produce a homogenous mortar, which will stick to the shovel. The concrete to be composed of two parts of mortar and three of stone. After the mortar shall have been mixed as specified above, add the stone and mix with an iron hoe, until all of the stone shall be completely covered with mortar; the mixing to be accomplished without further addition of water, the stone, however, to be watered carefully in the pile at least one hour before using. The concrete to be dumped into forms and compressed to a compact mass. Repeated ramming to be carefully avoided."

Asks that Alaskan Railway Commission Be Retained.—Mr. Charles D. Marx, president of the American Society of Civil Engineers has submitted to President Wilson the following resolution which was adopted at the annual meeting of the Board of Direction of that society held in New York on Jan. 20:

> "Resolved, That, in the opinion of the Board of Direction of the American Society of Civil Engineers, it would be unfortunate for the present Alaskan Railway Commission to be superseded, and that the interest of the public demands that the present Commission be allowed to carry out the construction as well as the location of the line."

BUILDINGS

Design Features of the Lake Shore & Michigan Southern Ry. Engine Terminal at Air Line Junction, Ohio.

(Staff Article.)

The Lake Shore & Michigan Southern Ry. has constructed, at Air Line Junction, Ohio, the main units of a locomotive terminal which will give it a plant both comprehensive and compact. The portion included in the present building program comprises an engine house consisting of twenty-seven 90-ft. stalls, another containing thirteen 105-ft. stalls, two fan houses, a power house, a machine and blacksmith shop between the two houses, and other requisite facilities. The sections of the engine houses now constructed are provided with temporary end walls, and the layout provides space for practically completing the circle in the case of each engine house. The 13-stall house was built for the Mallett pusher locomotives which are used in this locality and which require special facilities. The 27-stall house is used for freight engines of types other than the Mallet type. A similar type of construction is used for both engine houses. Each house is provided with a 90-ft. turntable.

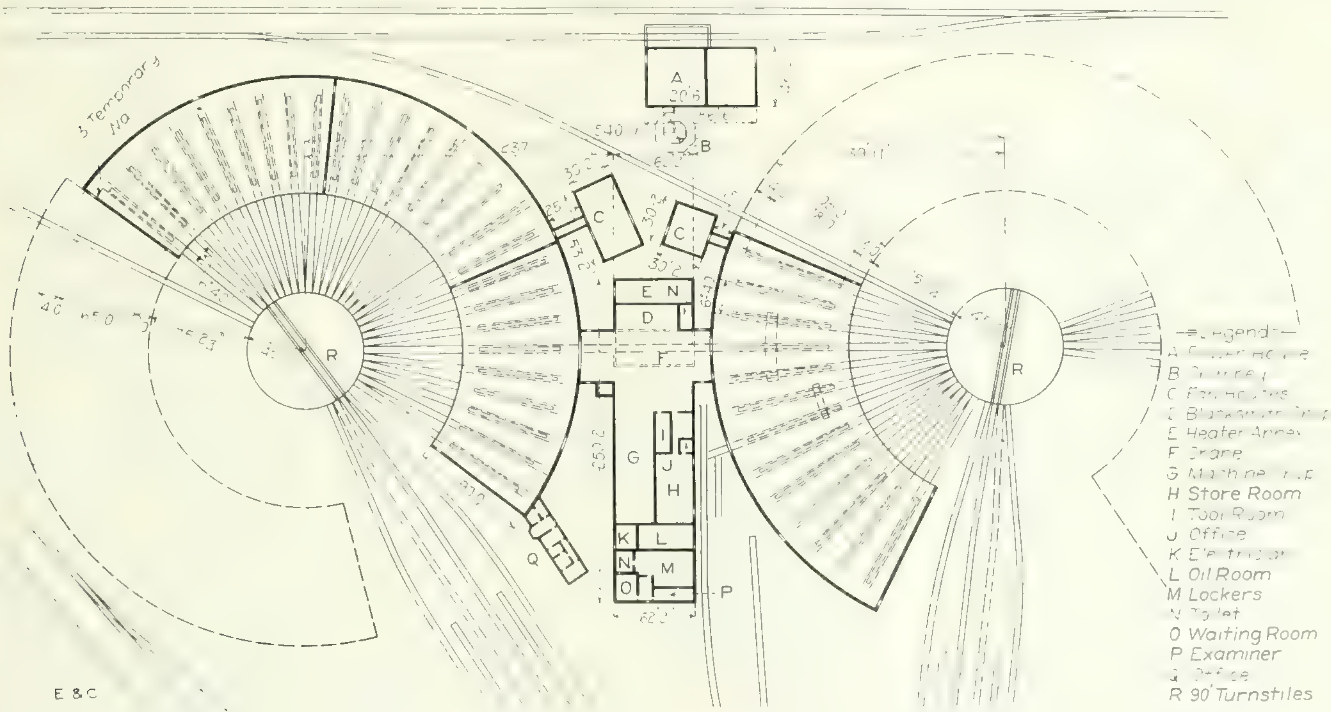


Fig. 1. Layout of Engine Terminal of Lake Shore & Michigan Southern Ry., Air Line Junction, Ohio.

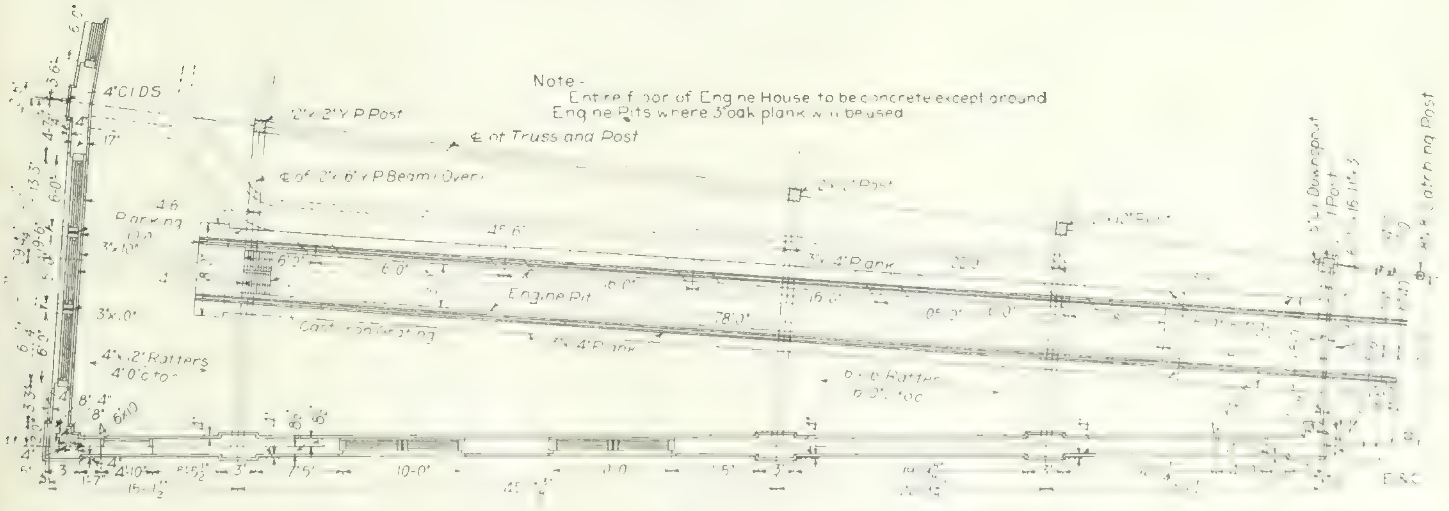

Note -
Entire floor of Engine House to be concrete except around Engine Pits where 3" oak plank will be used
℄ of Truss and Post
Engine Pit
4'C I D S
4" x 12" Rafters 4'0" c to c
E & C

Fig. 2. Plan of End Stall of 105-Ft. Engine House of L. S. & M. S. Ry., Air Line Junction, Ohio.

Figure 1 shows a layout of the terminal and indicates future extensions of the engine houses. Included in this improvement, but not shown in the drawing, are cinder pits, a coaling plant, and the necessary track facilities. The outside dimensions of the central power house are 46 ft. 2 ins. by 86 ft. 6 ins.; those of the fan house for the 27-stall house are 30 ft. 2 ins. by 53 ft. 2 ins.; for the other fan house the dimensions are 30 ft. 2 ins. by 30 ft. 2 ins.; while the outside dimensions of the main building, which contains the heater annex, the machine shop, the blacksmith shop, and minor departments, are 62 ft. 2 ins. by 250 ft. 2 ins.

By placing the machine and blacksmith shops between the two engine houses the facilities of each are made equally accessible to both engine houses. By referring to Fig. 1 it will be noted that one track continues through both engine houses and the machine shop. In the latter shop and under the track, there is an erecting pit, while above it there are two 75-ton "Shaw" electric cranes for use in repairing locomotives. Heavy parts of locomotives are transferred to the machine and blacksmith shops by means of jib cranes, one crane of this type being attached to the diagonally opposite corners of the frame for the 75-ton cranes. The jib cranes serve an industrial track turntable from which pass two tracks at right angles, these tracks running transversely across the machine shop, and parallel to and outside of the building, respectively.

STRUCTURAL FEATURES.

Engine Houses.—Figure 2 is a plan of the end stall of the 105-ft. engine house, and Fig. 3 is cross section of it. The foundation of this house and the entire floor, except around the engine pits where 3-in. oak planking is used, are of concrete. The typical intermediate stalls are similar to that shown in Figs. 2 and 3, the main difference being that the width, center to center of stalls, at the rear is 26 ft. 6⅛ ins., while for the end stall the corresponding width is 29 ft. 4¼ ins. This difference is made up in the pilasters, the size of windows being the same. Above the concrete foundations the walls are brick, 17 ins. thick, with concrete window sills. The building has a composition roofing, on 1¾-in. sheathing, with wood purlins and rafters.

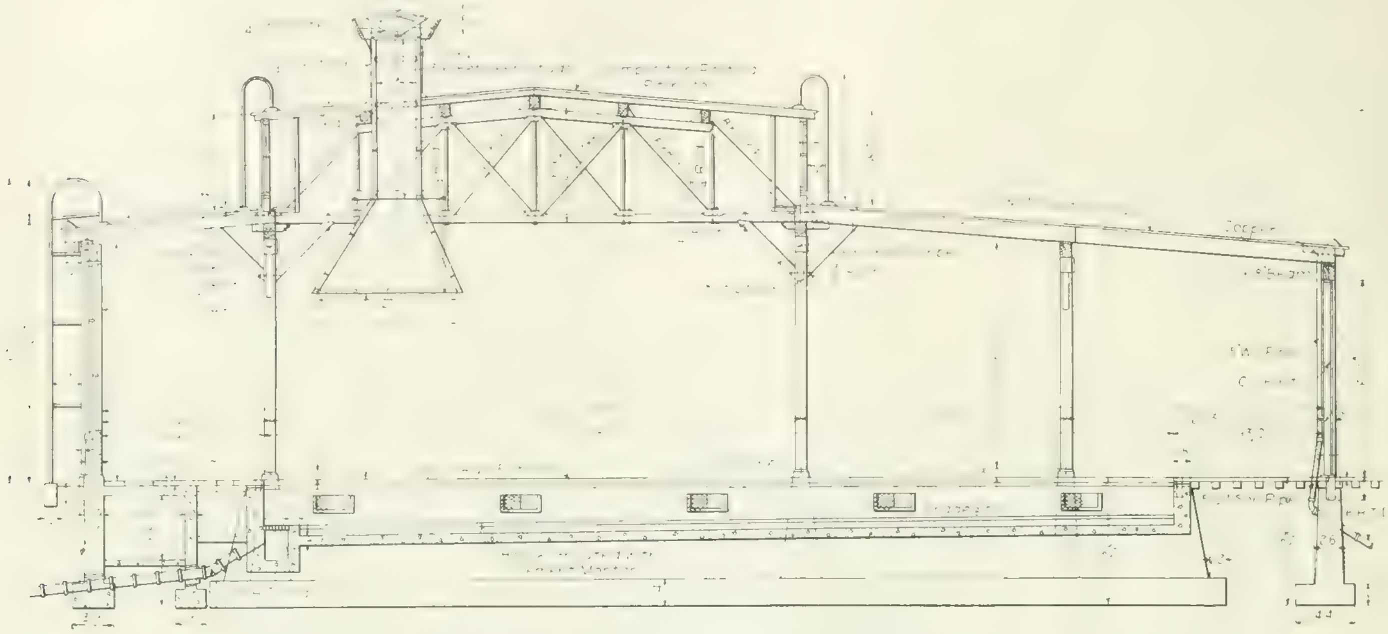


Fig. 3. Cross Section of Typical Stall of 105-Ft. Engine House of L. S. & M. S. Ry., Air Line Junction, Ohio.

The concrete engine pit has an inside width of 3 ft. 10 ins., an inside length of 78 ft., and depths of 2 ft. 9 ins. and 3 ft. 6¾ ins., respectively, at the front and rear. The bottom of the pit has a hard-burned brick surface and a 10-in. concrete base, with a thick layer of sand between the two. At the rear of the pit there is a sump, which extends 3 ft. below the bottom of the pit.

The engine house has three intermediate lines of 12x12-in. yellow pine columns, their spacing being as shown in Fig. 3. These columns are anchored to their concrete foundations by means of 1-in. dowels 12 ins. long. The line of columns at the front of the structure are cast iron. Over the 45-ft. 6-in. central bay there is a wood roof truss, the details of which are shown in Fig. 3. The details of the smoke jack are also shown in drawing; the bottom of the jack being 16 ft. above the top of rail. On account of the small spans, no roof trusses are required for the front and rear bays of the engine house, the composition roofing and the sheathing being carried on heavy wood rafters. Double 8x8-in. knee-braces are used for those columns which support the roof trusses.

The structural features of the 90-ft. engine house are similar to those just described.

Machine Shop.—A plan of the building which houses the machine shop, and of the adjacent blacksmith shop, is shown in Fig. 1. It will be noted that extensions of the main building connect with the two engine houses. Over the track which runs through the machine shop this building has a height, from floor to bottom of roof trusses, of 40 ft. 6 ins. The remainder of the building is considerably lower. Figure 4 shows a longitudinal section through the heater annex, the blacksmith shop and a portion of the machine shop (see Section A-A, Fig. 1). The drawing indicates the types of construction used, and gives the general dimensions for this part of the building. It will be noted that the footings extend about 11 ft. below the finished floor. The blacksmith shop has a 12-in. cinder-fill floor, while the machine shop has a 2-in. yellow pine floor, laid on sleepers embedded in the cinder fill. The traveling crane has a span of 24 ft. The main part of the machine shop and store room has a clear width of 60 ft. and a clear height of about 19 ft.

Power House.—The location and size of the power house is shown in Fig. 1. The electric power used in this terminal is not generated at this plant, the power equipment being only that required for the generation of steam for heating purposes, for operating the fire service pumps and the boiler washing apparatus, and for furnishing power for the compressed air machinery. Figure 5 is a cross section of the power house. This drawing shows the general dimension and the type of construction used. It also indicates the type of ash storage bin and delivery system used.

Safe Methods of Wrecking Buildings.

The following data on safe methods in connection with the wrecking of buildings were issued by the engineering and inspection division of the Travelers' Insurance Co. of Hartford, Conn. Although some of the recommendations appear self-evident, they are nevertheless pertinent, as they are constantly being ignored in practice. Even though the character of the work is hazardous, little systematic thought has been given to it, and there are practically no published data available. Lack of skill and forethought in laying out the work and in handling the men is no doubt responsible for a large proportion of the accidents, but many of them are also due to the employment of careless or unskilled help. It is seldom possible to pay more than a small wage, and the men who are available often have no qualifications for the work except physical strength. As a rule, too, the work must be carried on rapidly in order that new construction may begin; and this frequently causes the contractor to overlook important points in connection with safety, or tempts him to neglect precautions that he thoroughly understands and that he knows the men should take.

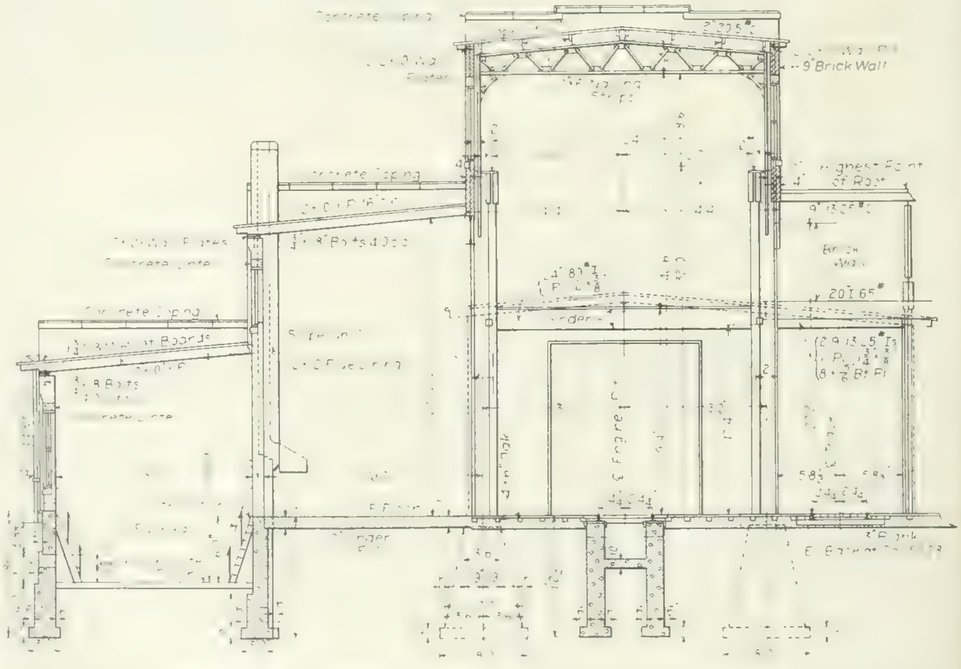


Fig. 4. Longitudinal Section Through Heater Annex, Blacksmith Shop and Portion of Machine Shop, L. S. & M. S. Ry. Terminal, Air Line Junction, Ohio.

PRELIMINARY MEASURES.

The wrecking of a building appears to the onlooker to be a simple and an easy task, but it nevertheless calls for experience and skill, because there are many dangers connected with it even when the structure to be demolished is quite small; and in the case of a large structure these hazards are multiplied many times. Every such job should be supervised by a person of sound judgment, who should also be capable of handling the working force competently and effectively. The men should also be selected, so far as possible, with reference to their capabilities, and should be assigned to the particular kind of work for which they seem to be best fitted. If it appears, after a short trial, that a man is endangering himself or others, and that he is slow to grasp the safety idea, or stupid or blundering in executing the orders he receives, he should be transferred at once to work of some other kind.

Before beginning the actual work of demolition a careful study should be made of the structure that is to be torn down and of its surroundings, and a definite plan of procedure should be mapped out, which should thereafter be followed as closely as possible. This is especially important when haste is essential, because the work can be executed much more rapidly when it proceeds in accordance with a definite scheme than when it is carried out in a haphazard manner. In formulating this plan it is necessary to consider the safety of adjoining buildings, and provision should be made for all requisite safeguards to prevent damage to the surrounding property. Extensive shoring of other buildings is often imperative, and full provision should be made for carrying out all necessary operations of this kind promptly and thoroughly, and in a safe and workmanlike manner. When a fire, flood or other catastrophe has partially wrecked a structure it may also be necessary to shore up or brace some of the walls or other parts of the building that is to be taken down before the wrecking operations can be safely started.

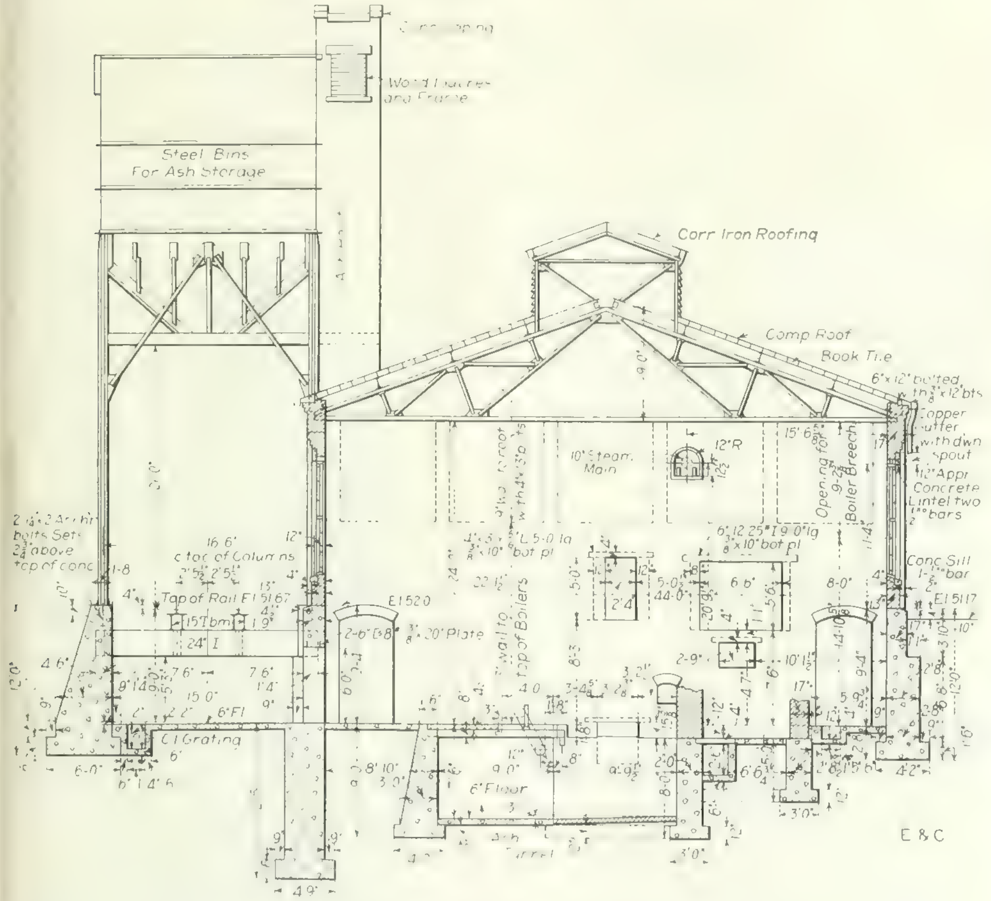


Fig. 5. Cross Section of Power House and Ash Storage Bin of L. S. & M. S. Terminal, Air Line Junction, Ohio.

If the building extends to the street line, or approaches it closely, ample precautions must be taken to protect the public, with as little inconvenience to traffic as possible. It is often important to erect bridges and sheds over the sidewalks in front of buildings that are being razed, to protect pedestrians from falling materials, tools and other objects. Whenever temporary structures of this kind are employed see that they are strong and substantial in every way, and use nothing but first-class material in them. If a sidewalk shed is to be used in connection with subsequent construction work it is best to build it before the demolition begins, whenever this course is practicable.

Make sure at the very outset that the gas pipes have been disconnected and that all electric wires in the building are "dead"; and if a strong odor of gas is subsequently perceived stop the work until the source of the gas has been discovered, and do not allow the men to look for it with lanterns or with open lights of any other kind.

PROCEDURE AND EQUIPMENT

The demolition work should always proceed systematically, story by story; and the work on the upper floors should be entirely completed before any of the supporting members or other important parts on the lower floors are disturbed. By proceeding in this orderly manner it is easy to eliminate various important hazards, such as leaving weak and unsupported walls and chimneys towering above the workmen.

If material is to be thrown from an upper floor, station watchmen on the ground where they will command every means of approach, to warn all persons who may come near and prevent them from entering the region of danger. Except in special cases, however, material should never be thrown down in this way. It is far safer to lower it by means of ropes or hoists, or to send it down through proper chutes.

Chutes should be provided in all cases for the removal of bricks and other loose debris, and they should be completely enclosed so that it will be impossible for the material to fall out until it reaches the bottom. The chutes should not extend in an unbroken line for more than two stories, as otherwise the material passing through them may attain a dangerous speed. Gates or stops should be placed at both the top and bottom of each chute, and the upper gate as well as the lower one should be arranged so that it may be operated by the workman at the lower end in case the material becomes jammed. If jamming occurs do not attempt to loosen the material by hand, but use pickaxes, shovels or tools of some other kind. Place a danger sign at the discharge end of every chute, and do not permit workmen or other persons to stand near a chute, nor to leave teams near one, except while loading from it. Extra flashboards should be placed on a wagon that is to be loaded from a chute.

Men engaged in cutting concrete should use safety handles for holding the chisels, and should wear goggles for protecting their eyes from flying fragments of material. Goggles should also be worn in all other places where work is done that is likely to injure the eyes.

Sections of wall should never be loosened and allowed to fall on the floors of buildings that are being demolished, as the shock transmitted to the floor may cause it to give way; and chimneys and large sections of wall should never be pulled down bodily, even upon the ground, without taking every possible precaution to avoid accident, not only to the workmen, but also to other persons. When an operation of this nature is about to be performed a knot or crowd of idle sight-seers usually congregates at the nearest place from which a good view may be obtained, with but slight regard for their own safety. The man in charge of the work should see that all such persons retire permanently to a place well beyond the danger zone before the wall is disturbed.

It is always better and safer to remove walls part by part rather than to throw them down bodily; and if they are so thin or weak as to make it dangerous to go upon them to remove the bricks or stones of which they are composed scaffolds or stagings should be erected beside them for the men to stand upon. If this work is done from the inside of a building horse-scaffolds may be used to advantage; but these should always be of substantial construction and should rest upon a firm and level foundation. They should never be erected so that they rest upon beams alone, but should always stand upon floors. If the floor covering has been removed a temporary layer of planks should be placed upon the beams to support the horses. Piles of brick, stone or other loose material should never be used by the workmen in place of scaffolds or platforms, nor should scaffolds or platforms rest upon such piles, or be supported by them.

As a rule too little care is given to the construction of scaffolds and other similar structures, especially in demolishing buildings. As the scaffolds are for temporary use only, they are often made of discarded material, insecurely fastened together and inadequately supported; and they are frequently loaded far beyond their safe capacity, with serious results. Structures of this kind should always be made of first-class material, and should be designed with a suitable factor of safety. They should also be thoroughly tested before anyone is allowed to go upon them. Scaffolds and stagings should be of ample width, and their platforms should be provided with footboards and substantial hand rails whenever they are more than 5 ft. above the ground or the nearest floor below. Scaffold platforms should not be used for the storage of materials, but should be kept free from all obstructions so that the workmen may move about upon them in safety. Accumulations of snow and ice should be promptly removed, and when the platforms become slippery they should be liberally sprinkled with sand or ashes. When removing heavy stonework the scaffolds should be reinforced wherever necessary in order to make them safe under the extra load.

In addition to the dead weight scaffolds are likely to be subjected to lateral stresses, and to enable them to resist such lateral stresses they should be stiffened by proper diagonal braces.

Remove all stagings and other similar temporary structures as soon as they have served their purpose.

Leave stairs and stair railings in place as long as possible, as they are in constant use and are much safer and more convenient than ordinary ladders. Wherever ladders are used upon the work take special care to have them sound and strong, and see that the sides and rungs are free from slivers and projecting nails and screws. They should also be firmly secured so that they cannot be displaced in any direction, and when they rest on stone or concrete or any other material upon which they are likely to slip they should be provided with safety shoes. Workmen in ascending or descending ladders should not carry loads that will interfere with the free use of both hands for holding onto the ladders; and they should always face the ladders when ascending or descending.

Except while in actual use openings in floors should be kept covered to prevent loose materials and tools from falling upon persons below. The men should be forbidden to throw heavy masses or large quantities of material from the upper floors down upon the lower floors. Old materials and rubbish should be removed from the premises as fast as they accumulate, and they should not be heaped up on the various floors, nor on the ground immediately outside of the building. Brick and stone which have been removed should be stored in neat piles not more than 7 ft. high, and the piles should be braced, if necessary, to prevent them from falling over. They should not rest directly upon the ground, but should be placed on foundations of planks or boards. All projecting nails in boards, planks and timbers should be carefully removed, hammered in, or bent over in a safe way; and if time will not permit of doing this immediately the material should be temporarily stowed in piles, with the points of the nails projecting downward, and attention should be given to the nails at the earliest practicable moment. Jagged pieces of roofing material, conductor pipes and other similar refuse should be promptly and carefully disposed of. All of the windows should be removed during the early stages of the demolition work to prevent injuries from flying pieces of glass, and no broken glass should be left lying about in the building.

ACETYLENE TORCH.

In demolishing buildings containing steel beams and other similar metallic structural elements the acetylene cutting flame is exceedingly useful and is now widely employed. Work of this kind should always be done by an experienced man, however, who thoroughly understands the process and who also has sufficient knowledge of structural principles to avoid cutting off important supporting members which are required for strengthening the part of the building that still remains standing.

Beams that are about to be cut should first be strongly secured or supported by ropes or chains so that they cannot drop when they have been cut away from the other steelwork to which they were attached. When the cut is completed the two ends are often held together by fused oxide, so that a blow from a sledge is necessary to separate them. However well the beam may have been secured it is likly to swing slightly when the ends are finally severed, and unless the workman is watchful his hands may be caught and crushed.

Continued exposure of the eyes to the acetylene flame acts injuriously upon them, and all operators of acetylene torches should be provided with colored glass goggles, and they should wear them faithfully. They should also wear suitable gloves to protect their hands from burns.

Acetylene gas is poisonous, even when highly diluted with air, and care should be taken to avoid inhaling it. It acts upon the blood in a manner similar to carbon monoxide, the effects of which are well known in connection with coal gas poisoning. Special care in this respect should be exercised when using the acetylene torch in confined spaces.

Combustible material of every kind should be removed from the immediate vicinity of the acetylene torch, because fires may be started by direct contact with the flame or by the fall of highly heated pieces of metal or of oxide.

Be careful in handling tanks containing acetylene gas or oxygen, and never permit them to be dropped nor to be subjected to shocks of any other kind. Do not allow the tanks to be exposed to the direct rays of the sun, nor to a high temperature from any other source, because the heat will increase the pressure and may cause the tanks to burst.

TOOLS.

See that the tools used by the workmen are kept in good condition at all times. Axes, picks, shovels, hoes and all other tools should be discarded or laid aside for repairs as soon as their handles become split, loosened or broken. Sledges, coldchisels and other similar tools should be redressed and restored to proper condition as soon as their heads become burred or mushroomed. Tools should not be left lying about on stagings or stepladders, nor in elevated places of any kind where they may fall off and injure persons below. Men working in gangs should be careful to keep a suitable distance apart, to avoid striking one another with their tools. When tools are to be raised to the working level they should not be lifted by the use of slings or ropes alone, but should be hoisted in suitable buckets, barrels or boxes, and secured from falling out.

HOISTS AND RUNWAYS.

Hoists, operated by hand or by power, are frequently employed in large wrecking operations, and there are many precautions that should be observed in connection with them. It is important that frequent and thorough inspections be made of all the ropes, cables, slings, sheaves, hooks and other parts of the apparatus, and any that are found to be dangerously worn or otherwise defective should be renewed immediately. All exposed gears should be guarded, and adequate braking facilities should be provided. Hoisting cables that pass through floors should be enclosed to a height of 7 ft. above each floor, and they should also be boxed in at points where they pass over stairways and passageways, and wherever they extend along near the floor level. Sheave blocks, when secured to floors to change the direction of the cables, should also be boxed in or otherwise effectively guarded. Shaftways for material hoists should be enclosed at each floor, preferably by wire screens, to a height of 7 ft. above the floor; and gates should be installed at the entrances of the hoistways at every floor. The platforms of hoist cages should be provided with stops to prevent wheelbarrows from rolling or sliding off. Workmen should never be permitted to ride on material hoists, nor on hoist chains or hooks, nor on loads of any kind; and they should never slide down the ropes or cables, nor pass under loads that are suspended in the air. An adequate system of signaling should be adopted, of such a character that there will be no uncertainty as to the signals that are given.

All runways should be substantially constructed and effectively braced or otherwise supported to prevent bending and swaying. Single-plank runways for wheelbarrows should not be permitted. Three planks should be used, as this gives a sufficient width and also affords a good track for the wheel of the barrow, which has a full plank for its support instead of having to travel along a crack, as is the case when two planks are used. Runways that are more than 5 ft. above the ground should be provided with substantial hand rails, and cleats should be nailed to them whenever necessary to afford a firm footing for the workmen.

FOUNDATIONS.

When demolishing buildings great care must be taken to avoid undermining or in any way disturbing the foundations of adjoining structures. Whenever necessary the adjoining buildings should be shored up, or other adequate precautions taken to prevent collapse. If the foundations of the building that is being razed extend below those of the adjoining buildings only short sections should be removed at one time. The neighboring foundations may then be undermined, also by small portions, and extended to the level of the new foundations. When loose soil is encountered and it seems likely that cave ins may occur, and also when foundations extend to a considerable depth, sheet piling may often be used to advantage.

BLASTING.

It is sometimes necessary to do more or less blasting in connection with demolition operations, but so far as possible this should be avoided. When explosives of any kind are used they should be put in charge of some experienced and thoroughly trustworthy person, who should be held responsible for the exercise of all possible precautions in connection with the storage and use of them. The shots should preferably be fired electrically, and in case of a misfire nobody should be permitted to approach the place where the charge is located for at least two hours. Ample warning should be given to all persons in the vicinity before a charge is fired, and when a fuse is used it should not be lighted until it is absolutely certain that everyone has removed to a safe position. Smoking and the use of open flames of any kind near explosives should not be tolerated.

Reinforced Concrete as an Emergency Repair for an Iron Chimney.

Recently one of the iron chimneys, 90 ft. in height, at the steam power house of the Borough Electric Works, Wallingford, Conn., showed unmistakable signs that the iron plates were very seriously corroded at a point approximately 6 ft. from the base. At this point decided wrinkles were observed, and a small hole was discovered near the line of rivets at the first and second plates.

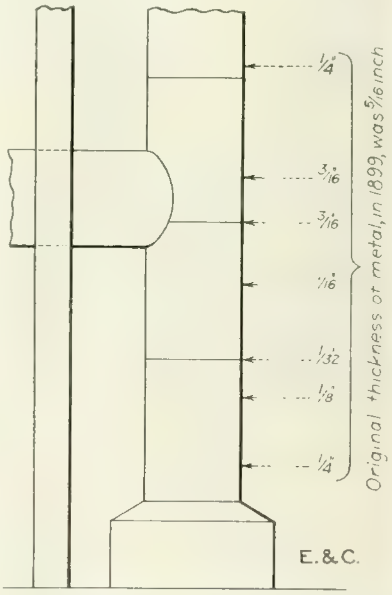


Fig. 1. Sketch Showing Extent of Corrosion of Iron Chimney.

Upon drilling test holes, as shown in Fig. 1 the alarming discovery was made that, from a point approximately 5 ft. 6 ins. from the bottom of the first plate, and extending from 6 to 8 ins., the plates were barely 1/32 in. in thickness. Above and below this zone the metal increased in thickness to ¼ in., showing that the loss in thickness due to the corrosive action of the gases had been only 1/16 in. in 15 years. At the time that this chimney was erected, in 1899, the thickness of the iron in the lower 30 ft. was 5/16 in., that in the next 30 ft. was ⅜ in., and in the upper 30 ft. 7/16 in.

The test holes which were drilled in the plates at different heights showed that the average thickness of the plates in the first 30 ft. was ¼ in. (except at the point of greatest corrosion), and it was assumed that the thickness of the remainder was not less than this thickness. At the point where the breeching joined the chimney, the former was entirely corroded throughout approximately the entire bottom half.

At this time the entire load was being carried by the boiler using this chimney. The engines were operating non-condensing, the turbine plant being out of commission owing to the lack of condensing water; therefore the boilers using this chimney could not be shut down and any repairs must be made with the chimney in use and carrying gases having a temperature of 400° F. and over. Considering these facts, it was a difficult problem to make the necessary repairs and keep the plant running. Many methods were considered, the makers being unwilling to do the work under the existing conditions. Finally the superintendent of the plant concluded that at least a temporary repair could be made by putting a reinforced concrete collar, or shell, around the weakened portion, and extending it upward to embrace those plates having an average thickness of ¼ in.

The matter of replacing the weakened plates was taken up with the engineers of the company, and they agreed with the superintendent that the use of the reinforced concrete shell was the most simple and least expensive method of making this repair. Moreover, considering that the average loss in thickness of the plates above and below the zone of greatest corrosion had been approximately 20 per cent, this method of repair would extend considerably the life of the chimney, possibly to the time when the present boilers would be replaced by boilers of a different type and designed for a higher steam pressure, or when the plant would be operated entirely by turbines.

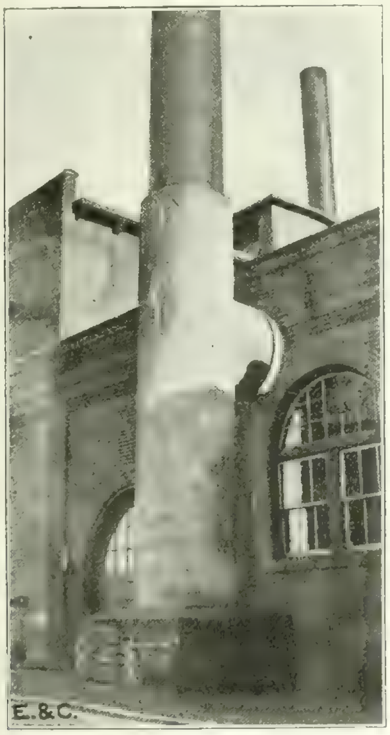


Fig. 2. View of Completed Reinforcement of Iron Chimney.

In making the repairs reinforcing steel, having a diameter of ⅝ in., was placed in horizontal and vertical planes, on 8-in. centers, the bars being placed approximately 3 ins. from the chimney and securely wired at each intersection.

A circular form having a diameter 1 ft. greater than that of the chimney was constructed, this form being made in sections so that each section could be handled and placed in position easily. The reinforcing bars and the forms were extended to a height of 25 ft., thus embracing approximately 6 ft. of those plates having the greatest average thickness of ¼ in. The same type of reinforcement was placed around the breeching to the side of the boiler house.

The work was completed in about four days. During the time that the top portion of the work was being done, i. e., the pouring of the concrete, the boilers were being operated at maximum capacity, the temperature of the flue gases being about 600° F.

The concrete was composed of Portland cement, sharp sand, and screened gravel, mixed very wet in the proportions 1:2½:4½. The concrete was mixed very wet both on account of the high temperature of the gases in the chimney and the depth of the forms—about 25 ft. Very little ramming or spading could be done. The concrete set very uniformly, and little troweling was required after the forms were removed. A few cracks have developed at the top, where the temperature was the highest during the pouring of the concrete, but no serious results are anticipated from these cracks.

Figure 2 shows a view of the chimney with its reinforced concrete shell.

The contractor for the work described was the Sperry Engineering Co., of New Haven, Conn. The data were obtained, partly from a paper by A. L. Pierce, superintendent and electrical engineer, Borough Electric Works, Wallingford, Conn. (presented before the recent convention of the American Association for the Advancement of Science), and partly from the author of that paper.

Elements of Buildings-Factor Costs and Some Specific Data.

It has been stated by A. Hamilton Church, in his work on "Production Factors in Cost Account and Works Management," that "no one at the present time can say what is a standard buildings factor proper to a machine shop, a foundry, or a rolling mill, and this implies that no one is in a position to say that this or that particular instance is an example of efficiency when it is discovered." The attempt to produce some definite data on buildings-factor costs is made by Harold L. Green in a paper published in The Engineering Magazine, from which we have taken the following:

It has been my privilege to develop burden charges in several large industrial plants during the last two years. The development of a buildings factor, which should include all the expenses attendant upon the ownership, use, and occupancy of a building, and which should be expressed in terms of an annual charge per square foot of floor space in the building, was a necessary part of this work. Although an explanation of how these buildings-factor costs were determined and what the costs were found to be in several industries would not set up absolute standards of efficiency, such data would enable relative comparisons to be made, and would serve as a basis for studying the elements of buildings-factor costs with the object in view of approaching a maximum efficiency.

Therefore it is the purpose of this article to state the elements of the buildings-factor costs as determined by the writer; to describe how the costs were obtained; to state the average cost of these elements as found in a large number of specific cases; and to draw brief conclusions, based on the above results, as to how an efficient land-and-buildings factor may be attained.

ELEMENTS OF BUILDINGS FACTOR COSTS.

There is no fixed set of elements making up a land-and-buildings factor. In the majority of cases, however, the elements discussed in this article will include all the costs making up a complete factor for the purpose of a square foot distribution to departments or production centers as the cost-accounting practice may require. Thus the elements which have been selected are almost universal, while those particular to special industries are not considered. A classification of these elements together with an explanation of how the cost of each was determined follows:

(1) Fixed charges on land.
(2) Fixed charges on buildings.
(3) Fixed charges on building fixtures.
(4) Power and light.
(5) Heat.
(6) Buildings expense.

COSTS OF ELEMENTS.

Fixed charges consist of interest, taxes, insurance, depreciation, and repairs, and these are calculated as a percentage of the appraisal value of the land, buildings, and fixtures. The interest rate was taken at 5 per cent in all cases. Tax and insurance rates were determined for each particular case. These rates were quite uniform, however, and 1 per cent for taxes and 0.5 per cent for insurance would be fair averages. On buildings the rates for depreciation and repairs averaged 2 per cent and 3 per cent respectively, while for buildings fixtures, which consist of steam and water piping, electric light wiring, elevators, sprinkler systems, etc., rates of 5 per cent for depreciation and 5 per cent for repairs were used.

For convenience these rates are summarized in the following table:

	Land, per cent.	Buildings, per cent.	Fixtures, per cent.
Interest	5	5	5
Taxes	1	1	1
Insurance	..	0.5	0.5
Depreciation	..	2	5
Repairs	..	3	5
Total	6	11.5	16.5

It is evident that correct interest, tax, and insurance rates can be determined. Correct reserves for depreciation and repairs are open to considerable discussion, however, and the correct reserves will vary with the type of buildings under consideration. As a basis for this article about 25 mill-construction buildings used for paper, textile, and machine-building industries, and costing from $1.25 to $1.50 per square foot, have been selected. The rates given above for depreciation and repairs were used in these mills, and appear to be correct, judging from accumulated cost-accounting records.

The cost of the first three elements—fixed charges on land, buildings, and fixtures—was determined; then, by calculating proper annual interest, tax, insurance, depreciation, and repair charges as a percentage of the appraisal value of the land, buildings, and fixtures, the costs of these subdivisions were obtained.

The next two elements—power and light, and heat—include the cost of power used for lighting buildings and operating elevators, and the cost of steam used for heating. These costs are, of course, based on a determination of how much power and heat is used for these purposes, and how much it costs to make the power and steam in the particular plant.

The amount of steam used for heating was estimated theoretically by the same methods which would be used in designing a heating system for a mill building, and these theoretical results were checked with the known difference in coal consumption between winter and summer months due to heating. Power used for lighting was frequently developed by a separate generator, which enabled a log of switchboard readings to be used in making this determination. In a few cases power for lighting was purchased. Power used by elevators is, in most cases, a relatively small item and depends on the size of the elevators and the frequency with which they are used.

In determining the cost of the steam and power used, fixed charges on land, buildings, fixtures, and equipment, as well as operating charges for fuel, labor, supplies, etc., are included. In the several plants under discussion the average cost of steam was 30 cts. per 1,000 pounds, and of power 2 cts. per kilowatt hour. The cost of power, heat, and light was determined then by estimating the power, heat, and light used, and by calculating the cost, taking into consideration the cost of power at the plant in question.

The last element, buildings expense, is made up of expense items attendant upon the operation of practically all factory buildings. Under this head there has been included labor, such as watchmen, elevator operators, janitors, etc., and the cost of supplies used for cleaning buildings, the cost of water for general factory use, and other similar items.

DIVISION OF COSTS.

An attempt has been made in the preceding paragraphs to describe definitely how the total land-and-buildings factor has been determined. If this has been done, the data following should have a practical value for comparative purposes, and this discussion should serve as a basis for a study of buildings-factor costs with the object in view of approaching a maximum efficiency.

The average cost per square foot of floor space, in the buildings described above, and determined as explained in the previous paragraphs of this article, was 22 cts. As an illustration of the meaning of this cost, take the case of a boring mill in a machine shop which may occupy a space 20 ft. by 20 ft. when allowance is made for the machine, the operator, and the necessary movement of work at the machine. A square foot factor or buildings factor of, say 25 cts. would mean that it costs 20 × 20 × 25 cents, or $100 a year to house this machine. Assuming a working time of 2,500 hours a year, it would mean that this cost accumulates at a rate of 4 cts. an hour. This buildings-factor charge is an appreciable percentage of the wages paid the machine operator, and is but one of several equally important factors making up the total burden of the industry.

Relatively, the buildings-factor charge was found to be divided between the elements as shown in Table I.

From a study of buildings-factor charges in a large number of plants, the percentages and costs given above have been selected as being those which are attained in average practice. If, in a given plant, any of the above elements are materially greater than the averages shown in Table I the reason should be at once apparent. The factory site may be on valuable land, the buildings may be of an expensive design, heating and lighting systems may be inefficient, and items chargeable to buildings expense may need investigation.

TABLE I.—DIVISION OF A TYPICAL BUILDINGS-FACTOR CHARGE.

Item.	Per cent.	Cost, cts. per sq. ft.
Fixed charges on land	10	2.2
Fixed charges on buildings	56	12.3
Fixed charges on buildings fixtures	9	2.0
Power and light	4	.9
Heat	14	3.1
Buildings expense	7	1.5
Total	100	22.0

DISCUSSION OF COSTS.

By far the most important item is that of fixed charges on buildings. The selection of good building materials, when making repairs or additions, offers an opportunity for a reduction in depreciation and repair charges, which cause about half of this expense. The amount of interest charged to cost will be increased, but the savings in depreciation and repair charges will usually compare very favorably with this amount. Interest and tax charges on land may be decreased by the selection of a cheaper site, and there are many cities offering such locations to desirable industries at the present time. Insurance charges may be lowered by making a few changes in fire protection equipment, and by insuring with mutual companies, with whom very low rates may be secured.

And after building site and building materials have been selected, and each of the fixed charges lowered as much as possible, the building designed to give the greatest amount of floor space for a given cost will reduce the buildings factor greatly. Or if it is desired to erect a new building to provide a definite amount of space, it is well known that it will be much cheaper to construct a wide building four stories high than to attempt to get the same amount of space in a one or two-story building covering a much larger ground area. All the above considerations affect the resultant buildings factor, and the cost per hour of housing every machine in the plant.

Lighting and heating system costs can be checked also. If lighting costs are high, the equipment may be at fault, lights may be poorly placed, they may be of a design which takes more power than a better lamp would need, or the cost of the power itself may be too high. Excessive heating costs may show that the design of the system is at fault in respect to the location of heating surfaces, the needless exposure of heating surfaces to outside temperatures, the disposition of returns from the system, the methods of circulation, etc., or again the cost of the steam itself may be too much.

A reduction in buildings expense may be secured by an investigation as to the necessity, or as to the economy of use, of the items going to make up this element.

In conclusion, then, the organization that can secure a cheap site, that can occupy buildings of good construction and of economical design, that can install efficient heating and lighting apparatus, and that can provide for the proper care-taking of their property, will have the lowest buildings-factor charge, and will have made an important step toward a maximum efficiency in one of the largest factors making up the burden of an industrial organization.

It is announced that the Government of Greece has decided to open to international competition the contract for constructing the water and sewage disposal system for the cities of Athens and Pireaus, to cost about $90,000,000, the money for the work having been appropriated.

WATER WORKS

Field and Office Methods Employed by Louisville Water Co. in Checking Construction Gang Payrolls.

Contributed by G. D. Crain, Jr., Louisville, Ky.

A foreman of a construction gang in the service of the Louisville Water Co. devised a method of juggling his payroll returns. Discovery of this condition led to the adoption by the company, which is a municipally owned corporation, of a new system of checking its payrolls. Formerly the construction gang foremen have kept time on their gangs and the payrolls have been made up on the time so taken and reported. The new system, which is here described, consists primarily of a timekeeper, on a motorcycle, whose reports supplement those made by the various foremen. The foremen continue to keep their records as formerly, but these records are checked against the reports of the motorcycle timekeeper at the close of each day.

The Louisville Water Co. ordinarily keeps eleven gangs of men at work, each with its foreman or boss workman. Three of these gangs give their time to pipe-laying, seven are gangs of plumbers with their laborers, and there is one gang of cleaners. Ordinarily there are in the neigrborhood of 100 men under the subordinate bosses, though when the work is heavy there are often as many as 300 men employed, the various gangs being increased in size by the addition of laborers. In the nature of their work the various gangs are often separated from each other by miles. The River Pumping Station is about five miles from the Company's offices on Third St., while from 44th St. and Greenwood Ave to the filter plant and standpipe in Crescent Hill the distance is probably eight miles. So in working out the new system of checking it was necessary to provide some means by which the timekeeper could get over the territory easily and quickly.

In brief the system is this: Each afternoon a "routing sheet" or "daily work sheet" for the day following is made up in the office of the chief engineer and superintendent, Mr. James B. Wilson. A number of duplicates are prepared by carbon copy. One copy goes to Mr. Wilson, one to the motorcycle timekeeper and one to each of the foremen on the jobs, the sheets constituting memoranda of their instructions. With this sheet in his possession, the motorcycle man knows just where each gang should be working, and, generally, how many men should be at work in each gang. He and the foremen have been furnished with duplicate time-sheets, on which are printed or written the names of each of the men in every gang. It is the business of the motorcycle man to get around to every gang at least twice during each working day, and, when there is night work going on he must keep tab, on the same basis, on the men at work under such conditions.

Each afternoon at the close of office hours the foremen present their time sheets and reports to the superintendent's office, and the motorcycle timekeeper turns in his sheets to the auditor of the company, Mr. John S. Morris. Sheet by sheet and name by name these sheets are checked against each other by representatives from the two offices, and it is easily ascertained if there is a discrepancy. In such cases the men who turn in the reports are required to give an explanation, or an investigation is made promptly, insuring that whatever attempt may have been made to practice fraud will be exposed right at the outset.

Of course the check is not an absolute one, and shows principally that when the motorcycle timekeeper called on the various jobs the men the foreman reports as having put in a day were actually at work. If the foreman put an extra man at work during the last few hours of a day after, perhaps, the motorcycle man had paid his calls, the records would conflict on this point, but the explanation would be easily confirmed. However, the system prevents any possibility of one foreman or a series of foremen reporting somebody who was regularly employed elsewhere as working for the water company and drawing wages from that source.

The plan under which the motorcycle timekeeper works is simple. With the routing sheet before him, he knows where the various gangs are to be found at approximate intervals during each day. He maps out his route to suit himself, never making the same round twice in succession. This much is certain, however—every foreman can expect to see him at least twice every day, and every workman at least twice a day can expect to be called on to report "his time" to the man who comes upon a motorcycle and asks for it. The idea, of course, is that since there is no certainty when the timekeeper will call, and a possibility that he may call at any moment, every foreman will attend to keeping things regular. This is the way it is working out, too.

"Get the time of every man in the ditch" are, essentially, the instructions issued to the timekeeper, and he is carrying them out to the letter. For instance, he rides out the Newburg Road to Rope Walk Lane, where T. J. Sweeney is foreman of a pipe-laying gang of ten men engaged in putting down a 6-in. pipe to supply a new subdivision in that southeastern corner of the city. He has the list the foreman has furnished, and, leaving his wheel at one side, he makes the rounds of the ditch and checks after each man's name the hour he reported and whether he has been steadily engaged. Finally he has marked all present except John Smith. So he asks Sweeney.

"I sent him down to the store at Bardstown Road and Bonnycastle Ave.," Sweeney explains, "to telephone the office for some drilling tools. Struck rock again."

Then the timekeeper sits down to wait till, Smith comes back, getting Smith's report on his time when he does return. He may not show up again at Sweeney's corner for hours, maybe not until just as the men are stowing their tools away for the night. He may pay his return call in 15 minutes, and make a mental calculation as to whether everything is all right. But Sweeney cannot be assured that he will not have another visit, for often the timekeeper's sheets indicate that he has made as many as five calls on every gang. This is easier when the work is light and when there are few men in the ditches. There might be supposed to be some opportunity for collusion, but this is regarded as extremely remote. The foremen and the timekeeper are each bonded to the amount of $5,000. This plan having been put into effect as a result of the recent investigation of this part of the system.

There are other ways, also, of checking up. For instance, the records of the Company, extending over a period of years, have been classified and averaged until it is known pretty definitely just about what it costs to lay every foot of pipe of a given dimension before the work is undertaken. If the cost proves to be running too high the foreman gets a chance to explain. "Struck rock" is laconic, and also frequent in explanation of apparently excessive costs. Also, it is usually valid, and is an explanation that can readily be substantiated. There is more difficulty in estimating in advance the cost a repair job is coming to, for there is no telling what condition of affairs and pipes is going to be uncovered. Here the opportunity to take advantage of the Company may perhaps be greater, but on the other hand the amount of "graft" possible in each individual case is usually too slight to make the effort worth while.

The case of abuse of confidence referred to in the opening paragraph was that of a foreman who had been in the Company's employ for six years. The total amount of what he is believed to have got by padding his payrolls probably never will be definitely known, but it is said to have been considerable. It was extensive enough, in the opinion of the officers of the Company, to justify the cost of instituting the present checking system. The salary of the timekeeper is $50 a month, and it costs the water company $3 a month to keep his motorcycle going, according to Mr. Wilson. The timekeeper devotes his entire time to the work he is doing, and keeps the motorcycle at home, so that he is in position to make night runs when, as noted, there is night work being done.

The routing sheet referred to in this connection is of interest. The plumbing gangs, consisting of the plumber and his helper and the necessary number of workmen, are listed as follows on this sheet, the following being the day's work of the gang:

L. DOHERTY & T. CROSS.

42000—1133 Lydia, ⅝-in. service, Harris, Dixon.
42004—310 Stiltz Lane, ⅝-in. service, Jordan, Mears.
7069—315 E. Chestnut St., 1½-in. service, Dulaney, Willis.

The names at the top are those of the plumber boss and his helper, the plumber being foreman on the job. The numbers at the left are the service numbers, while the jobs are located by the street numbers. The nature of the work is indicated next and the names of the laborers assigned to each job are indicated at the extreme right of each line. The pipe-laying gangs are listed with the name of the foreman only, the names of the men employed being supplied before the job starts by the foreman. The Sweeney job referred to, for instance, was listed on the routing sheet, as follows:

T. J. Sweeney . . . . . Newburg Road, Rope Walk Lane & S. E. Lay 6-in. Line.

In addition to these entries, the names of the men in charge at the filter plant and pumping stations are entered and it is the duty of the timekeeper to keep the time on all the employes at these places. The records of the Company, in these cases, as in the others, are made up from the reports of the foremen themselves, and have been for years, the Company having relied on the integrity of these men for faithful discharge of that duty. Nor has there been anything more than the one case of abuse of trust as far as is known, but that was an expensive one, and the officers of the company have worked out the system outlined here to make sure that similar irregularities do not occur again.

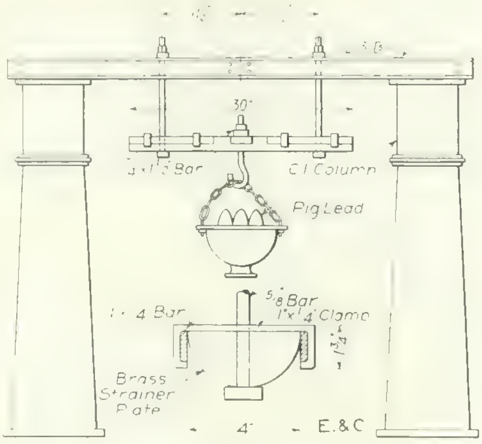
Method and Results of Strength Tests on Strainer Plates for Baltimore Water Filters.

The tests here described were made at Baltimore to determine the strength of the semi-elliptical brass strainer plates adopted for the new rapid sand filters at that city. The information given is from the latest annual report of the Baltimore Water Board. At the time the tests were made Mr. Ezra B. Whitman was President of the Water Board and Water Engineer and Mr. James W. Armstrong was then, as now, Engineer, Filtration Division.

APPARATUS

The apparatus used for breaking the plate consisted of two cast iron stands, which supported two 3-in. channels, riveted together and separated by steel plates. It is illustrated in the accompanying figure.

The plate to be tested was made of commercial sheet brass, 30 ins. long, No. 15 Browne & Sharpe gage. It was bent to the form of a semi-ellipse, whose major diameter was 4-in. and whose rise was 1¾-in. The brass plate had three 21-32 in. holes drilled through it, 11½ ins. from center to center. The plate was suspended by ⅝-in. bolts passing through the two outer holes, and the load was applied by means of ⅝-in. hook bolts, which passed through the center holes and was supported by cross-bars of ¾ by 1½-in. steel. The brass plate had its concave side turned upward. In order to keep it from flattening out under the weight of the loads, ¼-in. by 1-in. bars were clamped along its edge at four points by 1-in. by ¼-in. clamps.



Elevation Showing Method of Testing Section of Brass Strainer Plate and Cross Section of Plate Under Test, Baltimore Water Filters.

The ¼-in. by 1-in. bars were cut at the center point and separated so as to permit the brass plate to bend freely. The hook bolt that carried the load was supported by ¾-in. by 1½-in. bar-iron, resting on top of the brass strainer plate. It had four pins inserted into it, which prevented the strainer plate from spreading. A 12-in. valve bonnet suspended by a chain was used for supporting the load which was applied in the form of pig lead.

First Experiment.—The first plate to be broken was a No. 15 Browne & Sharpe gage. Under the initial load of 179 lbs. the plate deflected 1/32 in. at the center. Under load of 244 lbs. it deflected 1/16 in., and under load of 309 lbs., it completely failed by bending at the center, the upper edge of the plate buckling inward. It was found that this plate was annealed in the process of bending and its strength was thus greatly reduced.

Second Experiment.—This plate was also No. 15 Browne & Sharpe gage, 30 ins. long, supported and loaded in the same manner as the previous one. On application of the initial load of 179 lbs. there was an apparent deflection of 1/16 in., but this deflection must have been due to improper adjustment of the plate, as it only settled 1/64 in. when a load of 369 lbs. was applied. With the application of each additional load, a further deflection of 1/64 in. was noted, until a weight of 777 lbs. was reached, when a slight buckling was noticed at about the center point of the plate. On the application of a load of 847 lbs. the plate failed completely by buckling at the center.

Third Experiment.—The third test was made on a brass plate 29 ins. long, made of No. 12 Browne & Sharpe gage, bent, supported and loaded in the same manner as the other plates. There was no deflection upon application of the intial load of 179 lbs., nor upon a load of 244 lbs. With the addition of each new pig lead which weighed from 65 to 70 lbs., deflection increased from 1/64 to 1/32 in. until 515 lbs. was reached, and upon application of 580 lbs. the plate failed completely by buckling at the center. This plate was injured by annealing prior to the process of rolling, which accounts for its very low strength.

CONCLUSIONS.

The strainer system in the Baltimore filters has the brass strainer plates held in position by ¼-in. brass "U" bolts, spaced 11 ins. from center to center. In applying the wash water they are stressed uniformly in an upward direction, due to impinging of the water against the plates. The "U" bolts will act as supports. As it is not possible to make a test under actual operating conditions, it was decided to take double the space and apply the load at the center. A length of 23 ins. between supports was used instead of 22 ins. in order to make allowance for the cross-bar supporting the load. The load and distance between the supports of the test piece were such that the bending moment developed was approximately four times greater than could be obtained with a similar load applied under actual operating conditions.

It will thus be seen that Plate No. 2, which is the only one broken that gave a fair test, would have safely withstood a load of a little over 3,000 lbs. had it been tested under the conditions that obtain in actual operation. This gives a factor of safety of between seven and eight.

An Example of State Regulation of the Operation of a Small Water Works in Pennsylvania.

The Public Service Commission of Pennsylvania recently handed down its decision in the case of Robert W. Mehard et al., vs. the New Wilmington Water Supply Co. The chief point at issue was the reasonableness and equity of the service rates in force and the character of service rendered. The complainant alleged that the schedule of rates of the public service company were unjust, unreasonable and discriminatory; and that the facilities and service were not adequate or sufficient for the accommodation and safety of the public. The company agreed to discontinue their existing schedule of rates and post and file as required by law, a new schedule showing the rates to be charged. Under the facts as shown by the testimony introduced, the Commission ordered the company to install certain improvements and conduct its business in accordance with certain directions contained in its reports, the substance of which is here given. on April 23, 1914, and was decided Dec. 4, The case was submitted to the Commission 1914. The report and order of the Commission are here given in abridged form from report No. 43.

SUBSTANCE OF REPORT OF COMMISSION

Consumers of the New Wilmington Water Supply Co. filed a complaint against the rates and service of the company, alleging that the rate of 40 cts. per 1,000 gals. for patrons who use 25,000 gals. or less a quarter is unjust and unreasonable; that the rule in the rate schedule which provides that where meters have not yet been installed the old flat rate will be charged is discriminatory and unjust, inasmuch as no provision is made for the installation of meters and no reason given why meters may not be duly installed; that the service furnished and maintained is not adequate for the "accommodation and safety" of its patrons and the public; that the pipes put down by the company are in some instances too small for the proper distribution of the water to consumers; that owing to the numerous dead ends in the distribution system, filthy and unwholesome water is furnished at certain times; that the fire plugs used by the company are not of standard make and could not be used to attach iron couplings in the event of a fire calling for outside assistance; that the cesspool of the superintendent's house is within 50 ft. of one of the wells from which water is taken into the reservoir; that the surface water, on account of defective appliances, flows into the reservoir, contaminating the water and rendering it unfit for domestic purposes.

The respondent in his answer sets forth that the company has not tried to enforce the new schedule to which complainant objects, but continued during 1914 to collect for water at the old rates which have been in use practically since 1893, and against which there have been no objections filed; that the rates of the new schedule, if enforced, would not have yielded sufficient revenue to maintain adequate service and pay a reasonable return upon the investment, and therefore the company does not oppose the issuance of an order enjoining the use of the new schedule, but petitions to be permitted to withdraw the schedule in question and to be allowed to continue charging for water at the old rates; that the service and facilities of the company have been in all respects reasonably adequate and sufficient for the accommodation and safety of its patrons and the public; that the Department of Health of the state issued a decree, dated Sept. 21, 1914, approving the quality of the water, but requiring the company to have prepared, and to submit to that department for approval, plans in detail for the extension and improvement of its reservoir and distribution system; that a competent engineer has been engaged to prepare the plans and to carry into effect the order of the Department of Health; that only reasonable time is requested to prepare these plans when the company will submit to this Commission details of the proposed improvements, which it is believed will meet all the criticisms which have been directed against its service; and that in the meantime it joins in the prayer of the petitioner asking for the disapproval of the new schedule of rates filed some time ago with the Public Service Commission.

Complainant accordingly made application at the hearing for permission to amend his complaint against rates so as to apply to the old rates, the rates that are now (1914) charged and collected, and that were in effect at the time when the complaint was formally made. Permission was granted and the complaint was made broad enough to include the old rates.

In this proceeding the petitioners prayed that respondent be required:

(1) To amend its schedule of rates and regulations to the end that they may be just, reasonable and in no way discriminatory.

(2) To supply and maintain such service that shall in all respects be reasonably adequate and sufficient for the accommodation and safety of its patrons and the public.

(3) To improve its facilities and to install such new facilities as will remove the defects complained of and correct such other defects as may appear to the Commission.

The following facts are taken from the record in this case: New Wilmington is a small borough of about 800 people, and the seat of a college of approximately 300 students The water works reservoir is located outside of the borough limits and gets its supply of water from several wells and springs within a distance of 200 or 300 ft. from it. The capacity of the reservoir is 300,000 gals.

The water is supplied from the reservoir through an 8-in. main and distributed through the business section of the town, principally in 8-in. and 6-in. pipes. Outside of that area 4-in., 2-in. and 1¼-in. pipes are used, although on some streets pipes are used in the distribution system that are only 1-in. and ½-in. in diameter.

About 50 or 60 ft. from one of the wells used in supplying water is a cesspool connected with the house occupied by the superintendent of the water company. The plumber of the borough testified that he considered this cesspool a menace to the health of the town, but had never reported it to the local Board of Health or to the Health Department of the state, nor had he ever heard of any one else who had made complaint against it. There are times when the water is not fit for domestic consumption, because of its offensive odor and bad taste. This is found to be the case in the spring of the year after the snow melts, after very heavy rains, and after the sewers of the town are flushed. Some of this trouble is also ascribed to the number of dead ends found in the distributing system and the poor circulation of the water resulting therefrom. No complaints were ever filed with the company on account of the poor quality of the water except in the spring of 1914, when a very high freshet carried surface water into the springs and polluted them. As soon as the matter was called to the attention of the company, the springs so affected were shut off and the trouble corrected. Certificates from two prominent local physicians state in effect that they consider the water furnished by respondent to be pure and wholesome, and do not know of a single case of sickness or disease that has occurred in the borough of New Wilmington that can be attributed to the water that is used.

In a few cases the service has not been satisfactory. The public schools have not at all times sufficient water to keep the closets working properly; and in the case of a fire along a 2-in. line the pressure of the water was so low that it would not throw a stream over 10 or 15 ft. high. There is also some trouble to get a sufficient quantity of water along a few streets where the supply is furnished through a 1-in. pipe.

The company filed with the Commission a schedule of rates for meter service in June, 1914, to supercede the flat rates then in effect. The meter rates were fixed at 40 cts. per 1,000 gals. for consumers using 25,000 gals. or less a quarter; 35 cts. per 1,000 gals. for consumers using from 25,000 to 50,000 gals. per quarter; 30 cts. when using over 50,000 and less than 100,000 gals. and 25 cts. when over 100,000 gals. were consumed per quarter. Sixty meters were installed, but were not used on account of the general protest that came from the consumers against the proposed meter rates. The company thereupon continued to charge and collect the old rates for flat service, from all but five patrons, instead of attempting to put the new schedule of rates into effect. Under the old service a flat rate of $10 per house is charged when there is no bath, and $20 per house having a bath and water closet.

The New Wilmington Water Supply Co. has a capital stock of $23,150 which has been all paid in. It has no mortgage or bonded indebtedness, and last year and for some years past, paid a 6 per cent dividend. Its gross receipts in 1913 were $2,808.23 and its gross earnings between $3,200 and $3,500. In 1913 it paid for operating expenses $638.12, for taxes $126.67, for construction $739.07, and had a cash balance left for the year of $481.49. There is no sinking fund maintained, and nothing set aside to take care of depreciation in the plant. No salaries are paid except to the treasurer and engineer. The company furnishes service for 201 consumers and 24 fire plugs.

It appears from the evidence that the respondent has been required by the State Department of Health to make certain specific changes and improvements in its plant and equipment, with a view of improving the service, that the quality of the water has been analyzed and duly approved by the health authorities of the state; that the flat rates now and heretofore charged and collected are not excessive, unreasonable nor discriminatory; that in posting and filing a schedule of rates and not putting it into effect, the company has been derelict in the discharge of a duty which it owes to its patrons and the public; that its system of book-keeping is obsolete and unsatisfactory, and that the respondent has no record or even approximate figures of the physical valuation of its plant, nor a correct map in its possession of the highways occupied by its distributing system, which shows the character of the pipes laid on the different streets.

In view of the foregoing facts the Commission drew the following order:

ORDER.

This case being at issue upon complaint and answer filed, and having been duly submitted by the parties, and full investigation of the matters and things involved having been had, and the Commission having, on the date hereof, made and filed of record a report containing its findings of fact and conclusions thereon, which said report is hereby referred to and made a part hereof;

Now, to wit, Dec. 4, 1914, the New Wilmington Water Supply Co. is hereby ordered to

1. Sunbmit to this Commission a copy of the plan showing the improvements in its plant and plant facilities which were made in pursuance to the decree of the Department of Health under date of Sept. 21, 1914.
2. Place on file with this Commission a map of the Borough of New Wilmington, showing on it as of Dec. 1, 1914, all the lines of pipes and their respective dimensions that have been installed in its distributing system.
3. Post in its office and file with this Commission its schedule or schedules of rates and regulations which it will follow in the transaction of its business.
4. Have an appraisal made of the physical valuation of its water plant now established and operated at New Wilmington, and to submit duly certified copies of such inventory to this Commission.
5. Revise its system of bookkeeping so that it will conform in all essential points with the suggestions which they may obtain from the Bureau of Accounts and Statistics of the Public Service Commission.
6. Forward to this Commission a correct copy of its balance sheet annually for the ensuing two years, beginning Jan. 1, 1915.
7. Flush the fire plugs at least four times a year and to maintain a type of fire plug to which any standard fire hose can be attached.
8. Install an automatic pressure gage at the reservoir and at the highest elevation in the town receiving service, and keep a weekly record in its office for inspection of the pressure at these two designated points.
9. Adopt some plan which will not make it possible for the surface water to flow in the different springs at any time or under any conditions of weather, and to report the character of such protection to this Commission on or before Jan. 15, 1915.

Considerations Affecting the Selection of Deep Well Pumping Machinery.

It is unfortunately true that a large number of deep well pumping plants are installed on what might be called "catalog knowledge," and without proper tests and measurements or an intelligent understanding of the requirements of the situation. In such cases success comes only by accident and, moreover, what is thought to be success is more often only freedom from acute trouble. In the latter event the owners never know the improvement in results that might have been made by a different design. The wide variation in results obtained in pumping from deep wells and the many conflicting claims made for the several types of machinery in use prompted Douglas A. Graham, Principal Assistant Engineer with Dabney H. Maury, Chicago, to point out briefly some of the factors entering into the problem of constructing plants of this kind, in a paper before the annual convention of the Illinois Society of Engineers and Surveyors. In the paper, which follows, Mr. Graham also laid special emphasis on the absolute necessity for knowing the pertinent data before plans are evolved.

There are three general types of deep well pumping machinery on the market although there are additional divisions in some of these types. They are: air lift, reciprocating or plunger pumps, including one, two and three plunger machines, and rotary pumps, including turbine and propeller pumps. These types of machinery are all in common use and no detailed description is needed by those engaged in well work.

There are four general bases for comparing the several types of well pumping machinery mentioned above. These are: cost, efficiency, capacity and reliability.

The first cost may be easily ascertained from the machinery manufacturers and from the contractors bidding for the erection. As there are different forms, makes and grades of each class of machinery, it is difficult to give general comparative costs of the several types of pumping installations. The rotary turbine pump is probably the most expensive and the air lift the cheapest of the three. The reciprocating and the propeller pumps vary in cost between these two limits.

Efficiency is a more difficult matter to estimate, as unreliability or ignorance of bidders, uncertain or varying well conditions, improper erection and difficulty of testing combine to produce results different from those expected. In general it may be said that, of the best designs of the three types mentioned above, the plunger pump ranks first in efficiency, with rotary pumps second, and air lift generally a poor third.

If the wells are already drilled, the required quantity of water may determine the type of pumping machinery. With a given size of well, and average conditions, the air-lift stands first in regard to amount of water that can be delivered, with the rotary pump second, and the plunger pump third.

From the standpoint of reliability the order of merit is again changed. The air lift, with all of its moving parts above ground and easily accessible for inspection and repairs, is well in the lead, with the reciprocating pump second and the rotary pump third, especially at lifts of 100 ft. or more.

The four general standards of comparison above stated are commonly recognized, and a comparison of each case can readily be made by reducing all these factors to the basis of annual cost, including operating expenses, interest and depreciation. There are a number of other factors, however, which cannot be stated in general terms, and which affect, not only the importance of the general characteristics of each type, but may dictate one type to the exclusion of all others from consideration.

The more important of these factors are: size of well, straightness of well, character of water, both chemical and physical, pumping level of well and its probable fluctuations, number of units permitted, or the emergency reserve available, skill of the contractor who is to do the erecting, and the character of attendance and care the plant will receive after it is constructed.

For example, a turbine rotary pump cannot be successfully installed in a well smaller than 12 ins. in diameter, and the larger sizes produce the best results. A well so crooked as to cause a bend in rods or shaft of plunger or rotary pumps should never be used for these classes of machinery, except with a full knowledge of the breakdowns and repairs that are bound to result. Air lift is admiraly adapted to crooked wells. Water high in sulphuric acid or carrying sand makes the use of either the plunger or turbine pump expensive, requiring heavy slow-corroding drop pipe.

The pumping level of a well at the capacity required is of prime importance in the selection of a pump. The pumping level usually varies widely for different rates of pumping, especially in the deeper sandstone wells. The statement of the water level in a well is meaningless unless the corresponding pumping rate is also given, although the rate of pumping is seldom given when data of this sort are requested from operating engineers. It is of utmost importance to know the pumping level before buying a pump, and a knowledge of the behavior of other wells in the territory is of great importance in estimating the probable changes which may be expected in the future.

The effect of varying water level is different in each class of machinery. In the air-lift the efficiency is largely dependent on securing the proper submergence of the air pipe. This should be about 60 per cent for the best results. In installing an air lift an estimate may be made in advance and the pipe readily raised or lowered after the tests are made until the desired point is reached. After the erector leaves, however, there is small chance for the adjustment of the air pipe by the station employes. They seldom have the necessary knowledge and it is rare that convenient means for measuring the pumping level are provided. Practically all well levels change with time and some vary rapidly, one instance of a drop of 70 ft. in one week being known to the writer. If a water level 100 ft. below the surface should drop to 120 ft., the air pipe, which had been 250 ft. below the surface, would have to be lowered 50 ft. If this were not done, the submergence would drop from 60 per cent to 50 per cent, with a corresponding material loss of efficiency. The air lift, therefore, while easily adjusted within reasonable limits, is materially affected by changes in the water level, and it is probable that few of these plants maintain their best efficiencies very long after they are installed. Many tests of old air lift plants show efficiencies as low as 10 per cent over all, while the manufacturer's guarantees now run to 30 and 40 per cent. This is due partly to changing water levels and partly to improvements in design.

The plunger pump also is affected materially by the original pumping level and its variations, although its reliability changes more than its efficiency. The rods, pump head and motive power must be designed for given loads. As long as the water level remains above the working barrel all goes well, as the entire machine is usually designed for a head equal to the depth the plungers are placed below the surface plus a constant surface pressure. If, however, the water level drops below or close to the barrel, trouble is sure to begin. The pump will take air and breakage and loss of efficiency result. If the condition of the well permits, the barrel may be lowered, but the strain on all parts is thereby increased and trouble is likely to occur. Plunger pumps are not suitable for changing well conditions and should be specified only on thoroughly proven data.

The turbine pump has the same limitations as the plunger pump with an important addition. The efficiency and capacity of a turbine are only at a maximum for a very short range of head fluctuation and fall off very rapidly as the head increases. It is absolutely essential that a pump of this class be designed for a definite and known water level, and a change in this level frequently requires the reconstruction of the entire pump. There are some forms of rotary propeller pump which do not have this objection as they are built in sections and can be extended within the limits of strength and of motive power.

The number of units in the proposed plant and the emergency reserve, in the form of water storage or connection with neighboring supplies, may have an important bearing on the problem. With a number of units and sufficient reserve, the hazard due to breaking pump rods is materially reduced and such an accident can usually be repaired in a few hours. With the danger of interrupting the service, this contingency resolves itself into a matter of cost of maintenance. With only one unit, however, the importance of continuous service greatly enhances the value of the reliability of the air lift.

The skill, experience and responsibility of the erection contractor is of great importance, especially where anything but air lift is considered. If possible, a pump should be erected by its makers, or by their trained representatives, and the responsibility of the contractor and pump maker and their policy in dealing with customers' complaints should be carefully investigated. It is often better to have a fairly good well pump made by a concern which stands back of it, than a better pump which does not value the satisfaction of its customers enough to help them overcome the difficulties that are so often encountered in well work.

The erection of a well pump is of almost equal importance with its design, and must be carefully considered in selecting the type of machinery to be used. Many a good pump has been unsatisfactory because of improper installation or of unsuitable well conditions which should have been detected and reported by a competent erector.

The character of the attendance a plant will receive may vitally affect the selection of the type of pumping machinery. Few accidents can happen to an air lift which will not be immediately detected and remedied, although the efficiency may fall off very materially under unskilled or careless management. The other types of plants are more delicate and require constant and intelligent supervision.

The causes of trouble with well pumps are many and sometimes obscure. Probably the most common ones are crooked wells, sand in the water, too low a water level, or, as it is often stated, a lack of water, too high speed, and incorrect alignment.

The crooked well is the bane of the pump man's existence, and unfortunately is exceedingly common. It is difficult to drill a straight well where the rock strata are not homogeneous and horizontal, and the difficulty of measuring the well, coupled with the lack of competent construction supervision, has been largely responsible for the acceptance of so many crooked wells throughout the country.

A long line of rods or a shaft rotating at high speed cannot be expected to work around a corner without giving trouble, and, even where a pump is set on an incline to conform to a straight but inclined well, the unbalanced condition of the loaded parts is likely to give trouble. It is a perfectly safe rule never to install a plunger or rotary pump except where the rods or shaft can be made perfectly straight, and even inclined wells should be avoided as far as possible.

If the water level in a well drops to the barrel or pump, the machine will take air instead of water. This causes severe shock and is a frequent cause of pump trouble.

Plunger pumps should never be run at a greater speed than 90 or 100 ft. of plunger travel per minute, and the higher the lift and the larger the pump, the slower should be the speed. For ordinary crank motion pumps, operating with lifts of 50 and greater, 75 ft. per minute plunger speed is to be preferred.

As mentioned before, improper alignment of a well pump is a very common cause of trouble and no pains should be spared to avoid this condition. It takes an expert erector skilled in this class of work to produce the best results, and this is particularly true when a slight crook in the well or a general slope to the bore require that the pump be set on an incline in order to avoid undue stresses on the rods or shaft. Facing a pump in a different direction, and inclining it slightly from the horizontal, will sometimes make a pump work more easily and eliminate much of the trouble from breakdown. Proper alignment of motor or engine is essential, particularly in direct connected or geared units, as the vibration set up by a poorly aligned gear or shaft greatly increases the stresses in the machine.

It is useless to spend time and money in determining the well conditions and obtaining the right machine, and then to trust the installation work to any practical mechanic who may be the lowest bidder for the work. One would not think of trusting the adjustment of a six cylinder automobile motor to a foundryman, yet many well pumps are installed by men with as little special knowledge of their work as a founder might be expected to have of the gas engine. Unskilled erectors are responsible for many well pump troubles, and the greater the lift or the more unsatisfactory the well conditions, the greater becomes the importance of the skilled erector.

Unfortunately for the engineer, it is often a difficult matter to determine accurately the data necessary for the proper selection of well pumping machinery. Where the digging of the well is included in the work, or where there are sufficient reserve units to permit the dismantling of the well for testing and examination, the difficulties are not great, though the tests are rather expensive. But where the well is in constant use, it is generally very difficult to gain access to the water level and the condition of the well must be judged from the history of its construction and the operation of the existing pumping machinery. All wells are straight, according to the reports of the men who drilled them, but continual breakdowns, that cannot be explained by the lack of water or by too light rods or shafts, are generally indicative of a crooked well or improper erection, and should be viewed with concern.

Well pumping installations are found most frequently in the smaller towns and villages, where the engineer, if there was one, was generally limited to the absolute minimum of expenditure required to furnish a plant that would deliver water. This explains in part why it is so rare in such plants to find provision for measuring the water levels or the pump discharge. Apparatus which will show the water level in a well is simple and costs but a few dollars, and its presence adds materially to the safety of the plant and the ease with which its efficiency may be watched. Water levels, particularly in well populated regions, are gradually lowering, and sometimes very rapid drops in level are experienced. With provision for daily inspection the time when the water level will drop to the pump suction may be anticipated, while without it the operator never knows what the next day will bring. With apparatus for measuring water levels and discharge, installed as a permanent part of a plant, the efficiency of the machinery may be easily determined and maintained, and when the time comes for improvements, the data necessary for the proper selection of the new machinery may be readily and cheaply obtained.

It is impossible to lay down rules for the selection of well pumping machinery, as each case is a separate problem. The advantages and disadvantages of each class of equipment vary materially with changing conditions. Each installation must be considered by itself, and it is only by a knowledge of the machinery available, and the accurate determination of the pertinent data, that a well pumping plant can be installed with reasonable assurance of success.

Electric Locomotives in Mountains.— Large electrically propelled locomotives recently passed successful tests on the Elkhorn Division of the Norfolk & Western Railroad.

Fourteen thousand horsepower was needed to start a full tonnage train and nearly 8,000 was used to propel. Two locomotives, one at each end, were used to haul the train, which weighed 4,000 tons. Each locomotive weighed 2,700 tons and the starting effort on the drawbar reached 180,000 lbs., enough to move a 250-car train.

A test of electric braking was also successful. The engines were able to hold the train at steady speed on a mountain grade without the train brakes. The electric energy saved on the down grade is returned to the system for use on other trains.

The electrified portion of the Norfolk & Western extends 100 miles over a mountainous section of the southern West Virginia coal fields.

ROADS AND STREETS

A Modification of the New York Standard Guard Rail Providing Concrete Posts.

A modification of the standard type of wooden guard rail used by the New York State Highway Commission is described by H. E. Smith, a division engineer of the Commission, in an official publication of the Commission, as follows:

The usual practice has been to provide guard railing along the edge of a shoulder on embankments more than 3½ ft. above the natural surface of the ground below. In such cases the fill is graded away from the edge of the shoulder on a slope of 1 on 1½. In cases where the height of the embankment is less than 3½ ft., it is customary to omit guard railing and to flatten out the slope beyond the edge to 1 on 4, which is considered sufficiently flat to be safely traveled on without danger of overturning.

It therefore appears that where a roadway is elevated above the natural surface, protection to travel may be offered either by erecting guard railing along the edge of the shoulder, or by flattening out the slope beyond the edge of the shoulder by finishing each fill to a slope of 1 on 4. It is a matter of study of comparative cost to determine which of these two methods should be pursued in providing protection to the traveling public.

An examination of the cost of guard railing, as compared with the cost of earth fill required to make the flattened slopes, elicits some interesting information. Where the roadway is on embankment and elevated 3 ft. above the natural surface of the ground, the cost per foot of roadway is about the same whether guard railing at 25 cts. per foot be used, or whether a flattened slope be made of excavated material, at 50 cts. per cubic yard. Taking into account, however, the interest on the investment, cost of repairs, renewals, etc., a depth of earth fill of 8 ft., using a flattened slope, will cost no more per foot of roadway than will wooden guard railing. Wise economy would therefore suggest that in every case, except where there is a shortage of earth required to make a fill, guard railing be dispensed with and the flattened slopes be used where the height of the embankment is as much as 5 or 6 ft. above the natural surface either side.

The standard guard railing in use by this department is composed entirely of wood. On account of the short life of this type of guard railing, requiring renewal at intervals of 12 or 15 years, also requiring painting every few years, it has been a matter of study to devise some modification that would be more durable and require less expenditure for renewals. The concrete-wood guard railing shown in Fig. 1 is composed of concrete posts and wooden rails properly bolted together.

The posts, if properly built, will not require renewal unless broken by accident. They will probably require lining up from time to time, which will, however, be a small item of expense in ordinary cases. The rails are of wood and are easily replaceable without expert help. There are other types of concrete guard railing in use in which the rails as well as the posts are composed of concrete. It seems desirable that the rails should be of wood rather than of concrete, in that the former are elastic and offer resilience in case they are run into by vehicles. It would be entirely possible to construct guard railing so heavy and strong as to successfully withstand the impact of any vehicle. It is thought, however, that guard railing of this character would better not be used. It is easily conceivable that one would be more likely to escape injury by running over an embankment than by running into a guard rail if built of too substantial character.

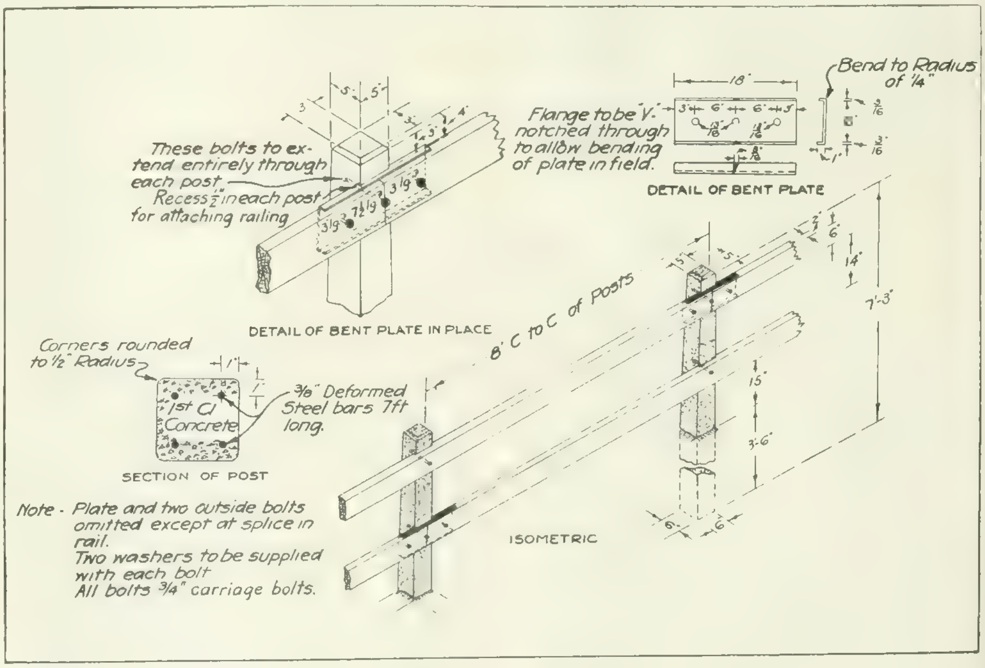

These bolts to extend entirely through each post
Recess ½" in each post for attaching railing
DETAIL OF BENT PLATE IN PLACE
Flange to be V-notched through to allow bending of plate in field.
Bend to Radius of ¼"
18"
DETAIL OF BENT PLATE
8' C to C of Posts
7'-3"
14"
15"
3'-6"
6"
5"
Corners rounded to ½" Radius
1st Cl Concrete
⅜" Deformed Steel bars 7ft long.
SECTION OF POST
Note - Plate and two outside bolts omitted except at splice in rail.
Two washers to be supplied with each bolt
All bolts ¾" carriage bolts.
ISOMETRIC

Fig. 1. Details of Guard Rail with Concrete Posts.

The joints in the rails occur at the center of alternate posts on long stretches, but joints are also made on consecutive posts where angles occur in the guard railing. At such joints a bent plate is used to splice the ends of the rail. Wherever it is necessary to carry the guard railing on a curve to conform to the curve of the highway, the plates are bent in the field to conform to the curve of the highway, and it will be noted that the bent plates are V-notched in each flange to facilitate the bending of them. Where the guard railing is to be used on steep grades, the rail recesses in the posts should be cored out to a proper angle to fit the grade of the road where they are to be used. Guard railing of this type has not yet been erected, though there is an aggregate of 11,400 lin. ft. of guard rail of this type embodied in two contracts which will be erected next season. All the materials required for this type of guard railing are easily obtainable, except the bent splice plates, which, however, may be obtained at a cost of about 20 cents each. The other details as to this type of guard railing are shown and do not require further explanation.

Recommended Standard Form for Reporting Costs of Road Construction.

The committee on road materials of the American Society of Civil Engineers (Proceedings American Society of Civil Engineers, p. 2977, Vol. XL) recommends in preliminary report the following form for reporting costs on road construction and maintenance.

SUBDIVISION OF COST DATA.

The committee believes that, along the lines of standardization in reporting cost data and for general benefit, it would be advisable for highway departments, in making their regular periodic reports, to adopt a tabular form for presenting their records of costs of their construction work, which should include data or figures in columns as follows: (1) Identification of work; (2) Description (width, thickness and material or form of construction); (3) Length; (4) Area of pavement or surface. (5) Construction expenditures for; (6) Preliminary surveys and plans; (7) Grading; (8) Surfacing; (9) Bridges and culverts; (10) Under-drains; (11) Superintendence and inspection; (12) Miscellaneous; (13) Total of above; (14) Rights of way and damages; (15) Total construction and rights of way and damages; (16) Administration, legal and general engineering expenses; (17) Total expenditures and overhead expenses.

For the maintenance expenditures there should be a tabular form showing, in columns: (1) Identification of work; (2) Length; (3) Area; (4) Maintenance expenditures for labor; (5) Material; (6) Hire of teams and equipment; (7) Inspection and superintendence; (8) Miscellaneous; (9) Total of above; (10) Administration, legal and general engineering expenses; (11) Total cost of maintenance.

Each table, of course, should carry such foot-notes or text as might be necessary to supply the further information as to unusual rates of pay or other conditons advisable to be shown. In compiling costs of any item of work done, the committee believes that it would be advisable and of great public benefit if, hereafter, all such figures be compiled whenever practicable on the following basis: Total cost to be reported per unit for: (1) Cost for materials delivered on site of work; (2) Cost for labor and teams placing materials; (3) Cost for machinery engaged in placing materials and in finishing the work; (4) Cost for inspection and superintendence; (5) Cost for general overhead charges. In foot-notes or in the text such statements as may seem desirable in any case should be made concerning rates of pay, conditions, and circumstances.

DATA FOR METHODS AND COST REPORT ON BITUMINOUS PAVING.

The outline given in the accompanying tabulation is that recommended by a committee of the American Society of Civil Engineers. This list of questions was prepared with special reference to bituminous paving, but its application to other types of construction is possible with but small modification. The data asked constitute the essential features of a methods and cost description of a construction project.

GENERAL INFORMATION.

State .... County ....
Town .... Road ....
Contractor ....
Length of road ....
Width of metal surfacing (average) ....
Area of metal surfacing (total) ....
Thickness of surfacing after rolling, with area of each:
2-in. .... sq. yds., 4-in. .... sq. yds., 6-in. .... sq. yds.
8-in. .... sq. yds.; 10-in. .... sq. yds., 12-in. .... sq. yds.
Amount of crown, maximum .... minimum ....
Nature of subgrade (1) ....
Percentage of grade (maximum) .... Length .... ft. .... per cent
Percentage of grade (minimum) .... Length .... ft. .... per cent
Percentage of grade (mean) (2) .... Length .... ft. .... per cent
Date of beginning of construction of metal surfacing ....
Date of completion of construction of metal surfacing ....
Average rate of progress of construction of metal surfacing per working day .... sq. yds.
Average number of hours per working day .... hours.

CLASS OF HIGHWAY OR NATURE OF TRAFFIC.

....
....

AMOUNT OF TRAFFIC OR TRAFFIC CENSUS FOR...... HOURS (AVERAGE) (3).

Date of census ....

Horse-Drawn Vehicle Traffic.	Empty vehicles.	Loaded vehicles.	Est. (in lbs.) of maximum load per inch of tire.	Passenger vehicles.
One-horse vehicles	....	....	....	....
Two-horse vehicles	....	....	....	....
Three-horse vehicles	....	....	....	....
Four-horse vehicles	....	....	....	....
Five-horse vehicles	....	....	....	....
Six or more horse vehicles	....	....	....	....
Motor-Vehicle Traffic.				
Motorcycles	....	....	....	....
Motor runabouts	....	....	....	....
Motor touring cars (four or five seats)	....	....	....	....
Motor touring cars (six or seven seats), including limousines or landaulets	....	....	....	....
Motor wagons or drays	....	....	....	....

FORM OF CONSTRUCTION.

(i. e., macadam, gravel, sand or other surface, and whether treated with a bituminous material by mixing, penetration or other method.)

....
....
Artificial foundation, nature of (4) ....
....; depth ....

HAULING DISTANCES.

Average length of haul for gravel .... miles
Average length of haul for stone .... miles
Average length of haul for sand .... miles
Average length of haul for shells .... miles
Average length of haul for bituminous materials .... miles
Average length of haul for binder or grit .... miles
....
....

RATES OF LABOR (per day).

Foreman .... $........ Roller and engineer .... $.
Labor (ordinary) .... Water cart or sprinkler ....
Labor (special) .... Scarifier ....
One-horse team and driver ....
Two-horse team and driver ....
Three-horse team and driver ....

EQUIPMENT (5).

Rollers:— number .... kind .... weight .... tons
Water carts:— number .... kind .... capacity .... gals.
Oilers:— number .... kind .... capacity .... gals.
Scarifiers:— number .... kind ....
....
Mixing plant ....
....
Kettles and accessories ....
....
....
Distributors ....
....

MATERIALS.

BITUMINOUS MATERIAL.

Kind of material ....
Trade name ....
Purchased from ....
Shipped from ....
Furnished by party of the first or second part ....

CHARACTERISTICS AND ANALYSES (6).

	Tar compounds.	Asphaltic compounds.
Specific gravity	....	....
Water soluble material (organic)	per cent	per cent
Water soluble material (inorganic)	per cent	per cent
Free carbon	per cent	per cent
Ash	per cent	per cent
Solubility in cold carbon tetrachloride	....	per cent
Fixed carbon	per cent	per cent
Paraffin	....	per cent
Melting point of normal material	degrees	degrees
Evaporation 5 hours at 170° C.	per cent	per cent
Melting point of residue	degrees	degrees
Penetration of residue at 4° C.		....
Penetration of residue at 25° C.		....
Evaporation 5 hours at 205° C.		per cent
Melting point of residue		degrees
Penetration of residue at 4° C.		....
Penetration of residue at 25° C.		....
Solubility in 88° B. naphtha		per cent
Character of solution (oily or sticky)		
Distillation	....	
Up to 105° C.	per cent	....
105° C. to 170° C.	per cent	....
170° C. to 225° C.	per cent	....
225° C. to 270° C.	per cent	....
270° C. to 300° C.	per cent	....
Viscosity 100° C. (7)	....	
Engler viscosimeter	seconds	seconds
Lunge tar tester	seconds	seconds
Penetrometer		
New York Testing Laboratory viscosimeter.		
Viscosity 25° C. (7)		
Engler viscosimeter	seconds	seconds
Lunge tar tester	seconds	seconds
Penetrometer	....	....

Methods and Cost of Constructing Nine Miles of Concrete State Road in California.

The following data concerning the construction of a section of state road in California were given by J. B. Woodson in a recent issue of the California State Highway Bulletin.

A portion of the San Joaquin Valley artery of the State Highway which has been constructed and under traffic for a longer period than any other section, is a 9.55-mile piece extending northwesterly from the city of Fresno to the banks of the San Joaquin River. The contract for the construction of this road was

New York Testing Laboratory viscosimeter.. . . . .

Amount of bituminous material used per sq. yd. (in gals.).
First course..............................second course.
Surface coat. ... . total . . . . . .
Temperature to which material was heated.
First course......................second course....... .surface coat.
Temperature of air during use of bituminous material.
Maximum ....minimum ....mean . . . . .
Data of beginning of use of bituminous material.........................
Date of completion of use of bituminous material........................
Average rate of progress of using bituminous material (per day in gallons).
First course..................second course...................surface coat.
General weather conditions during use of material...... ....
Cost, f. o. b. cars, of bituminous materials (per gallon)...........
Freight on bituminous materials (per gallon).....................
Cost of loading and hauling bituminous materials (per gallon).....
Total cost delivered on road of bituminous materials (per gallon).......
Cost of heating bituminous materials (per gallon).........................
Cost of spreading or mixing bituminous materials (per gallon)...............
First course..................second course...................surface coat.
Total cost in place of bituminous materials (per gallon)......................
Total cost in place of bituminous materials (per sq. yd.).......................
Contract price in place of bituminous materials (per sq. yd.)...................

METAL SURFACING.

	Telford or other base	1st course.	2nd course	Binder or grit	Totals
Name (8) of material used...........					....
Abrasion test (9) of material used....					
Absorption test of material used......					
Fracture (10) of material used.......					
Crushing strength of material used (lbs. per sq. in.)..................					
Thickness after rolling of material used					
Size (11) of material used............					
Amount (in tons) or cu. yds. (12) of material used					
Cost, f. o. b. cars, of material used, per ton or cu. yd. (12).............					
Freight on material used, per ton or cu. yd. (12)........................					
Cost of loading and hauling material used, per ton or cu. yd. (12)........					
Total cost delivered on road of material used, per ton or cu. yd. (12)..					
Total cost delivered on road of material used, per sq. yd............					
Cost of scarifying and shaping old surface, per sq. yd....................					
Cost of laying or spreading of material used, per sq. yd....................					
Cost of watering and rolling of material used, per sq. yd.............					
Total cost in place of material used, per sq. yd..........................					
Contract price in place of material used, per sq. yd...................					
....					

REMARKS.

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NOTES AND EXPLANATIONS.

(1) In stating "nature of subgrade" note whether sandy, clayey, loamy, or otherwise and whether readily and thoroughly compacted by rolling.

(2) "Mean" percentage of grades to be obtained by multiplying length of grade by its per cent, adding all products together and dividing by total length.

(3) If possible "average" should be arrived at from two or three separate determinations. State number of determinations from which "average" is secured.

(4) After "Artificial Foundation, nature," sufficient information should be inserted to indicate whether simply a layer of gravel is used, and nature (sandy or otherwise) of same; or whether a foundation is laid by hand of large stone; or whether a layer of crushed stone is rolled into the subgrade before commencement of surfacing proper.

(5) Under "Equipment" should be stated any charges paid as rentals.

(6) For methods of determination of characteristics listed, see "List of Analyses and Methods of Testing Bituminous Materials" proposed by Committee.

(7) In reporting "Viscosities" of course figures can only be given in terms of the one (or more) instruments applying in any case.

(8) Give, if possible, geological "name" of material used in each course. Reference, "Rocks," by Kemp.

(9) "Abrasion test" should be stated in terms of French coefficient of wear.

(10) "Fracture" should be stated as "cubical" or "scaly."

(11) "Size" should be stated as maximum and minimum of sizes of openings in screens to pass and hold stone used.

(12) Cross out unit not used.

Name . . . .
Title . . .
Address

Reporting Officer.

Date . . . ,19.

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let in August, 1912, to the Worswick Street Paving Co. of Fresno. The laying of concrete pavement was begun in October, 1912, and the completion of concrete was in April, 1913.

The system used in throwing open a section of pavement to traffic is that after the concrete has reached an age of 21 days, if a side road be conveniently handy to divert the travel away from the new operations, the concrete is cleaned off, a barricade placed at the diversion point and all types of vehicles are permitted thereon.

The pavement consists of a 4 in. base of Portland cement concrete, 15 ft. wide, covered for the most part with a ½ in. wearing surface of asphaltic oil and broken stone screenings or coarse sand, and has a crown rise of 2¾ ins. In addition, 3 ft. shoulders widen the width of traveled roadway to 21 ft.

Recognizing the fact that a firm foundation is one of the first and most important principles of good engineering as applied to road construction, the contractor was required to plow or scarify the existing roadway and after pulverizing and cultivating the broken up portion, to wet thoroughly and roll to the greatest possible compactness. In this way a subgrade was secured which showed no perceptible movement under a ten ton road roller.

In order to secure water for wetting the subgrade and concrete, wells were drilled at convenient points and connected with a 2-in. pipe line. Wherever irrigation canals or old wells were not available new wells were bored and the water pumped through the pipe line up to a distance of approximately one mile on each side of the pumping station. In this way sufficient water was secured for settling the sub-grade, mixing and placing the concrete and keeping same wet for the required period of six days despite the prediction of outside parties that a concrete base for country roads in as warm a section as the San Joaquin Valley would not be practicable owing to the impossibility of economically handling the water question and of keeping the concrete moist until thoroughly cured.

GRADING.

The contract for grading was on a mileage basis though the present policy of this Commission is to prefer the yardage basis. The contract price was $900 per mile or 10.2 cts. per square yard of concrete pavement.

After the roadway was graded and thoroughly watered and rolled, timber headers of 2-in. by 4-in. planks placed on edge and securely nailed inside of supporting stakes were placed along the outside for pavement forms. These headers conformed to the lines and grades of the edge of the finished pavement and the subgrade was then shaped to the finished grade of the bottom of the concrete by a wooden template, the bottom of the template conforming to and approximately 4 ins. below the finished crown of the concrete. By "approximately" is meant that the subgrade was usually finished a little above the final grade, depending upon the nature of the material forming the foundation, and the final rolling and wetting compacted the dirt to the desired grade.

The grade was then kept clean and thoroughly wet immediately in advance of the concrete to insure obtaining a full 4 in. thickness and to prevent any of the water in the concrete being absorbed by a dry subgrade.

MIXING AND PLACING.

A 1:2½:5 mixture was used for the concrete, which when properly mixed with clean and well graded material has proven to be perfectly satisfactory. This requires on the basis of 45 per cent voids 1.3 barrels of cement to the cubic yard of concrete.

A Foote ⅝ cu. yd. mixer was used throughout, and the concrete was mixed with just enough water to be of a jelly-like consistency, care being taken not to have the mixture so wet that the mortar would flow away from the coarse aggregate, with a resultant "lean" mixture.

After being placed, the concrete was struck with a template riding on the header boards, and was followed up sufficiently close with wooden tampers and smoothed with a wooden float, there being sufficient roughness on the finished surface to insure cleavage of the oil wearing surface.

The construction of a 4-in. satisfactory pavement demands practically no leeway in any departure from the specifications. Coarse aggregate for concrete that runs a high percentage of materials passing a one inch screen requires an excess of sand to get the finish and therefore makes a weaker mixture of concrete than the specified quantity of sand. Also too much material in the coarse aggregate passing a ¼ in. screen again reduces the quality of the mixture due to the fact that sufficient tests can be made rapidly enough to adjust the sand at the mixer.

The coarse aggregate on this contract was entirely of clean gravel from the Friant pit. The gravel was well graded from ¼ in. up to 2½ ins. The sand was also from the same source; great care being taken to eliminate the clay dirt that was mixed with the sand at the pit.

Frequent tests were made both in the division office and by the resident engineers on the work to determine the amount of objectionable material in the aggregate. Material that tests over 6 per cent by weight in material passing a 100 mesh screen was considered not satisfactory. This part classified as silt.

The cracks appeared at fairly regular intervals of from 25 to 35 ft. However, no bad results have been occasioned by reason of these cracks, as the first concrete laid was open to traffic seven months before the oil surfacing was applied and on this section there was no perceptible breaking down or disintegrating of aggregate.

With the oil surfacing complete and the concrete now close on to two years old, it would be a comparatively hard matter to locate the cracks unless one were making a special search.

Concrete was run during 104 days or an

average of 484 lin. ft. per day of concrete run. On 24 days out of 104, over 700 lin. ft. were made, and on six days the daily progress was over 800 lin. ft. The highest run for any 8 hours was 857 lin. ft. with the following crew:

1 foreman	$ 4.00
1 engineer	3.50
1 water tender	2.00
1 chute man	2.10
4 chute men at $2.00	8.00
11 wheelers and shovelers at $2.00	22.00
1 wheeler	2.25
2 men handling planks at $2.00	4.00
2 men smoothing concrete at $2.00	4.00
1 man tamping	2.00
1 man brooming	2.00
2 men handling cement at $2.00	4.00
1 wagon spotter	2.00
1 two-horse wagon and driver (handling boards)	4.50
1 man helping (handling boards)	2.00
1 concrete mixer, fuel, etc	5.00
1 pump and engineer	6.00
33 men, total on concrete work	$79.65

857 lineal feet = 158.7 cu. yds. = $0.503 per cu. yd. or 5.6 cts. per sq. yd. of concrete 4 ins. thick.

The total cost of this 9.55 miles of road, covering grading and concrete base, and including cost of cement, was $49,359, making a price of $5,168 per mile or $0.587 per square yard of pavement.

WEARING COAT.

In order to determine an adaptable wearing surface that could economically be applied, two types were placed on this section. One was a mastic mixture consisting of a composition of approximately equal parts of asphaltic cement, 70 to 80 penetration, and powdered lime rock spread to a thickness of ⅜ in. on top of which, after laying, was spread broken stone screenings or coarse sand as needed to absorb the excess of bitumen as it appeared on the surface or as the mixture softened under the heat of the sun.

The other surfacing consisted of an application of approximately ½ gal. per sq. yd. of asphaltic oil spread at from 250 to 300 F. containing 90 per cent of 80 penetration asphalt, on top of which was spread sufficient sand or screenings to absorb the oil. Approximately 0.488 gals. of 90 per cent asphaltic oil per square yard and 260 tons of screenings per mile making 0.03 tons per square yard, making a final thickness of slightly less than ½ in.

TABLE I.—SUMMARY OF COSTS.

	Total cost.	Per mile.	Per sq. yd. of concrete.
Grading	$ 8,591.10	$ 900.00	$0.102
Concrete base (including cement)	49,358.92	5,168.48	0.587
Bituminous surfacing (including mastic)	7,730.19	809.44	0.092
Culverts, monuments, guard rail, etc.	820.32	809.44	0.009
Totals	$66,500.83	$6,963.82	$0.790

In conclusion the writer wishes to state that it is now lacking a few days of being two years since the first portion of this road was thrown open to traffic; and with the exception of slight maintenance on oil surfacing and dirt shoulders, there has been no failure of any nature observed in the pavement.

Methods and Cost of Constructing a Concrete Road in LaSalle Co., Illinois.

The methods and cost of constructing a concrete road on a steep grade and involving a sharp curve were discussed by B. H. Piepmeier in a paper before the Illinois Society of Engineers and Surveyors as follows:

The concrete road at Marquette Hill, La Salle County, Ill., was constructed by the state highway department during the fall of 1914. The work was financed by the Marquette Cement Manufacturing Co. of La Salle, Ill. It begins at the south end of the Illinois River bridge at La Salle and extends in a southerly direction for 2,374 ft., and was designated by the county board as a state aid route, but on account of financial difficulties and the character of the road referred to, it was evident that the county was not going to provide for the improvement for several years; so the Marquette Cement Manufacturing Co. proceeded to finance the construction, inasmuch as it was the main road from La Salle to their plant at Oglesby. There were several features of construction connected with the improvement of this road which the writer feels is worthy of consideration.

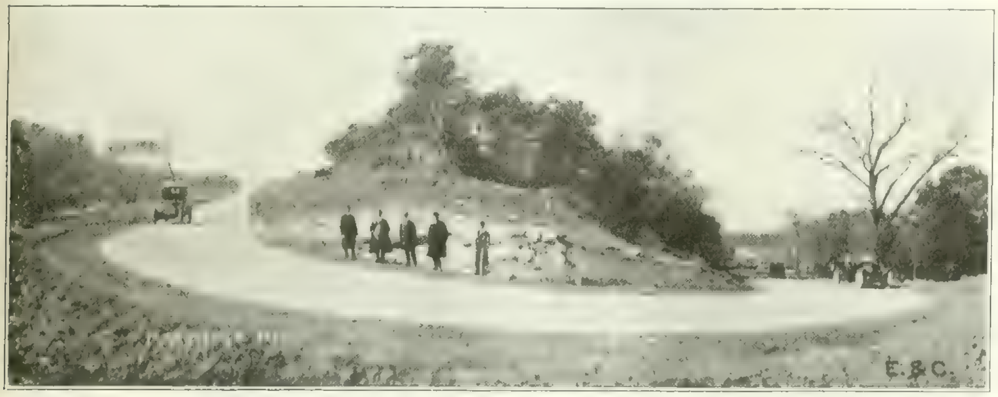


Fig. 1. Sharp Turn on Marquette Hill Road, La Salle County, Illinois.

LOCATION.

The old earth and gravel road started from the south approach of a river bridge on an 8 per cent grade and within 600 ft. approached a 10 per cent grade. It followed along the side of a deep ravine and made several unsightly turns before reaching the top of the bluff, including a "hairpin turn" of 309°, 600 ft. south of the bridge.

A careful survey of several possible routes was made with the idea of finding a new location. Estimates showed, however, that the old location was the best and plans were accordingly prepared to follow closely the old route, eliminating the curves as much as possible and excavating the hill to get the minimum grade.

The most practical grade line for the road proved to be a 75 per cent grade, starting from the south approach of the Illinois River bridge and extending for a distance of 1,800 ft. The grade was then broken and gradually lessened until it was made level at the top of the hill, 2,400 ft. from the bridge. It was impossible to eliminate the "hairpin turn" of 309°, Fig. 1, about 600 ft. south of the bridge. However, the curve was swung out as far as possible and constructed on a radius of about 80 ft. It was also excavated heavily on the inside so that drivers could see about 200 ft. ahead when making the turn.

EXCAVATION.

The estimated excavation necessary to provide a 7 per cent grade was about 18,000 cu. yds. on the 2,400 ft., of which about 2,000 cu. yds. were in rock, 2,000 in shale and the balance in red clay. The excavation was let to a local contractor for $6,410.89 complete. The excavation was simplified, inasmuch as practically all material was dumped into the ravine at the side. The average haul was about 150 ft., so drag scrapers and wheelers were used. On the "hairpin turn" it was necessary to excavate about 14 ft., of which 2 to 6 ft. were in solid rock. The rock was loosened by dynamite and loaded in wheel barrows and horse carts and dumped over the side into the ravine.

TABLE I.—UNIT COSTS OF MARQUETTE HILL CONCRETE ROAD, LA SALLE COUNTY, ILLINOIS.

Item.	Total cost.	Cost per sq. yd.
Engineering and inspection, furnished by state	....	.....
Superintendence, furnished by state	$ 300.00	$0.063
Excavation, let by contract	6,410.89	1.350
Gravel, f. o. b. siding, 868 cu. yds. at $1.10	954.80	0.201
Hauling gravel	827.06	0.174
Sand, f. o. b. siding, 631 cu. yds. at $1.15	725.65	0.153
Hauling sand	515.33	0.108
Cement, 2,147 bbls. at 70 cts.	1,502.90	0.316
Hauling cement	264.55	0.056
Incidental hauling	123.42	0.026
Constructing and finishing earth shoulders	513.20	0.108
Shaping and rolling subgrade and side roads	210.00	0.044
Mixing and placing concrete, including cost of expansion joints, forms, water, etc.	1,299.66	0.274
Covering, seasoning and cleaning concrete	230.20	0.048
Cost of culverts and side drains	753.77	0.159
Freight on machinery	131.13	0.028
Total cost of road	$14,762.56	$3.108
Cost, excluding excavation and culverts	....	$1.599

Conditions:—

No allowance made for contractors' profit and overhead expenses.

Amount of pavement laid, 2,374 ft., 4,748 sq. yds.

Width of pavement, 18 ft.; thickness, 10½ ins. center, 8½ ins. sides.

Length of haul for materials, 1½ miles.

Rate of pay for mixers, 40 cts.; finishers, 40 cts.; rough labor, 35 cts.; teams, .625 cts. per hour.

After the rough excavation had been completed, the subgrade was shaped and rolled with a ten ton roller. Very little rolling was necessary, inasmuch as there were no fills on the entire road.

PAVEMENT DESIGN.

The one course concrete pavement was constructed on a flat subgrade, 18 ft. wide. It had an average thickness of 10½ ins. at the center and 8½ ins. at the side, making a crown of 2 ins. in the finished pavement. The cross section was maintained throughout the entire length of the road, excepting on the "hairpin turn." On this turn, the pavement was gradually widened from the point of curve to the width of 24 ft. at the center. In the center of the curve, the outside was elevated 10 ins. above the inside and gradually reduced towards the point of the curve. The outside elevation was secured by rotating the pavement about its center line.

On either side of the pavement there is provided a 4 ft. earth shoulder. On the outside of the sharp curve, the shoulder was widened to 12 ft. and banked with an elevation on the outside of about 2 ft. to give added protection to the traffic on the curve.

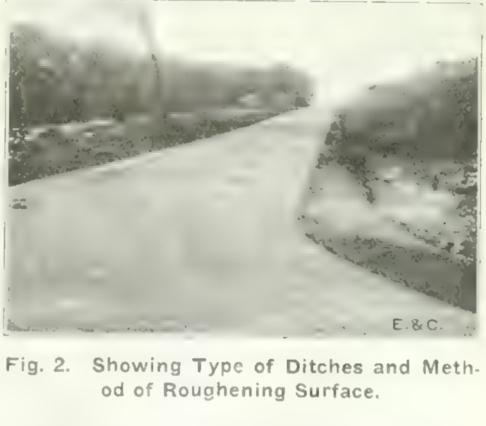


Fig. 2. Showing Type of Ditches and Method of Roughening Surface.

MIXING AND PLACING.

On account of the delivery of materials, the concreting was started from the top of the hill. It was first thought that there would be some difficulty in concreting down a 70 per cent grade, but with the consistency of the mixture used, there was no trouble. In fact there may be some advantages in concreting down steep grades, as the mixer will never fail to propel itself down the grade and any excess water used in washing out the mixer or in sprinkling the subgrade, will flow away from the finished work.

The concrete was mixed in the two sack standard Koehring Street mixer, in the proportion of 1-2-3½. Marquette Portland cement was used and washed sand graded from ¼ in. down, which tested 115 per cent of the standard Ottawa sand. The coarse aggregate was washed gravel, graded from ¼ in. to 1½ ins.

Water was supplied from the Illinois River by a 3 cylinder force pump driven with a 5 hp. gasoline engine. A 2 in. pipe line was laid along the side of the road and gate valves provided at intervals of about 200 ft. for supplying the water to the mixer and for curing the concrete. The 5 hp. gasoline pump lifted the water 200 ft. to supply the mixer at the top of the hill. While this over-worked the engine, there were but few delays caused from the shortage of water.

The concrete pavement was finished in the usual way, by striking off with a templet just behind the mixer. No wood floats, however, were used to finish the surface, but as soon as the concrete started to take on its initial set, it was roughened by dragging a coarse rattan broom over the surface at right angles to the center line of the road. The rattan broom left a uniformly roughened surface on the concrete pavement and one that is desirable upon grades of this kind.

JOINTS AND CURING.

The pavement was divided into sections of about 45 ft. All joints were placed at right angles to the center line of the road and protected by the Kahn armour plates. One-quarter inch felt was used in connection with the armour plates to provide for contraction and expansion.

The concrete was cured by covering it with tarpaulins as soon as it had taken its initial set. Within 24 hours after the concrete was placed, it was completely covered with about 3 ins. of earth which was wet down each day for about two weeks. After the pavement was 30 days old, it was freed from all earth and the road thrown open to traffic.

CULVERTS.

At intervals of about 800 ft. on the road, 12 in. cast iron culverts imbedded in concrete were constructed to carry the water from the upper side across to the ravine. On the upper end of the culverts, catch basins were constructed so as to collect all water from the ditch. Carrying the water across under the road at intervals, prevented excessive washing and eliminated the necessity of rip rapping or paving the ditch on the up-hill side.

COST DATA.

Table I gives an itemized statement of the cost of the improvement. It will be noted that the cost given is a little high for concrete pavements, but taking into consideration the extra thickness of the slab, it will be noted that the cost compares closely with the average price of concrete pavements.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

Electric Hydraulic Dredge for Cuyahoga River Improvements.

Contributed by H. Fies.

At the new plant of The Otis Steel Co., Brooklyn, Ohio, a suburb of Cleveland, an interesting engineering project is now under way, involving the reclamation of some very valuable land and the straightening of the Cuyahoga River. At this point the river makes a bend along the foot of a range of hills, the bend being in the form of a semi-circle about one mile in diameter and traversing a tract of ground containing about 350 acres, which heretofore has lain idle. It was decided to cut a new channel for the river directly across the base of this curve and to use the spoil from the cut to fill in the ground for the new steel works. The plant buildings were built on concrete piers so as to permit of raising the elevation of the land from 4 to 15 ft. above the old level. Directly in the patch of the new channel was a hill about 200 ft. high, through which it was necessary to cut, and which it was decided to cut entirely down in order to obtain sufficient material for completing the reclamation work and for filling in the old river channel.

The contract for the excavating and filling was let to P. T. McCourt, contractor, of Akron, Ohio, who decided that the most feasible method of operation would be to cut down the hill with steam shovels and to excavate the new channel with a hydraulic dredge, the letter at the same time to fill in the low ground through a long pipe line. Work was accordingly started on the hill in the spring of 1914 with two Marion Model 60 steam shovels, using dump cars to deliver the spoil to the various points around the hill which required filling.

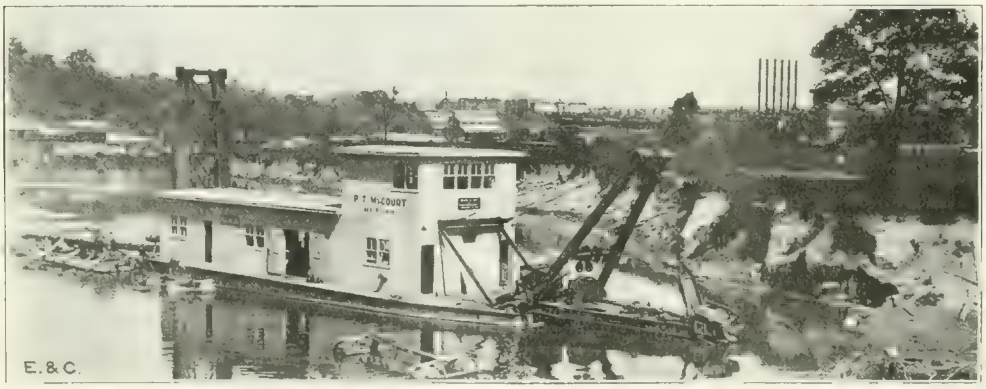


Fig. 1. Electric Hydraulic Dredge for Cuyahoga River Improvement.

The hydraulic dredge for this work is of special design (Fig. 1) and was built complete by The Marion Steam Shovel Co., Marion, Ohio. The hull is 80 ft. long, 25 ft. wide and 5 ft. deep, built of steel throughout. The frames of the hull run crosswise and consist of channels, top and bottom, with vertical angles connected thereto by gusset plates. Two fore and aft trusses provide the necessary longitudinal stiffness; these trusses being connected directly to both the top and bottom members of the cross frames. All plating for the bottom, sides and deck is laid fore and aft, the after part of the deck between the trusses being cut out to form a cockpit for the dredging pump. The bow and stern gantries are also of steel, the stern gantry being directly connected to the stern of the dredge and the after end of the main trusses, while the bow gantry is pin connected to supports on the deck and held in place by steel cables fastened to the forward end of the main trusses.

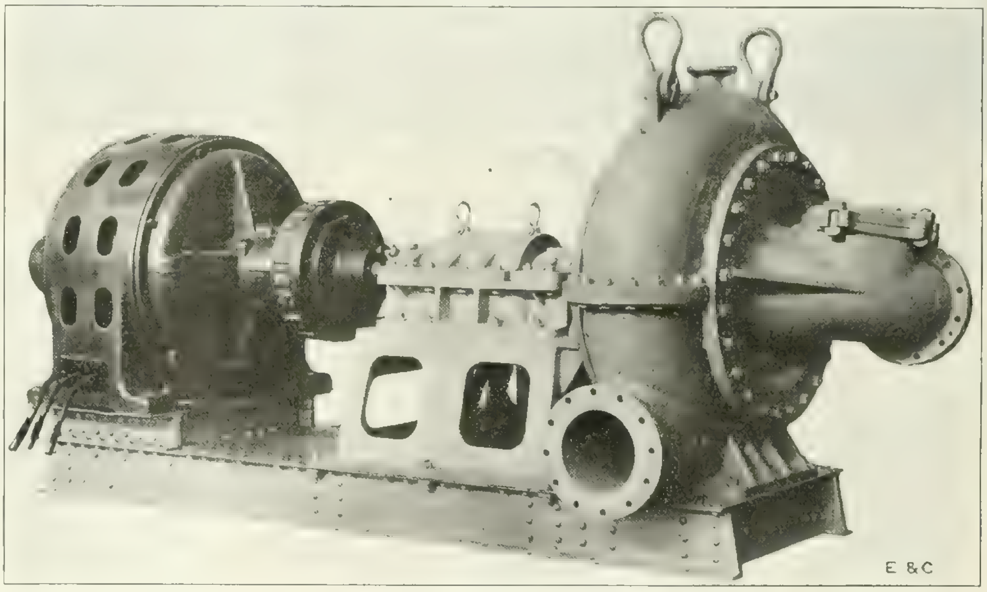


Fig. 2. Completed Motor and Pump Unit, Electric Hydraulic Dredge.

The pilot house is built on top of the fore and aft trusses, and so placed that the operator can have a clear view of the work at all times. The pilot house contains the winch levers, gages, switchboard, and all controlling apparatus so that all operations of the dredge are controlled by one man. The switchboard consists of three slate panels mounted on a pipe framework. On these panels are mounted a volt meter and an ammeter, together with the circuit breakers and fuses protecting the various power and lighting circuits. The lighting system is supplied with current taken from secondary of a 5-kva. transformer. A 10 in. searchlight is installed so it can be used either on the bank or pontoon line. All machinery is driven by 3-phase, 60-cycle, 2,200-volt, General Electric Co. motors; the variable speed motors being of slip ring type, equipped with 14 point reversing controllers. The current is brought on board by a flexible submarine cable connected to transmission lines running parallel to the cut.

The main dredging pump has 16 in. suction and discharge openings and is direct connected by means of a flexible insulating coupling to a 300 hp. motor mounted on the same bed plate (Fig. 2). The pump is designed to deliver 225 cu. yds. of solid material per hour through 1,000 ft. of discharge pipe and to an elevation of 12 ft. above the water line when running at 345 revolutions per minute. Owing to the great variation in the length of the discharge pipe line required at various times, the motor was provided with controlling apparatus for running continuously with 25 per cent speed reduction.

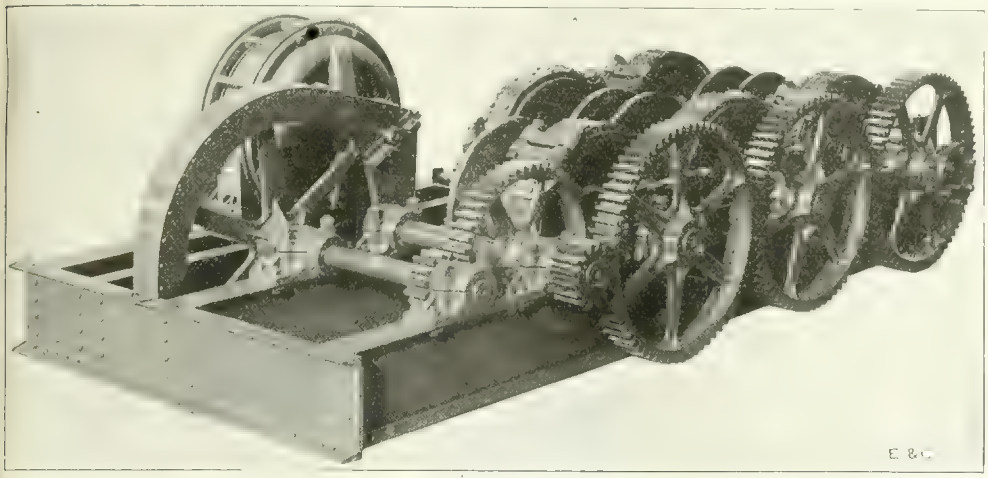


Fig. 3. Motor Driven Fire Drum Winch, Electric Hydraulic Dredge.

In order to knock down part of the hill and sluice material into the cut ahead of the dredge, a 2 in hydraulic giant is mounted on the bow of the dredge in such a way that it can be swung independently of the dredge and have a large radius of action. Water for this giant is provided by a 6-in., three-stage, Worthington turbine pump, delivering 1,300 gals. per minute at a head of 360 ft., and direct connected to a 200 hp. motor operating at 1,140 revolutions per minute. A 3 in. Worthington volute pump, direct connected to a 15 hp. motor, operating at 1,140 revolutions per minute is provided for fire protection, hosing down the deck, priming the main pump and for the various water sealed stuffing boxes on the pumps and suction pipe.

A five drum winch (Fig. 3) driven by a 20 hp. motor is used for handling the swinging lines, raising the cutter ladder and operating the spuds. The motor is provided with controlling apparatus for any variation in speed from full speed down to half speed and is also fitted with solenoid brake. The motor is direct geared through intermediate shafts to the drum shafts. Each drum is provided with internal expanding friction and outside brake band, each one of which is separately controlled from the pilot house.

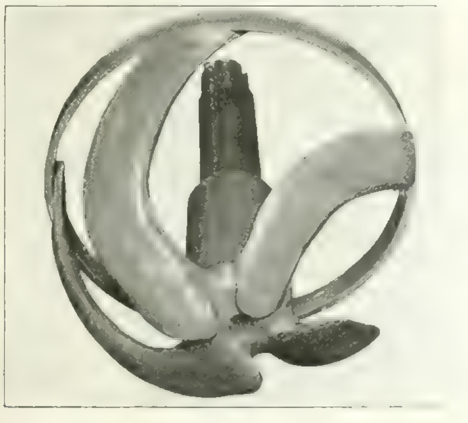


Fig. 4. Original Cutter Bends, Electric Hydraulic Dredge.

The cutter drive and suction pipe are mounted on a structural steel ladder, suspended at the bow of the dredge on steel trunnions, through one of which the suction pipe passes; this joint being sealed to exclude air by means of water forced into the packing by the 3 in. pump. The ladder is raised and lowered by cables running over sheaves in the top of the bow gantry and down to a drum on the winch machinery. The cutter is driven through reduction gearing by a 75 hp. motor, running normally at 575 revolutions per minute, but fitted with controlling apparatus for operating continuously at 50 per cent speed reduction. The cutter originally furnished was of the heavy type, having removable manganese blades, but after the dredge had been in operation the sub soil was found to consist of sticky blue clay of the sort commonly called "Gumbo," and the cutter was found to be unsatisfactory, owing to the material clogging it up and refusing to enter the suction pipe. A cutter was then installed having four knife-like blades, curved in the shape of an auger, as shown in Figure 4, and found to do excellent work. This cutter was later replaced with one of the same pattern, but of greater length (Fig. 5) as it was found difficult to properly gage the forward steps of the dredge with any great accuracy; the tendency being to overstep and leave uncut material behind the cutter. A great deal of trouble and delay has been caused by logs, which are found imbedded in the soil and which must be pulled out before the dredge can proceed. Some of these logs are 24 ins in diameter and 35 ft. long, and as high as six have been in the cut at one time. Figure 1 shows a view of the dredge just after starting operations, when the original cutter was still in use. This also shows the new buildings of The Otis Steel Co. in the background.

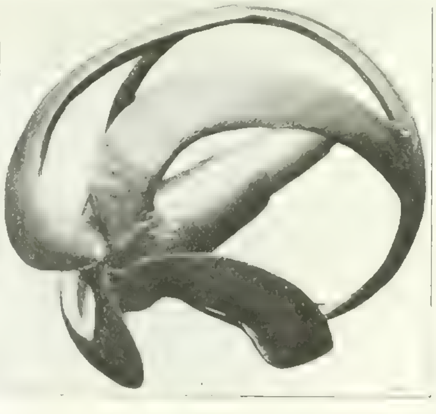


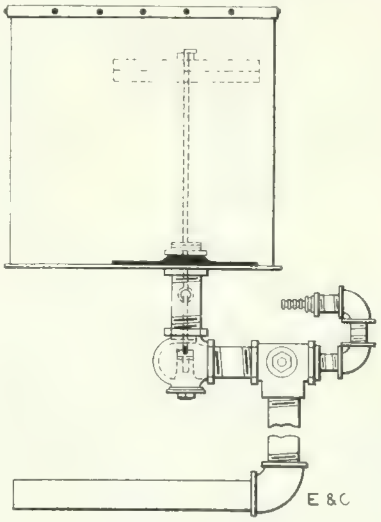
Fig. 5. Improved Cutter Bends, Electric Hydraulic Dredge.

The work on the new channel is progressing very rapidly; the steam shovels having completed their part of the work on the hill in the early part of September. The dredge was put in operation on June 25, 1914, and although some time was lost in changing cutters, it is expected that the work will be completed early this year.

The new channel will be 8 ft. deep and 150 ft. wide, but later on it will be deepened to permit of navigation. When this is done, The Otis Steel Co. contemplates the building of docks on the west bank of the river.

Automatic Water Tank for Northwestern Cone Batch Mixer.

An automatic water measuring tank has become a standard feature of machine concrete mixers and the illustration here shows a special design of tank for which advantages are claimed. The water is led into the tank through a three-way valve, which valve has a connection for city water. It is automatically shut off through the agency of a float, which has a free movement on the valve stem. A set collar is placed on this stem to regulate the amount of water to be placed in the tank. As soon as the float strikes this set collar, it will automatically lift the valve stem and shut off the water from below. The automatic lift and shut off is positive in that the pressure back of the valve holds this valve in place. When the water is discharged into the mixer, this pressure is relieved by cutting off the city connection in the three-way valve and the valve underneath the tank is allowed to drop, releasing the water, which is led through pipes into the interior of the drum. The tank is constructed of 20-gage galvanized iron and is securely fastened to the supporting frame by means of four rods on the outside of the tank. There is nothing about this tank to get out of order or shake loose. It is built strong and built to withstand all vibration. This tank is a part of the equipment of the cone batch mixer made by the Northwestern Steel & Iron Works, Eau Claire, Wis.



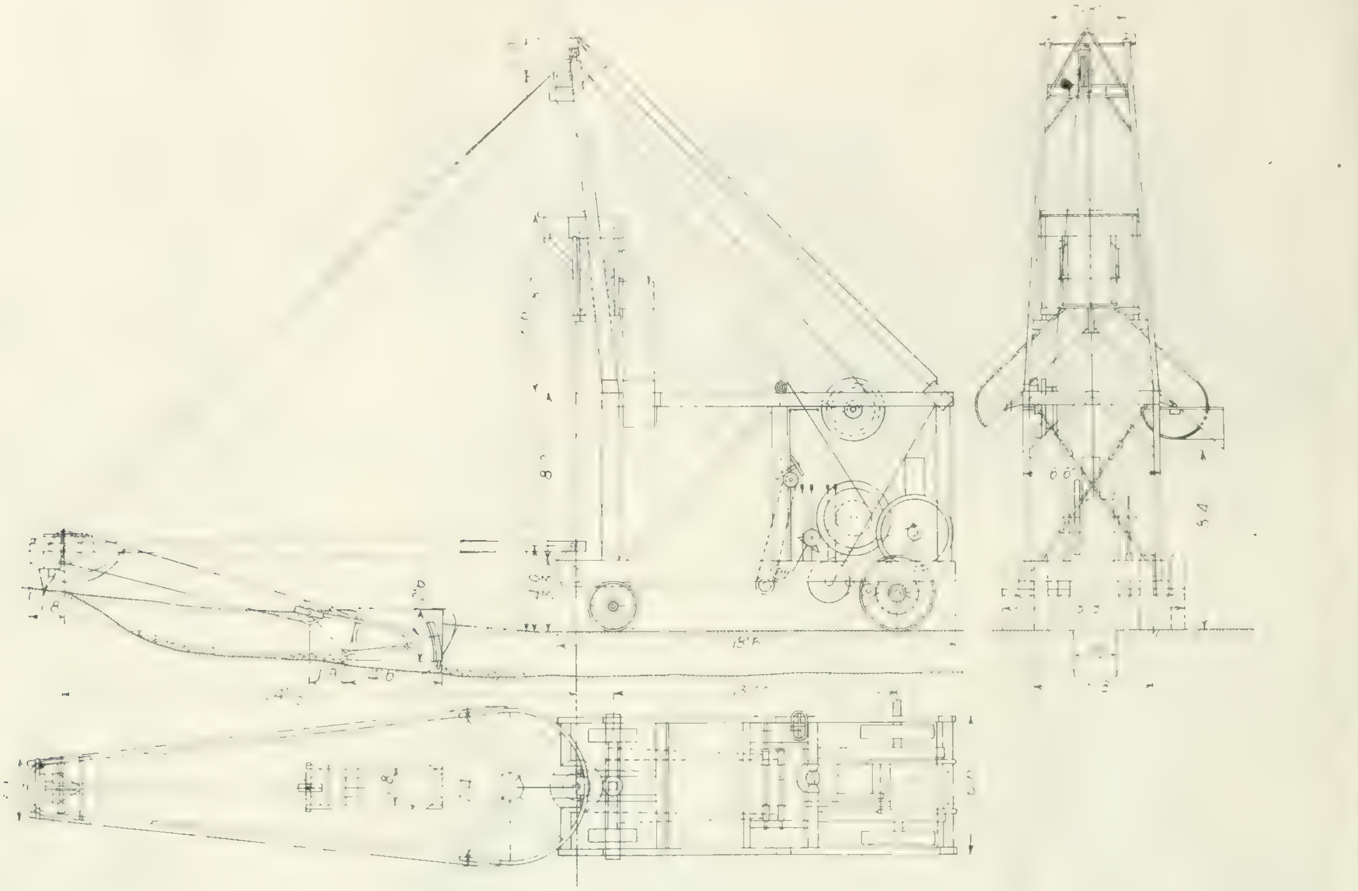
Automatic Water Tank for Concrete Mixers.

A New Type of Drag Line Excavator.

The type of drag line excavator illustrated herewith is suitable for the extension of water and sewer trenches, drainage and irrigation ditches, and for general excavating. It is also adapted for use in road and railroad construction and in placer mining. It is the invention of Joseph Pronovost, and is known as the Pronovost excavator. The illustration shows only the position of the drums and hoisting lines. The power may be supplied either by internal combustion or steam engines, or by electricity. The essential operating features are as follows:

The drag line is attached to the boom and runs through sheaves on the bucket. The boom pulls the bucket toward the end of the boom where it catches into a clutch and is lifted on the end of the boom, which swings it up to the top of the derrick. The open boom is a feature of the machine. The bucket is released, trips on the upper projection, dumps into the hopper, is righted by the lower projection and drops to the ground for another load.

A weight attached to the end of the boom line back of the drum takes up the slack, and while the bucket is coming up, a drum is taking in the line. When the bucket is released and dropped, the boom is lowered for another pull on the bucket.



New Type of Drag Line Excavator.

The lines run over a double sheave working on a swivel in the top of the derrick or head frame. One worm gear swings the boom to either side of an excavation and another turns the front axle of the truck, which is propelled by power applied to the rear wheels.

An attachment like a ploughshare on each side of the bucket breaks ground and serves to keep the bucket in line when trenching straight ahead. The bucket moves continuously in the same direction and there is no lost motion. By dumping into a central hopper, the delivery of material excavated is regulated, whether run into a cart, car or other conveyor.

The upper parts of the machine can be detached to clear overhead obstructions.

Mr. Charles Cummings, civil engineer, Marquette, Mich., furnished the information upon which the foregoing description is based.

A Frostproofing Admixture for Concrete.

(Contributed.)

This material is a fine white substance, about like cement, and from 2 to 4 lbs. to each batch of cement are used. The extra cost per cubic yard is about $0.75. Extensive tests have been made, and it is found that the concrete would not freeze even as low as six degrees below zero, the lowest temperature that was obtained when the tests were made. It was found further that of two briquettes, one with the frostproofing and the other without the frostproofing, the concrete without, froze hard as a rock, while the other was not effected in the least by the cold. It is further found that at the end of seven days that the concrete with the frostproofing stood 11 lbs. per square inch more compressing strain. Another advantage is that this material has a tendency to keep the forms from rusting, which is a decided advantage for reinforced work. The following is from the New England Bureau of Tests:

A number of briquettes of 1-3 mortar were made using cement of good quality and standard Ottawa sand. A portion of these contained 2½ per cent frostproofing to the amount of cement, the balance being untreated. The results of these tensile strengths are as follows:

Test period.	With frostproofing. Per sq. in.	Without frostproofing. Per sq. in.
3 days	176 lbs.	201 lbs.
7 days........	254 lbs.	243 lbs.

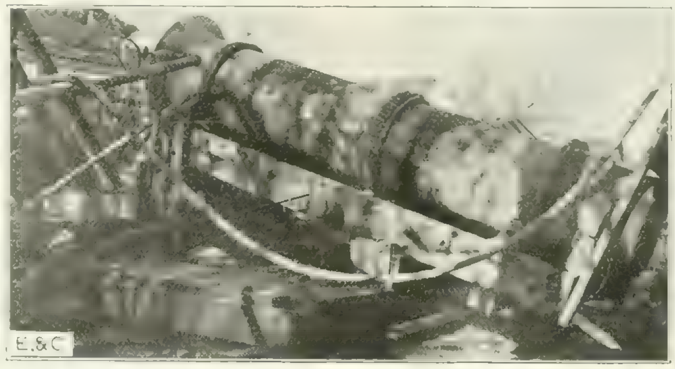
These results show that the frostproofing in the very early stages has a tendency to retard the setting slightly which is recognized as the best possible thing for good concrete, as it should not set too quickly. But at the end of a week tests showed the strength of the treated mortar to be superior to that of the untreated mortar.

In addition to the heat tests, one briquette with 2½ per cent frostproofing and one without, were placed out of doors immediately after making. The temperature 32 degrees went to 22 degrees that night. In the morning the briquette without the frostproofing was frozen hard while that containing it was not frozen, but of course had not hardened owing to the low temperature. The specimens were allowed to remain at room temperature for 48 hours and then broken, the results showing a strength of 52 lbs. per square inch for the untreated and 113 lbs. per square inch for that containing the frostproofing. These results clearly indicate the advantage of the preventing of freezing the mortar.

This frostproofing is made by the Lansing Co., Lansing, Mich.

A Pelton Wheel Driven Concrete Mixer.

While building the reinforced concrete building of the Ashland Creamery at Ashland, Ore., a unique manner of driving the concrete mixer was employed. When work was first started a 7 hp. gasoline engine was used, but due to constant rain and damp weather, much difficulty was experienced. A 6 in. Pelton water motor was the only other power available, so the owner, Mr. D. Perrozzie, tore out the gasoline engine, spiked the water motor to the mixer platform, and coupled it to the city water supply.



Concrete Mixer Driven by Pelton Water Wheel.

The photograph shows the rig as it finished the job. When it is taken into consideration that the first cost of the water motor was less than half that of the gas engine, the change proved very satisfactory to the builder.

Engineering and Contracting

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DAMS: All concrete.

All-concrete Dams: The Next Step in the Evolution of Masonry Dam Construction 89

Editorial discussing the possibility of the all-concrete dam becoming generally adopted in the near future. Compares concrete construction with the prevalent concrete and rubble type. E. & C., Feb. 3, 1915; 1½ cols.

PUBLIC WORK: 1915 Prospects.

In 1915 Let There Be More Public Work Than Ever 89

Suggests that city and other public work which has been postponed might with profit be started at once. Reviews previous periods of depression and finds no excuse for further delay in the beginning of proposed public works. E. & C., Feb. 3, 1915; 2½ cols.

WATER WORKS: School for Employes at San Diego.

A School for Water Works Employes at San Diego, Calif. 90

An editorial explaining and commending the plan in vogue at San Diego of holding monthly meetings of water department employes at which papers on water works topics are read by officials. E. & C., Feb. 3, 1915; 1 col.

TUNNELS: Lining, Cast Iron, Design.

Determination of Stresses in and Design of Cast Iron Lining for Subaqueous Tunnels 90

Gives formulas for computing weight and tabulates weights for eight tunnels; mathematical discussion of external forces acting on tunnel lining; discussion of stresses in tunnel lining; discussion of buoyancy with citation of tests. E. & C., Feb. 3, 1915; 5½ cols.

COMMISSION-MANAGER FORM OF GOVERNMENT: Comment on.

Comment on the Commission-Manager Form of Government 92

A correspondent states his belief that the commission form of government is preferable to the commission-manager form, and gives arguments and observations in support of his theory. Thinks cities are not yet ready for the newer form. E. & C., Feb. 3, 1915; 1½ cols.

TUNNELS: Rock; Construction Methods.

Method of Constructing Rock Tunnel of 50-Ft. Clear Width, Stockton Street, San Francisco 93

Describes the work of constructing this concrete-lined tunnel, and illustrating by diagram and views the work of driving, timbering, lining, etc. Describes contractor's plant and layout. E. & C., Feb. 3, 1915; 11½ cols.

BUILDINGS: Engine Terminal.

Design Features of the Lake Shore & Michigan Southern Railway Engine Terminal at Air Line Junction, O. 97

Describes and illustrates the design features of the compact and comprehensive engine terminal of the Lake Shore & Michigan Southern Railway at Air Line Junction, O. E. & C., Feb. 3, 1915; 11½ cols.

BUILDINGS: Safe Methods of Wrecking.

Safe Methods of Wrecking Buildings 98

Describes safe methods and procedure to be used in the wrecking of buildings. The hazards of this kind of work are not generally understood, and the article treats, in a commonsense way, of necessary precautions and recommended procedure. E. & C., Feb. 3, 1915; 5 cols.

CHIMNEY: Repair of Iron With Reinforced Concrete.

Reinforced Concrete as an Emergency Repair for an Iron Chimney 100

Describes and illustrates an example of the use of reinforced concrete for reinforcing the lower section of an iron chimney which had corroded badly. The work was done without interfering with the operation of the power plant. E. & C., Feb. 3, 1915; 2 cols.

BUILDINGS: Cost Elements, Data on.

Elements of Buildings—Factor Costs and Some Specific Data 101

A discussion by Harold L. Green of the elements of buildings-factor costs. Classifies the elements, and gives some specific data on the relative costs of fixed charges on land, buildings and fixtures, of power and light, of heat, and of building's expense. E. & C., Feb. 3, 1915; 3 cols.

WATER WORKS: Construction Gang Payrolls; Checking.

Field and Office Methods Employed by Louisville Water Co. in Checking Construction Gang Payrolls 102

Describes workings of timekeeping system whereby each gang foreman keeps time on his gang subject to the check of an extra timekeeper, who, mounted on a motorcycle, moves from gang to gang during the day. The system is successful. E. & C., Feb 3, 1915, 2½ cols.

WATER FILTERS: Strainer Plates, Method of Testing.

Method and Results of Strength Tests on Strainer Plates for Baltimore Water Filters 103

Describes and illustrates apparatus used in making strength tests on strainer plates used in Baltimore filters, and gives results of tests. E. & C., Feb. 3, 1915; 1½ cols.

WATER WORKS OPERATION: Regulation by State.

An Example of State Regulation of the Operation of a Small Water Works in Pennsylvania 103

Gives substance of the report of the Public Service Commission of Pennsylvania in case against New Wilmington Water Supply Company brought by citizens charging unjust rates and inadequate service. Quotes order of commission ordering substantial improvements in plant and methods in village of 1,100 population. E. & C., Feb. 3, 1915; 3 cols.

PUMPING MACHINERY: Deep Well; Considerations Affecting Selection.

Considerations Affecting the Selection of Deep Well Pumping Machinery 104

Discusses air lift, reciprocating or plunger pumps and rotary pumps from the standpoints of cost, efficiency, capacity and reliability. Also discusses effect on selection of type of pump of size and straightness of well, chemical and physical character of water, pumping level of well and its probable fluctuations, number of units permitted, emergency reserve available, skill of erector, and character of supervision under operation. E. & C., Feb. 3, 1915; 4 cols.

ROADS: Guard Rail, Concrete, Wood.

A Modification of the New York Standard Guard Rail Providing Concrete Posts .. 106

Describes and illustrates in detail the design of a combination wood and concrete guard rail. Gives comparative costs of wood guard rail and earth fill. E. & C., Feb. 3, 1915; 2 cols.

ROADS: Cost Reporting and Data for.

Recommended Standard Form for Reporting Costs of Road Construction 107

Gives essential data necessary in the preparation of methods and cost reports on road construction. Outlines proper subdivision of cost data for both construction and maintenance. E. & C., Feb. 3, 1915; 4 cols.

ROADS: Concrete, California.

Methods and Cost of Constructing Nine Miles of Concrete State Road in California 108

Describes methods and cost of grading, mixing and placing and the construction of a bituminous wearing coat. Unit cost of various items are given. E. & C., Feb. 3, 1915; 3 cols.

ROADS: Concrete, Illinois.

Methods and Cost of Constructing a Concrete Road in La Salle County, Illinois .. 109

Discusses location, excavation, pavement design, mixing and placing, joints and curbing, cost data. Road constructed on a heavy grade and involves a hairpin turn. E. & C., Feb. 3, 1915; 3 cols.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Telephone System.—There is an opportunity in near East for securing contracts for installation of an extensive telephone system. No. 15,419.

Surface Condenser.—Engineering and contracting company in Canada wishes to get in touch with American manufacturers of a surface condenser to take care of three high-pressure engines on a dredge. Catalogues, etc., are desired. No. 15,427.

Railway Ties.—Business men in one of the neutral European countries desires to receive offers, by cable, for the supply of about 5,000,000 oak railway ties.. Copy of the full report may be had on application to the Bureau of Foreign and Domestic Commerce and its branch offices. No. 15,440.

Pumping Machinery.—An American consular officer in one of the Portuguese possessions reports that the Government has decided to exempt from duties any material imported exclusively for irrigation purposes, such as pumps, rams, motor machinery, piping, etc. It is suggested that manufacturers of these articles send literature, catalogues, etc. No. 15,464.

Electrical Machinery.—Firm in Italy desires to communicate with American manufacturers of electrical machinery, fixtures, and supplies. Correspondence should, if possible, be in Italian. No. 15,473.

Steel Railway Bridge.—The Siamese Royal Railway Department, broad gauge, will open tenders June 1 for the supply of a steel bridge of 5 by 40 meter spans over the river Me Wang, at Lampang, on the northern railway. Drawings and specifications are for sale at the Siamese Legation at Washington; they may also be examined at the Bureau of Foreign and Domestic Commerce or its branch offices. Communications may be in English, and should be sent to L. Weiler, Director General of Siamese Railways, broad gauge, Bangkok, Siam. No. 15,456.

Locomotive, Dynamos, Etc.—Merchant in Far East desires to receive catalogues, price lists, etc., on locomotives, dynamos, and electric lamps. He is in the market for a locomotive of from 40 to 60 H.P.; a dynamo, three-wire system, direct current; and lamps of 14 and 220 volts. No. 15,459.

Agricultural Machinery, Etc.—Firm in Russia wishes to act as agent for American manufacturers or exporters of agricultural machinery, machinery for flour mills, etc. No. 15,441.

Crushers, Etc.—Engineer in France wishes to secure an agency for American mining machinery, such as crushing and washing machines. No. 15,443.

Pipe and Waterworks Supplies.—Municipality in one of the Spanish possessions needs cast iron pipe and other supplies for completing the installation of a city water system. No. 15,447.

Cement, Iron and Steel.—A representative of an importing firm in South America has called at the Bureau of Foreign and Domestic Commerce with a view to establishing commercial relations with firms in the United States for the importation of products from South America and for the exportation of American products to that country. No. 15,449.

Steel.—An American consular officer has transmitted a report, together with a set of specifications, relative a market in his district for mild steel. The name of a business man is given who wishes to obtain offers c. i. f. destination, cash to be deposited against documents. No. 15,444.

Machinery.—A business man in Europe desires to establish commercial relations with American manufacturers of machines and apparatus for the textile industry. No. 15,446.

INDUSTRIAL NOTES

Hugo Burgheim Co., Cincinnati, O., dealers in railroad and contractors' equipment, supplies and relaying rails, has moved its office to larger quarters in Suite 601, Mercantile Library Bldg.

Albert C. Lehman has been elected president of the Blaw Steel Construction Co. of Pittsburgh, Pa. Mr. Lehman has been vice-president and general manager of this company since its inception.

The Terry Steam Turbine Co., Hartford, Conn., has appointed Earl F. Scott, as its representative for the state of Georgia, with offices at 702 Candler Bldg., Atlanta, Ga. The Pittsburgh office, in charge of H. A. Rapelye, is now located at 1624 Oliver Bldg.

A branch office has been established at 900 Lytton Bldg., Chicago, by W. H. Anderson Tool & Supply Co., of Detroit, Mich., and Mr. F. B. Talley has been appointed Chicago representative. Among the machinery and equipment exhibited is a new 7-ft. mixer known as the Anderson Rotary Mixer.

The entire selling organization and executive division of the Koehring Machine Co. of Milwaukee, Wis., manufacturers of concrete mixers and concrete handling equipment, held their annual convention at the general offices of the company during the past week. About 40 representatives were in attendance.

C. R. Dodge and G. H. Edbrooke, formerly of Dodge & Dodge, have opened an office at 33 West 42nd St., New York City, and, under the firm name of C. R. Dodge & Co., will specialize in concrete handling equipment. They will handle a complete line of contractors' machinery, including the Milwaukee and Wisconsin concrete mixers and the Wylie self-supporting concrete chutes.

The George W. Jackson Construction Co. has opened offices in the National Life Bldg., 29 South La Salle street, Chicago, Ill. The company is organized under the laws of the state of Illinois with a paid up capital of $500,000, and is prepared to undertake the construction of heavy foundations, buildings of all kinds, railroad terminal construction, bridges, grain elevators, subways, tunnels and for complete underground and overhead construction of every description. George W. Jackson is president and engineer; Charles A. McCulloch is secretary.

The Raymond Concrete Pile Co., New York and Chicago, has been awarded recently contract for the following: 1,579 Raymond concrete piles for the foundations of the Schenley high school, Pittsburgh, Pa.; Edward Stotz, architect; James L. Stuart, general contractor. Foundation for Public School No. 5, Jersey City, N. J.; John T. Rowland, Jr., architect; W. H. & F. W. Cane, general contractor. E. D. Watt, licensee of the Raymond Concrete Pile Co., has been awarded the contract for Standard Raymond concrete piles for the Appraisers Stores, Milwaukee, Wis.; supervising architect, U. S. Treasury Dept., architect; Northern Construction Co., general contractor.

NEW CATALOGUES

Mortar Mixer.—Paper, folder. Eureka Machine Co., Lansing, Mich.

Shows the Eureka mortar mixer, its design and operation, and briefly describes its features. Gives general specifications.

Road Machines.—Paper, 6x9 ins., 8 pp. Ruggles-Coles Engineering Co., 52 Church St., New York City.

Describes and illustrates Ruggles-Coles portable and semi-portable dryers and heaters, giving details of construction and principle of operation, with views of plants in use and data as to capacities, fuel saving, etc.

Drilling Machinery.—Paper, 6x9 ins.; 26 pp. Sparta Iron Works Co., Sparta, Wis.

The January number of "The Sludge Bucket," containing several interesting articles on well drilling and machinery, and brief news notes, jokes, letters from drillers throughout the country and advertisements of Sparta drills and tools.

White Portland Cement.—Paper, 7x9 ins.; 32 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

The various uses of Medusa Stainless White Portland Cement are shown by numerous photographic reproductions and letters of appreciation from a number of architects, engineers, etc., who have used the material, are included.

Water Wheels.—Paper, 6x9 ins.; 64 pp. The Pelton Water Wheel Co., San Francisco, Cal.

Bulletin No. 8 illustrates and describes Pelton water wheels particularly adapted to driving mining, sawmill, industrial and other machinery. Contains considerable hydraulic information, formulas, data required for estimates, etc.

Concrete Machinery.—Paper, 8½x11¼ ins., 64 pp. Northwestern Steel & Iron Works, Eau Claire, Wis.

Catalogue No. 9, describing Northwestern Cone Batch Mixers, convertible batch mixers, hand batch mixers, contractors' hoists, towers and spouting, crushers, block machines, moulds and other Northwestern Concrete Machinery. Fully illustrated and gives comprehensive data and price lists.

Railway Line Material.—Paper, 8x10½ ins., 100 pp. General Electric Co., Schenectady, N. Y.

Bulletin No. 44,004, devoted to railway line material for direct suspension, covers practically everything in that class except poles and wires. All parts are illustrated and tables of miscellaneous data relative to construction, overhead material per mile, use of solid copper wire and cable, dimensions of grooved trolley wire sections, etc., are given.

CATALOGUE REVIEWS

Concrete and Mortar Mixers.—Paper, 6¾x 9¾ ins.; 32 pp. Eureka Machine Co., Lansing, Mich.

This booklet describing the Eureka Self-Measuring Mixer is well illustrated and contains interesting information as to the work of this mixer. The advantages of the self-mixing type of mixer, both for concrete and mortar, are set forth and a general mechanical description given, explaining particularly the arrangement of the revolving steel feeders and the use of the self-measuring device. A proportion card furnished with the mixer is shown in fac-simile, and instructions as to proportioning and testing are given. The gravity chute, belt drive, gearing, trucks and other parts are shown. Specifications and descriptions of the various outfits suited to different kinds of work follow, and illustrations show a number of large enterprises in which Eureka Mixers were used for the concrete or mortar.

Metal Silos.—Paper, 6¾x10 ins., 44 pp.; The Canton Culvert & Silo Co., Canton, Ohio.

The 1915 edition of the catalogue on "Zyro" Galvanized Anti-Corrosive Metal Silos shows many views of these silos which have been constructed in all parts of the country. Zyro Silos are made of sectional sheets of No-Co-Ro metal. This material, a galvanized, anti-corrosive and highly rust-resistant product with pure iron as the base, is described in detail, with a discussion of the causes and prevention of corrosion and rust. Tests are described and photographs of the results are shown. Then follow explicit directions for the erection of Zyro silos, with diagrams and sections, and views of construction work in progress. A table of sizes is also given. There is also a good deal of miscellaneous information relative to silage and silos in general.

CURRENT NEWS

The Doings of the Week.

Trade and industry showed continued improvement during the past week. In the basic industries such as lumber, copper and cotton there was a broadening of activity. Renewed interest was shown in the better class of railroad securities and considerable demand was manifested for high-grade bonds even including first-class public utility issues. One development of the week, important as foreshadowing future construction operations, was the sales of $10,000,000 of bonds by the Illinois Central R. R., and $49,000,000 of bonds by the Pennsylvania R. R. The financial situation now is practically normal with abundant money at low rates of interest. This explains in a measure why the present demand for bonds and high-grade stocks is better and broader than it has been before for many months. The prospects for an active building season in the larger cities are excellent as there should be little difficulty in financing new structures under the prevailing interest rates. The volume of new work in the construction field that reached the call for bids stage last week is smaller than in the previous week. Nevertheless it is well up to the average of the season of the year. Cities in the middle west are beginning to ask bids on street paving, and there also is considerable activity in other lines of municipal work. In the iron and steel trades there has been considerable progress toward recovery. Some independent concerns are now reported to be operating at 80 to 95 per cent capacity. The U. S. Steel Corporation's plants, however, are running at only about 50 per cent capacity, but this compares somewhat favorably with the 35 per cent capacity for December. The railroads have placed additional orders for rails—nearly 75,000 tons being ordered by western roads. Better prospects also are indicated for structural work. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Jan. 27 were as follows:

Finished Iron and Steel.	Jan. 27.	Jan 20.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.20	1.17½
Iron bars, Pittsburgh........	1.10	1.15
Iron bars, Chicago.........	1.00	0.97½
Steel bars, Pittsburgh........	1.10	1.10
Steel bars, New York........	1.26	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York......	1.26	1.26
Beams, etc., Pittsburgh......	1.10	1.10
Beams, etc., New York......	1.26	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh......	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.80	1.80
Galv. sheets, No. 28, P'gh....	2.90	2.75
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.50	1.50
Fence wire, base, P'gh.......	1.35	1.35
Barb wire, galv., P'gh.......	1.95	1.95

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railways.—A large amount of new financing is now being undertaken or is contemplated by the various railways. The Illinois Central, the Pennsylvania, and the Erie R. R. disposed of good-sized blocks of securities during the past week, and a number of other companies will make offerings shortly. It is too early as yet to expect any definite announcement as to construction plans for the coming season. It has been stated that the Pennsylvania R. R. contemplated the expenditure of $40,000,000 for improvements, betterments and equipment, and that the Baltimore & Ohio had a program calling for the spending of about $30,000,000. These are but unconfirmed reports, but undoubtedly both of these railroads have a large amount of work in view. It is the general impression among those familiar with conditions in the railway field that a great deal of construction will come up next month. No particularly large contracts appear to have been let during the past week and only one or two undertakings are reported as being figured on. One railroad with headquarters in Chicago has asked bids on a good-sized improvement.

Roads and Streets.—Very little work in the state highway field came up for advertising for bids last week. None of the larger states have commenced on their construction programs for the present year, and it probably will be several weeks before any large amount of state road work is advertised. One fair-sized job in King County, Washington, is ready for proposals. This calls for the improvement of the Mercer Island Road—an $80,000 contract. A number of fair-sized city paving contracts are now being advertised.

Bridges.—No particularly large undertakings in the bridge field appear to have come up for bids during the past week. Several counties in Iowa are calling for bids for the various materials for culvert construction during the present year, and Marion County is asking proposals on 5 steel spans, 4 I-beam bridges and 69 reinforced concrete culverts. Houston, Tex., opens bids Feb. 10 on a $37,000 bridge; the state engineer at Portland, Ore., is asking proposals on three reinforced concrete bridges for the Columbia Highway; the County Clerk at Nelson, Neb., opens bids March 3 on a reinforced concrete bridge of two 50-ft., two 55-ft. and one 60-ft. arches; the County Clerk at Elkins, W. Va., is asking bids on seven bridges, the largest having a 170-ft. span.

Drainage and Irrigation.—The principal job in the drainage field advertised for bids last week calls for 6,000,000 cu. yds. of excavation for the Little River Drainage District of Cape Girardeau, Mo. Two or three drain propositions in Minnesota also are ready for bids. The U. S. Reclamation Service is calling for proposals on a fair-sized excavation and concrete contract.

Waterworks.—Quite a bit of work came up for advertising in the waterworks field during the past week. Several small municipal systems are ready for bids, and a considerable amount of extensions and other improvements also are being advertised. Cordell, Okla., opens proposals Feb. 8 for extension of its water systems; Gordonsville, Va., is calling for bids for enlarging its reservoir; Laramie, Wyo., opens proposals Feb. 23 on extensions requiring 18,200 ft. of pipe; Mount Morris, N. Y., is taking bids until Feb. 19 for a waterworks to include 9 miles of 6-in. to 8-in. pipe; Orion, Mich., is asking proposals for a $35,000 waterworks; Philadelphia, Pa., opens bids Feb. 9, for furnishing and laying 48-in. pipe line; Hawthorne, N. J., is calling for proposals for a water supply system to include 83,000 ft. of pipe and a concrete reservoir.

Sewerage.—Several good sized sewer contracts reached the call for bids stage last week. In New York City the president of the Borough of Brooklyn is calling for proposals on three big sewer jobs, involving the construction of a large amount of 90-in. to 162-in. sewer. Milwaukee, Wis., began calling for bids on the first contracts in connection with the proposed new $10,000,000 intercepting sewer system. The work advertised calls for the construction of about five miles of brick and concrete sewer. Warren, R. I., is asking bids on a system providing for 15,000 ft. 8-in. to 18-in. sewers; El Dorado, Kan., opens bids Feb. 16 for constructing a sewage disposal system; Washington, D. C., is calling for bids on 12,800 ft. of 10-in. to 24-in. pipe sewer.

Uniform Compensation Law.

Some time legislation will be enacted that will provide a uniform workmen's compensation law. Interesting suggestions toward this highly desirable end, compiled by the committee on uniform state laws of the National Civic Federation, were made public last week. The committee suggests that compensation should be made only for injuries or death resulting from accidents arising in the course of employment, and that the law should exclude injuries occasioned to the employe by the willful intention of such employe to injure himself or another. Regarding the necessity of the last clause, it may be noted that under the provisions of one of the state compensation acts now in effect, a man's little toe or his little finger, for example, are apparently of much more value to the employer than they are to their possessor. Anyhow, it is asserted that in a number of cases employes have deliberately injured themselves in order to obtain the compensation provided by the law. It is suggested also that the law should make no provision for injuries resulting solely from intoxication of the injured employe and for casual employments. The compensation, according to the committee, should be based upon the average pay of the workman in the grade in which he is employed at the time he is injured, and a definite percentage of the loss of earnings should be paid periodically in case of injury or death. Payments on account of death, it is suggested, should be made periodically, the percentage of compensation to be based upon number and relationship or the extent of dependency of the next of kin. The committee suggests further that some inducements should be made to employers to re-employ injured men, especially where the law provides for their payment of compensation for definite periods. It also is recommended that the law should provide in death cases and where permanent total disability results, other than where the men are re-employed, that a lump sum should be paid to the commission. The object of this provision is to remove the danger of nonpayment of compensation spread over a period of years because of the insolvency of the employer. The workmen's compensation acts at present in force in various states leave much to be desired. The attempt of the National Civic Federation to secure uniformity in the law is a step in the right direction.

Improvement of Building Conditions.

After many years of agitation, definite action for the betterment of conditions in the building industry has been taken. At the annual meeting of the National Association of Builders' Exchanges held last week at Columbus, O., a report was submitted outlining the conclusions reached by the joint committees of the exchanges and the American Institute of Architects. Many improvements in existing conditions were recommended, final decision on which will be taken at a conference with the architects next month. The necessity for an improvement in present conditions is evident. A more equitable method of settling disputes between the contractor, the architect and the owner is needed; reforms in the methods of awarding contracts and the ethics governing estimating and bidding are desirable. With a uniform system of general conditions for building contracts, the contractor can conduct his business on a safer and saner basis.

Construction Under a Tent.

Building a building under cover in order to prevent delays from weather conditions enabled an Ohio contractor to establish a construction record for "dead of winter" work. The contract called for the erection of a 1-story structure 90 ft. by 202 ft. in size, with two monitors, for an acid building for a storage battery company. The contract was awarded at 3 p. m., Jan. 9, with the stipulation that it should be completed by Feb. 1. A considerable amount of concrete was involved, and on account of this and to guard against the effects of adverse weather, a circus tent 100 ft. by 350 ft. was put up over the site. Construction was started at 6 a. m., Jan. 10, with a force of 250 men, and in 16 days the entire job was completed.

A $400,000 SEDIMENTATION BASIN.

To Be Constructed at Torresdale Filters Philadelphia.

Bids to be Opened February 9 by Bureau of Water.

The sum of $400,000 is available for the construction of a new sedimentation basin at the Torresdale filters of the city of Philadelphia, Pa. The improvement requires a large amount of excavation and involves the construction of timber and concrete bulkheads, intake and superstructure, mixing chamber, outlet gate house and a considerable amount of miscellaneous work. The approximate quantities include the following:

Earth excavation, cu. yds.	600,000
Rock excavation, cu. yds.	500
Riprap (river gravel, pebbles or cobbles), tons	30,000
Riprap (quarry stone), tons	20,000
Timber and cribbing (long leaf yellow pine), M ft. B. M.	750
Timber and cribbing (short leaf yellow pine), M ft. B. M.	2,500
Portland cement, bbls.	6,000
Concrete, Class A, cu. yds.	4,000
Reinforcing rods, lbs.	100,000
Structural steel, lbs.	70,000
Wrought iron, cast iron and steel fixtures, lbs.	75,000
Water supply pipe, 4-in., lin. ft.	500
Yellow pipe plumb piles, lin. ft.	5,000
Railroad track, lin. ft.	2,300
Sluice gates and frames, 48-in. by 72-in.	4
Solution tank, piping and accessories.	
Buildings and all accessories.	
Hoist and conveyor.	
Pitometers and records.	

The material classed as earth is believed to be river mud, an admixture of sand, gravel, clay, boulders and ashes. The material may be either above or below the surface of the water. A portion of the excavated material will be used for the construction of the embankments forming the basin and its appurtenances, for refills and for grading grounds adjacent to the basin. The remainder will be disposed of at the option of the contractor. In general the embankment will be constructed from the material from the bottom portions of the excavation for the basin. Between the top of the retaining cribs and high water special care must be taken to place the embankment with the protecting faces of rip rap so as to prevent unnecessary erosion or waste of material. The rock work may be either above or below water. It calls for the excavation of all ledge rock and all boulders of more than ½ cu. yd. content. It is not expected that ledge excavation will be required for the basin, but will be limited to the inlet channel, and the channels from the gate chambers into the body of the basin, for the foundations of the gate chamber, and for leveling the bottom under the embankment cribbing.

The slopes of the embankments and shores of the basin will be protected by rip rap. Class A will be composed of river gravel, pebbles or cobbles; not more than 30 per cent of the class will be less than 3 ins in diameter. Class B rip rap will be hard, durable, quarry stone, run of quarry sizes, with not less than 70 per cent of man size or larger.

Two classes are specified for the timber cribbing, piling and stop logs necessary for the permanent features of the basin. Class A will be long leaf yellow pine, and Class B will be short leaf yellow pine or equal. Concrete will be used for the gate chambers, conduit, foundations and mixing chambers. In general it will be mixed in the proportions of 1 part cement to 9 parts coarse and fine aggregates, or 1 part cement to 7½ parts coarse and fine aggregate. The foundations of the several structures are 18 ft. more or less below high tide.

Bids for the construction of the sedimentation basin will be received by the Department of Public Works, Bureau of Water, of Philadelphia, Pa., until noon, Feb. 9.

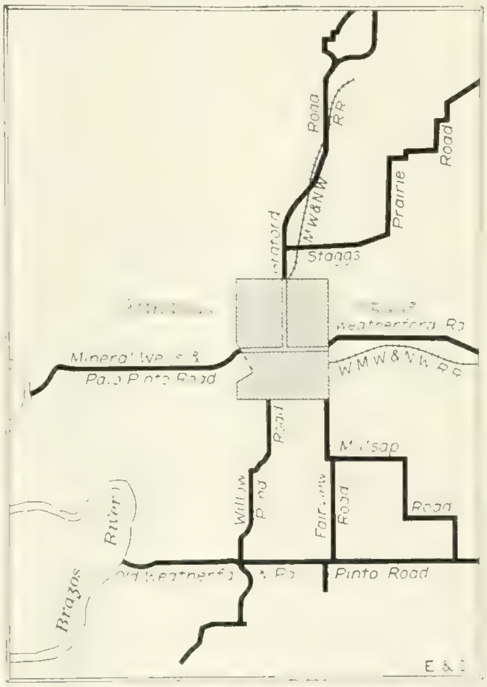
ROAD WORK IN PALO PINTO COUNTY, TEXAS.

37 Miles of Highway to be Improved.

Macadam — Gravel — Sand-Clay — Grading — Culverts.

The Commissioners of Palo Pinto County, Texas, are asking bids for the improvement of about 37 miles of highway in Road District No. 1. The names of these roads, and the length and classes of improvement are as follows:

Mineral wells and Palo Pinto Road, Mineral Wells and Weatherford Road, 6.3 miles, water-bound macadam, gravel, local stone; Mineral Wells and Garford Road, Mineral Wells and Salesville Road, 6.6 miles, water bound macadam, gravel, local stone and sand clay; Mineral Wells and Millsap Road, Mineral Wells and Fairview Road, 8 miles, same as above; Mineral Wells and Willow Pond Road, Old Weatherford and Palo Pinto Road, water bound macadam, gravel, local stone; Mineral Wells and Staggs Prairie Road, 5.8 miles, same as above. The location of these roads are shown in the accompanying map.



Location of Roads in District No. 1.

The approximate quantities include the following:

Clearing, 100 sq. ft.	60
Grubbing, 100 sq. ft.	60
Road grader work, lin. ft.	36,800
Slip or fresno work (100 ft. free haul), cu. yds.	123,900
Grading (earth), cu. yds.	8,200
Grading (boulders, detached masses, etc.), cu. yds.	2,210
Grading (solid rock), cu. yds.	1,110
Foundation excavation, cu. yds.	1,050
Macadam, cu. yds.	12,500
Gravel, cu. yds.	21,000
Local stone (quarried), cu. yds.	11,800
Local stone in fences, cu. yds.	6,200
Sand-clay (Fresno), cu. yds.	3,000
Sand-clay (wheeler), cu. yds.	3,000
Sand-clay (wagon), cu. yds.	3,000
Vitrified pipe, 18-in., lin. ft.	820
Vitrified pipe, 21-in. and 24-in., lin. ft.	380
Corrugated pipe, 18-in. and 48-in., lin. ft.	1,930
Bridges and Culverts.	
Grading culverts, cu. yds.	500
Concrete, cu. yds.	700
Reinforcing bars, lbs.	15,300
I-beams and channels, lbs.	57,800
Anchor and stay bolts, lbs.	200
Hand railing, lbs.	790

The roads, in general, will have a 16 ft. or 9½ ft. paved roadway. In the latter case there will be improved shoulders 3 ft. wide of sand-clay, gravel or local stone. The water bound macadam will consist of 3½ in. to 4½ in. (compacted measure) of ¼ in. to 3 in. crushed stone with dust filler and puddling. The base of the road may be sand-clay, gravel or local sand or field stone. The gravel roads will consist of a lower course 6 ins. thick at the center, tapering to 4½ in. at the sides and an upper course 2 ins. thick at the center and 1 in. thick at the sides. The gravel will be spread with a road grader except as to outside lines of the road which are to be marked off with chalk line and the gravel spread to line with shovels. The local stone construction provides for a telford base of local or field stone broken to pass a 4 in. ring, with voids filled with sand or clay, and a sand clay finish. The sand-clay roads will have a sand-clay base 7 ins. thick at the center and sand-clay finish 1 in. thick at the center.

Bids will be taken on the road work and the culverts separately or on both combined. The proposals will be received until 1 p. m., Feb. 8, by the County Clerk, Palo Pinto, Texas. James C. Travilla, Room 6, Haines Bldg., Mineral Wells, Texas, is the engineer.

CULVERT AND BRIDGE CONSTRUCTION IN IOWA.

Large Amount of Work Projected by Various Counties.

Marion County Opens Bids Feb. 23 on 69 Box Culverts.

Iowa counties are planning to make an early start on the large amount of bridge and culvert construction proposed for the present year. This work is being done for the replacement of waterway crossings by more permanent types of construction. The improvements will include the placing of many pipe culverts and the construction of a large amount of concrete culverts. The latter in general, will be of the box type, reinforced. There also will be a considerable number of pony truss bridges and I-beam bridges. Some of the counties will furnish the material, while in others the contracts will include both labor and materials.

A number of Iowa counties already are calling for bids for furnishing material for their work this season. Audubon County opens bids Feb. 5 for supply of about 5,000 lin. ft. corrugated culverts; Adams County opened bids Feb. 1 for furnishing car load lots of culvert pipe, reinforcing steel, and cement; Union County opens bids Feb. 3 for furnishing cement, sand, gravel, reinforcing steel and corrugated pipe.

Marion County, Iowa, is now asking bids for the construction of five truss bridges, four I-beam spans, and 69 reinforced concrete box culverts. The first mentioned group will include the following: 60 ft. by 16 ft. pony truss, estimated to cost $3,796; 70 ft. by 16 ft. pony truss, $4,490; 120 ft. by 18 ft. through truss, $7,891; 120 ft. by 18 ft. through truss, $8,395; 70 ft. by 18 ft. pony truss, $5,370. The I-beam bridges are as follows: 28 ft. by 16 ft. span, $1,681; 32 ft. by 16 ft. span, $1,959; 20 ft. by 20 ft. span, $1,937; 28 ft. by 16 ft. span, $1,240. All above structures are to have reinforced concrete abutments. Details regarding the reinforced concrete culverts are as follows:

Shipping point.	Distance, miles	Dimensions, in feet.	Concrete, cu. yds.	Reinforcing steel, lbs.	Estimated cost.
Group C.					
Dunreath	1	4x 4x28	25.6	1,420	$ 334
Percy	4	4x 4x62	45.4	2,750	600
Dunreath	½	3x 3x26	20.3	1,030	257
Dunreath	½	4x 4x26	24.5	1,310	312
Otley	3	8x 6x34	62.3	3,020	783
Dunreath	2	4x 4x50	38.4	2,270	506
Dunreath	2½	2x 2x40	15.0	1,010	235
Group D.					
Pella	4	6x 4x30	35.9	2,220	503
Flagler	5	3x 3x38	26.0	1,390	390
Flagler	3	3x 3x82	48.8	3,530	664
Everist	5	3x 3x26	20.3	1,030	307
Everist	4	2x 2x56	19.0	1,360	315
Tracy	3½	6x 4x32	37.5	2,350	536
Pella	2½	3x 3x52	32.8	1,830	437
Tracy	½	4x 2x30	18.5	1,200	247
Durham	1	4x 5x42	42.7	2,360	557
Everist	4	3x 3x52	32.8	1,830	486

Everist	4	3x 3x56	34.7	1,950	432
Everist	3	5x 5x34	39.5	2,680	561
Bussey	1	2x 2x58	19.5	1,100	293
Howell	2	6x 4x35	40.0	2,540	493
Durham	2½	3x 3x38	26.0	1,390	351
Harvey	1	12x10x40	160.2	7,177	1,835
Tracy	2	2x 2x48	17.0	1,180	261
Tracy	2	4x 4x22	22.2	1,150	293
Pella	2½	8x 4x31	48.2	2,020	606
Pella	4½	2x 2x68	22.0	1,620	366
Pella	5	4x 4x44	34.9	2,020	519
		Group E.			
Purdy	8	2x 2x32	13.0	840	235
Purdy	9	3x 3x60	36.6	2,070	653
Purdy	9	3x 3x28	21.2	1,080	380
Melcher	6½	2x 2x38	14.5	970	256
Melcher	5	3x 3x30	22.2	1,140	331
Melcher	6	2x 2x50	17.5	1,225	307
Whitebreast	3	4x 4x54	40.7	2,425	567
Melcher	1	4x 4x38	31.4	1,790	404
Purdy	8½	8x 6x52	85.5	1,300	1,422
Pleasantville	3	3x 3x42	28.0	1,520	478
Melcher	8½	3x 3x30	22.2	1,150	398
Whitebreast	5	3x 3x24	19.3	970	291
Melcher	2½	8x 6x28	54.5	2,575	683
Purdy	2	3x 3x42	28.0	1,510	371
Purdy	2	3x 3x46	29.9	1,630	397
Purdy	3	6x 4x28	34.3	2,100	463
Purdy	4	12x 7x24	78.7	3,860	1,030
Whitebreast	2½	5x 5x30	36.3	2,160	488
Kimball	3	3x 3x22	18.1	910	250
Kimball	½	4x 4x25	23.9	1,270	293
		Group F.			
Flagler	1½	3x 3x60	36.6	2,080	470
Flagler	1½	2x 2x52	18.0	1,280	276
Knoxville	1	4x 4x32	28.0	1,550	365
Knoxville	3	4x 4x26	24.5	1,310	337
Knoxville	4½	5x 5x40	43.8	2,750	626
Flagler	2	2x 2x40	15.0	1,010	235
Flagler	2	3x 3x28	21.2	1,100	285
Knoxville	7	2x 2x22	10.5	620	188
Knoxville	6	4x 4x60	44.2	2,660	650
Knoxville	4	3x 3x45	29.4	2,060	420
Knoxville	4	3x 3x24	19.3	970	268
Fifield	4	2x 2x34	13.5	880	211
Fifield	2½	3x 3x40	27.0	1,450	361
Fifield	2½	3x 3x30	22.2	1,150	287
Fifield	5	8x 6x52	85.5	4,350	1,125
Donley	1½	8x 6x30	57.1	2,720	702
Cordova	3½	4x 4x30	26.8	1,470	363
Knoxville	6	4x 4x60	44.2	2,660	628
Cordova	5	3x 3x40	27.0	1,450	391
Knoxville	4½	1x 4x46	36.1	2,100	519
Donley	2½	3x 3x64	38.5	2,200	553

The work is divided into six groups, Group A covering the truss bridges, Group B the I-beam spans and Groups C to F inclusive the culverts. Bids will be received on any or all of the structures, or on all the structures in any one group or combination of groups, with the stipulation that contract must be awarded on all or none of the structures in such group or combination of groups. In carrying out the work contractors will be required to remove only such old structures as interfere with the new construction. No filling will be required with these contracts. The construction will be carried out under the standard specifications of the Iowa State Highway Commission.

Bids for the work in Marion County will be received until 1:15 p. m., Feb. 23, by J. D. Schlotterback, County Auditor, Knoxville, Ia. W. O. Price, Knoxville, is County Engineer.

HIGHWAY CONSTRUCTION IN WISCONSIN IN 1915.

State Aid Fund of $1,206,221 Available.

About 1,250 Miles of Road to Be Improved.

The state aid fund for highway construction in 1915 in Wisconsin amounts to $1,206,221. The distribution of this fund among the various counties is shown in Table I. The approximate total construction fund available in each county is obtained by multiplying the fifth column in the table by the third. In this table the counties designated by a star are those in which part of the work will be done by contract. Most of the work, however, will be done by force account under the direction of the County Highway Commissioners as in former years. These Commissioners have direct supervision of the work done in each county. The cost of this supervision for 1914 was about 3½ per cent. and the state supervision was about 2 per cent of the amount of construction supervised. When the work is done by contract most of the higher types of roads, such as concrete and bituminous work, will be let out on a unit basis, while the remainder of the work will be placed on the basis of lump sum bids. The various types and mileages to be built during 1915 are about as follows:

	Miles.
Concrete	50
Stone macadam	350
Gravel macadam	200
Shale and other inferior surfacings	100
Grading	550
Total about	1,250

The state pays one-third of the cost of these roads and one-fifth of the cost of state aid bridges. Practically all of the funds were voted by direct tax and in only a few instances have bonds been issued.

The state supervision of the highway construction is in charge of the Wisconsin Highway Commission of which A. R. Hirst is State Highway Engineer. The work in the various counties will be under the direct supervision of the County Highway Commissions listed in Table II.

TABLE I.—DISTRIBUTION OF STATE AID FUND.

County.	Percentage of state tax paid in 1912.	Units in county.	Units voting taxes.	Total allotment, being amount of state aid asked.
Adams	.287	19	3	$ 1,800
Ashland	.652	14	10	10,825
Barron	.842	31	18	10,875
Bayfield	.614	22	12	11,550
Brown*	1.958	23	15	24,475
Buffalo	.650	22	16	9,245
Burnett	.221	19	11	5,400
Calumet	.936	11	3	2,900
Chippewa*	1.019	23	6	13,500
Clark	1.056	41	20	12,725
Columbia	1.631	32	21	24,510
Crawford	.526	21	8	4,600
Dane	4.916	51	34	40,547
Dodge*	2.831	37	18	25,514
Door*	.634	16	12	13,631
Douglas*	1.876	15	10	25,000
Dunn	.848	27	14	8,062
Eau Claire	.999	16	4	2,450
Florence*	.155	3	3	2,500
Fond du Lac*	2.454	29	10	16,400
Forest*	.438	9	9	15,250
Grant*	1.972	44	23	33,648
Green*	1.604	23	17	21,936
Green Lake	.793	14	10	7,195
Iowa	1.356	24	7	8,900
Iron	.302	10	8	13,806
Jackson	.587	21	15	9,706
Jefferson*	1.932	22	12	20,531
Juneau	.621	27	15	15,743
Kenosha*	1.404	8	7	13,253
Kewaunee	.731	13	9	10,000
La Crosse	1.390	14	14	31,283
Lafayette	1.465	26	16	13,236
Langlade	.659	16	6	5,741
Lincoln*	.626	15	14	11,400
Manitowoc*	1.978	21	12	23,275
Marathon*	1.810	53	17	11,075
Marinette	.931	16	16	17,446
Marquette	.404	18	8	7,400
Milwaukee*	19.439	13	10	248,750
Monroe*	1.009	31	17	12,162
Oconto	.763	21	9	6,750
Oneida*	.456	18	12	15,325
Outagamie*	1.961	30	5	8,900
Ozaukee	.813	11	5	5,300
Pepin	.249	11	4	1,950
Pierce*	.754	25	15	9,250
Polk	.757	34	20	10,750
Portage	.858	23	17	17,400
Price	.470	20	16	10,921
Racine*	2.605	14	8	15,106
Richland*	.856	20	10	18,225
Rock*	2.927	25	21	35,256
Rusk*	.410	24	10	11,691
St. Croix	.392	31	13	7,975
Sauk*	1.573	20	15	18,942
Sawyer	.364	13	8	6,000
Shawano	.996	35	21	[illegible]
Sheboygan*	2.246	22	11	21,400
Taylor	.492	21	13	7,700
Trempealeau*	.870	23	17	22,020
Vernon	[illegible]	31	18	17,865
Vilas	.241	9	6	7,500
Walworth	1.970	24	18	21,875
Washburn*	.263	19	14	7,175
Washington	1.229	18	8	7,900
Waukesha*	1.901	[illegible]	14	14,450
Waupaca	1.159	33	21	22,700
Waushara	.651	24	10	8,250
Winnebago*	.331	18	6	2,725
Wood*	1.037	27	20	22,625
	100.000	1,589	895	†$1,206,221

*Counties in which part of the work will be let to contract.

†This is one third of the total amount to be expended, as the state aid is 33⅓ per cent of the total funds raised.

TABLE II.—COUNTY HIGHWAY COMMISSIONERS OF WISCONSIN.

County.	Commissioner.	Address.
Adams	J. A. McGregor	Hancock.
Ashland	W. E. Dillon	Butternut
Barron	S. S. Berg	Rice Lake
Bayfield	John Sundell	Ashland
Brown	Geo. J. Cormier	Green Bay
Buffalo	Julius Reinhart	Nelson
Burnett	Hugh Jeffries	Danbury
Calumet	William Hoenig	Brillion
Chippewa	P. O. Lokrantz	Cippewa Falls
Clark	W. C. Thoma	Neillsville
Columbia	Clinton Quinn	Pàrdeeville
Crawford	J. N. Campbell	Bell Center
Dane	W. H. Somers	Madison
Dodge	E. T. Klug	Juneau
Door	August Moeller	Sturgeon Bay
Douglas	C. J. Morisset	Superior (E. E.)
Dunn	William E. Raven	Colfax
Eau Claire	Wm. J. Wolf	Eau Claire
Florence		
Fond du Lac	M. Costello	Fond du Lac
Forest	Wm. M. Sherlock	Crandon
Grant	Henry Mink	Lancaster
Green	E. L. Edwards	Monroe
Green Lake	T. J. Paull	Princeton
Iowa	J. W. Pearcey	Dodgeville
Iron	William Weber	Saxon
Jackson	A. D. Polleys	Melrose
Jefferson	R. D. Royce	Ft. Atkinson
Juneau	A. V. Robison	New Lisbon
Kenosha	John Herzog	Kenosha
Kewaunee	Moses Shaw	Algoma
La Crosse	John Hintgent	La Crosse
Lafayette	Geo. H. Priestley	Darlington
Langlade	T. W. Humble	Antigo
Lincoln	H. H. Kuehling	Tomahawk
Manitowoc	Frank Muth	Manitowoc
Marathon		
Marinette	Andrew Eklund	Peshtigo
Marquette	Levi Jones	Endeavor
Milwaukee	H. J. Kuelling	Milwaukee
Monroe	F. M. Johnson	Tunnel City
Oconto	James Devereux	Oconto
Oneida	Frank E. Parker	Rhinelander
Outagamie	A. G. Brusewitz	Black Creek
Ozaukee	Emil Schmechel	Thiensville
Pepin	Gale Goss	Durand
Pierce	C. F. Kenall	Ellsworth
Polk	J. R. McLean	Amery
Portage	Thos. E. Cauley	Stevens Point
Price	C. G. Nelson	Ogema
Racine	James Mutter	Racine
Richland	G. H. Mainwaring	Richland Center
Rock	Charles E Moore	Janesville
Rusk	Phil Koehler	Ladysmith
St. Croix	Joe Caffrey	Hammond
Sauk	George F. Post	Baraboo
Sawyer	E. J. Collett	Hayward
Shawano	O. C. Rollman	Shawano
Sheboygan	G. W. Ubbelohde	Sheboygan Falls
Taylor	H. C. Peterson	Medford
Trempealeau	E. J. Matchett	Osseo
Vernon	Alex Ristow	Genoa
Vilas	G. H. Jackson	Eagle River
Walworth	H. J. Peters	Elkhorn
Washburn	Fred L. Irwin	Spooner
Washington	Charles Johnson	Barton
Waupaca	C. J. Knudson	Scandinavia
Waushara	Fred Grimm	Wautoma
Waukesha	Charles J. Hahn	Delafield
Winnebago	James Binning	Oshkosh
Wood	Louis Amundson	Grand Rapids

A $1,250,000 Motor Speedway.

A motor speedway calling for an expenditure of about $1,250,000 is to be constructed by the Twin-City Motor Speedway Co. of Minnesota. There will be a 2-mile track of 6-in. concrete on a trap rock base of the same thickness. The track will pass over three subways or bridges 80 ft. by 130 ft., which will permit cars to pass from the outer field to the inner parkway. The course is to be 80 ft. wide, fully guarded by 2½ ft. retaining walls at both inner and outer edges. There also will be a 15 ft. wire netting, reinforced and stayed, to protect the inner and outer safety zones, both of which will be 30 ft. wide.

The grandstand will be 3,225 ft. in length and will have 1,612 boxes, each seating 8 persons. The stand will have total seating capacity for 74,172 people. It will be constructed of concrete, the trussed concrete steel system of Kahn bars and hy-rib being used. The grounds will have a complete hospital, power house, band stand and two round house racing car stations, each 600 ft. by 70 ft. There also will be eight rest rooms or toilets throughout the grounds, and as many toilets in the grandstand. The judges' stand will be a fireproof concrete structure, 4 stories in height. Entrance to the grounds will be obtained through three pedestrian gateways and four auto gates. The first mentioned will be equipped with auto-locking turnstiles, 6 to each gateway. The balance of the entire enclosure to the grounds will be surrounded by a concrete fence 8 ft. in height. Walter D. MacLeith, The Fulton, St. Paul, Minn., is the architect and engineer.

COWCASTLE DRAINAGE DISTRICT, SOUTH CAROLINA.

Expenditure of $186,371 Proposed for Drainage of 42,353 Acres.

793,923 Cu. Yds. Dredge Excavation; 330,076 Cu. Yds. Hand Work.

An extensive drainage undertaking is projected for the Cowcastle Swamp section of Orangeburg County, South Carolina. A preliminary examination and report on the project was made early last year by Mr. F. G. Eason, Charleston, S. C., Drainage Engineer of the Division of Drainage Investigations, U. S. Department of Agriculture. Later drain surveys were made and detailed plans and estimates prepared by Mr. Eason, assisted by H. G. Hawley and D. F. Culbertson, Assistant Drainage Engineer. The following notes on the proposed Cowcastle Swamp Drainage District are taken from the report of the engineer.

The district is situated in the southastern part of Orangeburg County and extends from Orangeburg on the west to Four Hole Swamp on the east. It comprises all of the land that drains to Cowcastle Swamp, either directly or through its tributaries, except an area of 2,492 acres adjoining Four Hole Swamp, which is not included owing to the insufficient drainage benefit that this area will receive from the improvements. The area of the district is 42,353 acres. It is about 18 miles long and averages in width about 3½ miles. The only railroad in this district is the Branchville & Bowman R. R., a narrow gage line running between the places named. In the eastern part of the district there is a lumber tram road that runs to Badham, S. C. Bowman is the only town situated within the district, though Orangeburg lies only about 1 mile northwest of the upper end.

The district lies in the upper part of the Coastal Plain, about 75 miles from the Atlantic Ocean. The elevation of the land ranges from about 100 to 200 ft. above sea level. The topography of the district is quite uniform throughout, consisting of flat areas separated by low ridges. The upper half of the district is perhaps as fully under cultivation as drainage conditions will permit. The cultivated land lies in irregular patches which are separated by bays and ponds. In the lower part of the district the area under cultivation is less, while the area of wet land increases. In the sections below Bowman the cultivated tracts are small and widely separated. Some of the uncultivated areas support growths of such timber as gum and cypress; others are covered with dense stands of vines and briars, while still others are open savannas. The main highways of the district are dirt roads in good condition. The streams are forded or crossed on wooden bridges. Soil borings along the ditch line in Cowcastle Swamp indicated that the predominating subsoil stratum through the swamp was composed almost entirely of sand with an intermingling of clay in several localities. The subsoil for the tributary branches consists largely of clay with a small percentage of sand. The primary outlet of the district is Cowcastle Swamp. The run through this swamp is ordinarily from 1 ft. to 5 ft. deep and varies in width from 5 ft. to 25 ft.; it winds through the swamps with many loops and bends. At the lower end, just before entering Four Hole Swamp, the channel is ill defined and the water spreads over the swamp. In most places the channel is obstructed with fallen and standing trees, logs, brush, etc. The lower end is in especially bad condition, being filled with tree tops resulting from timber operations. The above remarks in reference to Cowcastle Swamp apply in general to the tributary branches. These latter almost invariably flatten out into bays at the upper ends. The fall in all of these streams is ample for drainage purposes.

The recommended plan of reclamation calls for the construction of a system of ditches in the main swamps and branches. The ditches have been designed for floating dipper dredge work and for hand labor. The minimum dredge ditch will have a 14-ft. bottom width, 7-ft. depth and 1 to 1 slopes. Ditches of this character are proposed for the upper end of Cowcastle Swamp and the lower end of Buck Branch. The rest of the ditches are considered too short or of too small cross-sectional area to warrant putting in a dredge. The smallest ditch to be constructed by hand labor is recommended to have a 3-ft. bottom width, 5-ft. depth and ½ to 1 side slopes. Such a ditch has an 8-ft. top width. Most of the ditches, other than those to be dug by a dredge, will be of this size throughout. The dredged ditches will have 10-ft. berms on each side and the hand-made ditches 3-ft. berms.

It is necessary that a right of way be cleared through the swamp for each of the ditches. The cost of clearing this right of way is included in the unit price for excavation given below. By working upstream on Buck Branch all of the proposed dredge work can be completed with one set up of the dredge. The cost of excavation for all dredge work has been estimated at 8 cts. per cubic yard. All hand excavation has been estimated at 25 cts. per cubic yard. These prices as noted above include the cost of clearing right of way. The figures are based on contract prices for work in different localities where conditions are similar to those in this district.

It is proposed to construct steel bridges with concrete abutments over the dredged ditches; over the hand made ditches the bridges will be of wood. It is assumed that in most cases a 35 ft. steel bridge will be suitable for a ditch with 14 ft. base and that 15 ft. bridges will suffice for ditches with 3 ft. base. In making the estimate of cost, bridges have been allowed for at all public road crossings. It is estimated that the work will require 11 35 ft. steel bridges at $1,350 each, one 45 ft. steel bridge at $1,350, two 20 ft. wooden bridges at $75 each and 33 15 ft. wooden bridges at $50 each. The estimated total excavation required is 1,123,999 cu. yds., of which 793,923 cu. yds. is dredge work and 330,070 cu. yds. is hand work.

The total cost is estimated as being $186,371, the summary of this total being as follows:

Cowcastle swamp	$ 70,883
Crum branch (including Lateral B)	9,545
Shuler branch (including Lateral D)	7,739
Bird branch	4,060
Buck branch (including Lateral C, Beaver branch, and Lateral G)	31,294
Amy branch (including Lateral E)	5,975
Cummings branch	2,310
Mill branch No. 2	5,667
Boggy branch	2,938
Harry branch	3,127
Copes branch (including Lateral A)	2,360
Pitteau branch	1,249
Ruple branch	1,030
Austin branch	1,656
Funchesa branch	1,030
Bozzard branch	1,580
Mill branch No. 1	2,945
Collier branch (including Lateral F)	4,760
Last Resort branch	2,135
Patrick branch	5,150
Latimer branch	1,995
Total	$169.428
Engineering, legal and incidental	16,943
Grand total	$181,371

The principal item in this work will be the construction of the Cowcastle Swamp Canal. The swamp rises about 1 mile east of Orangeburg and extends in a general southeasterly direction for about 20 miles to its outlet in Four Hole Swamp. At the upper end the swamp is not more than 50 ft. wide. The width gradually increases, however, to about 1,400 ft. opposite Bowman, and at the lower end it is about 2,000 ft. The average width is about 800 ft. The proposed improvement in Cowcastle Swamp consists of a ditch throughout its entire length. From the upper end (sta. 0 + 00) to sta. 227 + 60, where Crum branch enters, this ditch is to be constructed with hand labor and will have a 3 ft. bottom and side slopes of ½ to 1. From sta. 227 + 60 to the end at Four Hole Swamp, the ditch is to be constructed with a floating dipper dredge. Along the upper portion there will be a minimum dredged ditch, the bottom width gradually increasing to 24 ft. at the lower end.

Dredging in Toledo Harbor, Ohio.

A 700,000 cu. yd. contract for dredging in Toledo Harbor, Ohio, is now being advertised for bids by the U. S. Engineer at Cleveland, Ohio. The location to be dredged is the inner portion of the channel through Maumee Bay and portions of the channel through Maumee River. The work is divided into four general sections as follows:

	Length, lin. ft.
Inner division, Maumee Bay	5,600
End of Sec. 1 to Toledo Terminal bridge	6,800
Wheeling & Lake Erie bridge to Ash street bridge	6,700
Cherry street bridge to L. S. & M. S. bridge	8,000

A channel about 21 ft. deep below mean lake level and not less than 400 ft. wide exists or has been secured through the above section, but this channel has filled to some extent, particularly at the sides. The dredged channel through the upper courses is not continuous, as natural deep water exists over portions of the distance. The work to be done consists in deepening the present channel to 23 ft., below mean lake level.

The portion of Maumee River where dredging may be required is crossed by six bridges, the smallest draw opening being 105 ft. and the lowest head room 14.7 ft. The usual working season is from about April 15 to Nov. 30. The locality is not exposed to severe action from storms and work can be carried on with little if any interruption from this cause.

The total estimated quantity of material to be removed, exclusive of allowable overdepths, is 706,000 cu. yds. scow measurement. The material is believed to be clay overlaid with sand and silt. The contractor may employ any method of dredging. If the material is not handled by dump scows it must be discharged shoreward for the established harbor lines. If handled in scows it must be deposited at dumping grounds, the average distance of transportation being about as follows:

	Dumping ground A, miles.	Dumping ground B, miles.
Section 1	8½	6½
Section 2	10	8
Section 3	11½	9½
Section 4	14	12½

The funds for this work were appropriated in 1914. The amount available for payment of contractor's estimate is about $95,000. Bids for the work as a whole will be received by Maj. P. S. Bond, U. S. Engineer, Cleveland, Ohio, until noon, Feb. 25.

Three Large Sewer Jobs, Brooklyn, New York.

Bids on three sewer contracts that will call for a total expenditure of several hundred thousand dollars are now being asked by the president of the Borough of Brooklyn, New York City. The principal items in the engineer's estimate of quantities for those four jobs are given in Table I:

TABLE I.

Size.	Prospect Place sewer.	Tompkins Ave. sewer.	Macon St. sewer.
162-in., lin. ft.	.....	2,737	.....
144-in., lin. ft.	.....	.....	767
138-in., lin. ft.	.....	.....	2,626
126-in., lin. ft.	.....	818	.....
114-in., lin. ft.	.....	.....	82
96-in., lin. ft.	.....	.....	377
90-in., lin. ft.	1,153*	.....	92
78-in., lin. ft.	798*	.....	11
72-in., lin. ft.	780*	.....	.....
66-in., lin. ft.	886*	.....	.....
60-in., lin. ft.	1,793*	.....	.....
48-in., lin. ft.	976*	.....	.....
42-in., lin. ft.	891*	.....	.....
Sheeting and bracing, M. ft. B. M.	1,200	1,800	2,150

*Brick sewer.

Alternate bids will be taken for constructing the 162 in. and 126 in. sewers of the Tompkins avenue system in tunnel. Alternate bids also are asked for constructing the large sewers in the Macon street system in tunnel instead of open cut. Bids for the above sewer will be received until 11 a. m., Feb. 10, by L. H. Pounds, president Borough of Brooklyn, New York City.

Thirtieth Annual Meeting of the Illinois Society of Engineers and Surveyors.

The Thirtieth Annual Meeting of the Illinois Society of Engineers and Surveyors was held at the Leland Hotel, Springfield, Jan. 27-29, 1915. Beginning with the opening session on Wednesday, Jan. 27, the sessions were devoted to the reading of papers, to the presentation of the reports of various standing committees, and to a general discussion of the papers presented, the latter constituting an important part of the program. On Thursday afternoon, through the courtesy of the local committee, and of other interests in Springfield, the members and visitors present were enabled to inspect the following industries located in that city: Water Works Pumping Station, Illinois Watch Factory, Sangamon Meter Works, the Springfield Paving Brick Co.'s plant and the Zinc Smelter, the route to the latter being over a state-aid concrete road. The annual dinner of the society was held at the Leland Hotel on Thursday evening.

In addition to the address of President Harman, which dealt mainly with license laws for engineers, country road problems and society activities, the following papers were presented: The Illinois Rivers and Lakes Commission; The Illinois Civil Service Commission; Paving Practice at Springfield; Burned Shale for Paving in Parks; Creosoted Wood Block Paving; The Design of Pavements; A Street Having Only One Gutter; Vertical Fiber Shallow Brick for Paving; Integral Curbs for Concrete Pavements; Selection of Deep Well Pumping Machinery; Surveys of Public Lands; Survey of the Pecatonica River; The Sewer System of Alton, Illinois; Assisting the Young Graduate Engineer; Water Supplies of Illinois; Economics of Brick and Concrete Roads; Brick Paving for Rural Highways; Concrete Roads at Marquette Hill; Common Defects in Concrete Road Construction; Pipe Culverts for Roads; Effect of Dry Weather on Macadam Roads; The South Quincy Drainage District; Bell-End Pipe for Land Drainage; Estimating Curves for Highway Bridges; The Testing Laboratory at Lewis Institute; and Methods of Handling Road Materials.

The following officers were elected: W. S. Shields, president; Paul Hanson, vice president; B. H. Piepmeier and H. L. Fixmer, trustees. The next meeting of the society will be held at the University of Illinois, Urbana, Ill.

New Cut Off for Lackawanna R. R.

There is good reason to believe that the next big improvement undertaken by the Delaware, Lackawanna & Western R. R. will be the building of the cut off between Pocono Summit and Cresco. The work is located in Pennsylvania and will cover about 12 miles of line. It will eliminate a number of curves, reduce the grades and shorten the distance to New York by from 2 to 4 miles. Plans for the undertaking are understood to have been completed and it is stated that the Board of Directors at its meeting this month will consider the matter of making an early start on the project. If the decision is favorable it is probable that bids will be requested while the contractors are still on the Nicholson cut off. This belief is based on the fact that several years ago when the Lake Hopatchung cut off was about completed bids were then requested on the Clarks Summit job. Two sections of the latter work are now completed, and it is expected that the entire cut off will be ready for operation by Sept. 1.

North Dakota Society of Engineers.—The seventh annual convention of the North Dakota Society of Engineers will be held in Minot, N. D., Feb. 4-5. Reports of committees on legislation, concrete, roads, bridges, drainage, irrigation and rivers, surveyor's field methods, industrial development and municipal improvements will be heard, and inspection made of points of interest in the vicinity. Mr. E. F. Chandler is secretary of the society.

Demand for Municipal Bonds.—The market for municipal bonds is improving steadily. On the New York stock exchange trading in these securities in the week ending Jan. 16 was over the $2,000,000 mark each day, with the exception of Saturday. The daily transactions for the week as compared with the corresponding week in 1913 and 1914 were as follows:

	1915.	1914.	1913.
Monday	$ 2,242,000	$ 2,920,000	$ 2,204,000
Tuesday	2,066,000	3,004,500	2,382,500
Wednesday	2,061,000	3,481,000	1,861,000
Thursday	2,083,500	3,962,000	1,716,000
Friday	2,427,500	3,457,000	2,041,500
Saturday	1,541,000	1,568,500	928,000
Totals	$12,423,000	$15,394,000	$11,131,000

Technology Clubs Associated.—The Third Annual Convention of Technology Clubs Associated will be held in Pittsburgh, Feb. 19-20, 1915. Invitations have been sent out to 11,500 alumni of the Massachusetts Institute of Technology and a large attendance and interesting reunion is expected.

NEWS LETTERS

St. Louis Items.

Mike Conroy spent last week here buying three carloads of mules and two engines, which he shipped to St. Catherines, Ont., Canada. Mike says he still had 1,300,000 yds. of work to complete on the Welland Ship Canal, which will keep him there for at least two years.

Gov. E. W. Major of Missouri, and Gov. Edward F. Dunne of Illinois, and former Gov. A. O. Eberhart of Minnesota, who have charge of the plans for establishing a system of uniform terminals on the Mississippi River, notified the Business Men's League that a conference will be held in St. Louis Feb. 18 and 19. The measure was taken up nearly a year ago for the purpose of improving the Mississippi, in order that the river cities may claim part of the additional business arising from the opening of the Panama Canal. The question of establishing warehouse terminals at all cities will be considered at the conference. A call will be sent out asking all Governors of States bordering on the Mississippi, Ohio, Missouri and Illinois rivers to appoint representatives to the conference. A similar call will be sent to the Mayors of all cities on the Mississippi, Ohio, Missouri and Illinois rivers. A delegate will be expected from each congressional district in the States, and the Mayor and two delegates from each large city.

John Beard of East St. Louis, is grading a small spur on the east side of the free bridge.

President Kinsey of the Board of Public Service conferred last week with Mayor Chamberlin of East St. Louis to arrange for permits to lay temporary switch tracks across streets in the vicinity of the east free bridge approach for the delivery of material to be used in the approach construction. A part of the material ordered for caissons will be delivered in about two weeks, and it is desired to have the tracks installed for prompt delivery. It is planned to begin the evacuations for the piers in about 30 days.

Dave Griffith is wintering on his farm on the Kansas City Southern, south of Kansas City, Mo.

A new corporation on Jan. 23 took over the entire assets, real and personal, of the Williamsville, Greenville & St. Louis R. R. Co. The latter road connects with the St. Louis, Iron Mountain & Southern at Williamsville, Mo., and extends 35 miles northeast through Wayne County. The stockholders of the Ozark Valley Railroad Company also own a large acreage of timber and mineral land in the county, which will be developed. An immediate resumption of work in the iron mines of the county, which have been closed down for months is expected.

Petitions for two new drainage and levee districts in St. Charles County will be filed in the Circuit Court of that county this week. The new districts, if formed, will mean the reclamation of about 18,000 acres of rich soil. J. H. Nolen, Commissioner of the State Department of Land Reclamation, spent Saturday in St. Louis conferring with St. Charles County land owners relative to the formation of the districts. Attorney Osmund Hensler of St. Charles, and his father, Representative R. C. Hensler, are counsel for the petitioners, who own three-fifths of the land included in the proposed districts. One of the districts is in the West Alton neighborhood and calls for the construction of levees paralleling the Mississippi River. The other, known as the Cottleville district, calls for the construction of a new channel for the Dardenne Creek. Commissioner Nolen departed for Caruthersville to attend a hearing in the Pemiscot Circuit Court, and expects to present his report for the State to the Legislature soon after his return to Jefferson City. The report will show, he said, that districts designed to reclaim more than 500,000 acres have been formed since the department was created by the 1913 Legislature. The hearing at Caruthersville is relative to a petition to enlarge a drainage district in that county from an area of 292,000 acres to one embracing 400,000 acres.

The Stone & Webster Engineering Corp. of Boston have completed financial arrangements for the construction of extensive terminals for its Interurban System at Dallas, Texas. The improvements will cost about $2,000,000 and expect to be finished within 16 months.

Murch Bros. of St. Louis, were awarded the contract to complete the new Westminster Presbyterian Congregation Auditorium in the Western part of the city.

Jack O'Callahan of the List & Gifford Const. Co. is spending his time with Mr. Brown, their bookkeeper in Kansas City. He has promised us a visit in the near future. Hope it will be soon, Cal.

A. C. Ridgeway, vice president of the Rock Island R. R., in charge of operation, conferred last week with F. H. Britton, president of the Cotton Belt, and E. J. Pearson, vice-president of the Missouri Pacific, on Arkansas & Memphis Railway Bridge and Terminal Company matters. At a recent meeting of officials of the three proprietary roads in New York, provision was made for financing the bridge company, the deal involving $5,000,000. The total cost of the work will be $7,500,000, of which about $2,000,000 has been spent. The meeting was to complete plans for expediting the construction work. J. W. Canada of Memphis, attorney for the Terminal Company; C. A. Morse and Chief Engineer Harry Clark of the Rock Island, were present. Mr. Ridgeway says that in the territory traversed by the Rock Island lines there is considerably more optimism regarding general business than heretofore. He looks for a gradual improvement from this on and says things in the West would be greatly helped along were the railroads in that region given the same advance in rates accorded the Eastern lines.

Wm. List of the List & Gifford Const. Co. has gone to Florida to look over his fruit ranch.

Plans for rehabilitating the long-disused marine ways at the foot of Davis street were agreed upon last week at a conference in the Comptroller's office of Street Director Talbert and C. E. Smith, chief engineer for the Missouri Pacific R. R. Smith had heard reports, he said, which caused him to believe that there might be a boom in river traffic this spring and he wished the city to be in a position to care for the boats. The railroads accepted a proposition that the rent of $120 a month it now pays the city for the property upon which the old ways are located be reduced to $10 a month, the railroad to put the ways in condition, with the plan in view of replacing the wooden structures with concrete as soon as possible. Two jobs are ready for the ways when the repairs are made. The city wishes to overhaul the Harbor Boat Erastus Wells and Philip Rohan, a contractor, will build a 180-ft. steel boat for the Government. He had contracts for three smaller boats, but owing to the conditions of the ways was forced to have them laid down in Alton.

A permit to erect a 10-story building on the site of the old Boatmen's Bank Building at Fourth and Washington avenue was issued by Building Commissioner McKelvey last week, to the Missouri Athletic Association. The permit specifies that the building is to cost $500,000, and to be of stone and reinforced concrete construction. It will be 112x115 feet. William B. Ittner and G. E. A. Brueggeman are the architects. About twenty building contractors have been asked to bid on the work and the bids will be opened in about two weeks.

Koenig's Labor Agency in St. Louis and Kansas City reports that the prospects for the early resumption of public work in this part of the country were never better than they are just now. During the past week they have received quite a number of inquiries from contractors as to what the outlook for labor is going to be this spring and summer. Several jobs were started last week, but were discontinued a few days later on account of the intense cold and heavy snow which occurred. At the present time there are all kinds of labor. American and foreigners, to be had at any old price here, but with a few weeks of warm weather when railroad companies begin putting on section and extra gangs, we look for a big change in the labor situation.

Billie Stolle of the Casper Stolle Quarry & Contracting Co., Falling Springs, Ill., was the only member of his family who escaped from ptomaine poison last week. His mother, two younger brothers and Mary Esselmont, the cook in the Stolle home were affected by the malady. Prompt assistance was rendered by his brother-in-law, Dr. John S. Guhman, who found the four poison victims unconscious on his arrival, and worked with the stricken family four hours before they were revived. Billie Stolle accounts for his escape from being poisoned by entertaining some friends down town and not going home for supper that night.

Major Clark S. Smith, U. S. Engineer office, St. Louis, will receive sealed proposals for the construction of approximately 100,000 cu. yds. of levees in the Elsberry, Mo., drainage district. Plans and specifications are on file in Major Smith's office and will be furnished on application.

A tentative order of the St. Louis County Court was submitted on Jan. 26th, to Director of Public Utilities Hooke, by which the court will issue a permit to the City of St. Louis to build an 8-mile pipe line to supply water to the new Industrial School at Fort Bellefontaine. It will cost $40,000. Two hundred men will be employed. The provisions in the order were approved by Mayor Kiel, and the formal acceptance will be filed by Director Hooke. The Court requires that St. Louis file a bond of $5,000 to protect St. Louis County against damages. The mains are to be laid and maintained under the supervision of the County Highway Engineer. The city is to permit connections to be made to the pipe to supply water for domestic purposes to residents on the Bellefontaine road adjacent to the water line.

The Kirkville, Mo., Commercial Club is getting subscriptions to raise $20,000 to extend the Big Creek Railroad to clay and coal deposits near Kirksville.

Bids for the $2,750,000 additional bond issue to complete the free bridge voted last Nov. 6, will be asked by the Board of Estimate and Apportionment within the next ten days. Be-

Dooling Bros. are going to resume work on the Burlington R. R. at Guernsey, Wyo., as soon as the weather will permit. This work has been shut down since last fall.

L. Vile, superintendent of Wood, Bancroft & Doty, wants to get in touch with several contractors that have drag lines and steam shovels idle. Address him care of Koenig's Labor Agency, 503 W. 5th St., Kansas City, Mo. A. B. KOENIG.

PERSONALS

General Theodore A. Bingham has resigned as consulting engineer to the Department of Bridges, New York City.

Mr. Ernest G. Eddy, who has been assistant city engineer of Lansing, Mich., for 14 years, has been chosen as city engineer, succeeding Mr. H. A. Sparks, resigned.

Mr. Leonard Metcalf of Metcalf & Eddy, consulting engineers, Boston, Mass., was elected president of the New England Water Works Association at the annual meeting in Boston, Jan. 13.

Mr. C. A. Ashley has been appointed city engineer for Naperville, Ill. He was formerly with Mr. Arthur L. Webster, county surveyor of Du Page County, Illinois, from 1906 to 1914. He was deputy county surveyor during 1911, 1912 and 1913. Mr. Webster was also city engineer of Wheaton, Ill., for four years, during which time Mr. Ashley was in his employ. Since April 1, Mr. Ashley has conducted a drainage engineering and general surveying practice at Naperville, which he will continue.

Mr. E. L. Gates has been appointed superintendent of highways of Du Page County, Illinois, with headquarters at Wheaton, Ill. Mr. Gates has had 12 years of experience on surveys in Du Page and surrounding counties. For two years he was in charge of a field party on the Aurora, Elgin & Chicago Railroad surveys. For two years he was in charge of field work for the engineering department of the city of Elgin, and for two years following held the same position at Wheaton. For seven years he has been in the Du Page County surveyor's office, five of which he was deputy county surveyor.

Mr. George Prentiss Robinson has resigned as city engineer of Santa Barbara, Cal., and has opened an office as civil engineer at 849 N. Mariposa Ave., Los Angeles, Cal. Mr. Robinson has held the office of city engineer at Santa Barbara for one year, during which time plans for work amounting to more than $300,000 were prepared, and the work begun. The projects include a concrete sea wall 1,876 ft. long and 17.55 ft. high, costing about $60,000; three reinforced concrete bridges, one of which includes a reinforced concrete bay with gate to regulate the height of water to be held in a semi-tidal basin lake; five miles of asphalt paving equal to about 102,000 sq. yds.; sewers and miscellaneous work.

Mr. Ernest E. Lothrop has been elected city engineer for Fitchburg, Mass., by the city council. The city is to build a large reservoir during this year, and the city engineer will have charge of that work as well as the routine street, water department and general engineering work. Mr. Lothrop has had 14 years of experience in civil engineering work, four years of which was for the Charles River Basin Commission, part of the time as assistant engineer in charge of the Watertown section. For one year he was engaged on the construction of a high service reservoir at New Britain, Conn. For the past four years he has been at Fitchburg, in charge of surveys and construction of the new disposal plant, trunk sewer, etc., at that place.

Mr. H. N. Legreid has been appointed county highway engineer of Humboldt County, Iowa, succeeding Mr. J. L. Parsons, who recently resigned. Mr. Legreid graduated from the University of Wisconsin Engineering School in 1908, and was engaged in drainage engineering and contracting in Wisconsin from 1907 to 1913. He was with the Mississippi River Commission in the summer of 1912 on survey of overflowed lands. During the year 1913 he was with Mr. C. G. Elliott, consulting drainage engineer of Washington, D. C., as assistant office engineer. For most of the past year he wsa assistant engineer on highway and drainage work with Mr. J. L. Parsons, then county highway engineer of Humboldt County. In addition to work on the county highways, Mr. Legreid also has the construction engineering work of five county drainage districts. Humboldt County will spend about $50,000 during 1915 in permanent road and bridge work.

Mr. Paul L. Bean has been made chief engineer for the Public Utilities Commission of the state of Maine. This commission has taken over the work of the former railroad and water storage commission and in addition has the power to make physical valuations and investigations of accidents. Mr. Bean was for two years with the Phoenix Bridge Co. as draftsman and checker. From 1907 to 1909 he was instructor in the Department of Civil Engineering, University of Maine, assistant professor from 1909 to 1912, and since 1912 has been associate professor of the department. He has had charge of the courses in hydraulics and structural engineering while at the university. During his summers Mr. Bean has been employed by the U. S. Geological Survey on investigations of lakes and rivers of Maine for storage and power purposes. He has had charge of work in stream gagings. For the past three years Mr. Bean has been a member of the firm of Boardman and Bean, consulting engineers, making a specialty of bridge designing in concrete and steel and investigations of kinds of structures, testing of materials and water power surveys.

Mr. A. K. Grimmer has resigned as city engineer of Medicine Hat, Alta., taking advantage of the present slackness in municipal work in Canada, to recuperate his health which has been affected by the strenuous work of the five years during which he has held that office. Mr. Grimmer graduated from the University of New Brunswick in 1905, and for the year following was engineer in charge of the Glenn Extension of the York & Carleton Railway. In 1906 he was appointed resident engineer on sewers and filtration plant at Fredericton, N. B. From 1907 to 1909 he was city engineer at that place, during which time he constructed 14 miles of sewers and a sewage pumping station, a filtration plant and 12,500 sq. yds. of paving, etc. In 1908 he was given the degree of M. Sc. by his university in recognition of his research work and thesis on water filtration. In the season of 1909-10 he was lecturer in civil engineering at the University of Manitoba. In 1910 he was chosen as city engineer of Medicine Hat. Since that time the city has grown from 4,000 population to 15,000, and much public work has devolved upon the engineer. This included the construction of a new water plant and filtration system, distribution system, reservoir, etc., for a population of 30,000; a complete sewer system, and 21 miles of sidewalks, curb and gutter. A natural gas distribution system was extended and fifteen gas wells completed, and a great deal of street grading, paving, stream diversion, street lighting and other work was done. Practically all construction work except the drilling of gas wells was done by day labor and Mr. Grimmer states that the results were satisfactory.

CONTRACTORS.

The McLean Contracting Co., of No. 1411 Fidelity Building, Baltimore, Md., recently awarded a contract on the large reinforced concrete and steel bridge supported by concrete and wooden piles, which is to be built at Hanover street, in Baltimore, is a contracting firm of long standing and much experience in work in Baltimore and vicinity. The president, Mr. Colin McLean, has been in successful business for fifty-five years and has associated with him, Mr. C. M. McLean, as treasurer, and Mr. William M. Malory as secretary. This firm has constructed piers, bulkheads, bridges, etc., for the Baltimore & Ohio, the Norfolk & Southern, the New York, Philadelphia & Norfolk, the Pennsylvania, the New York Central and other railways.

CIVIL SERVICE NEWS

The State Civil Service Commission of California will hold civil service examinations as follows:

Construction engineer, Highway Commission; $1,800 to $2,400. Application must be filed before Feb. 13. Examinations at Sacramento, Los Angeles and San Francisco, Feb. 19-20.

Civil engineer, Grade II; $1,200 to $1,800; Feb. 19-20.

Engineering draftsman, $1,200 to $1,800, Feb. 26-27.

Mechanical draftsman; $1,200 to $1,800, Feb. 26-27.

These positions are in the Highway Commission, Department of Engineering, or the State Harbor Commission. Applications may be secured from the State Civil Service Commission at Sacramento.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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The New Concrete Construction Processes and Appliances.

Coincident with the Cement Show being held in Chicago this week the American Concrete Institute holds its eleventh annual convention. The ten years of life of the institute have been years of wonderful development in concrete construction. This development has not been least in appliances for conducting concrete work and whose exhibition is one of the main purposes of the Cement Show. Because it has been the more common practice to proclaim the growth of the cement industry and the yearly more numerous uses of cement products, it is proposed here to point to features in which appliances and processes for concrete construction have become improved and, in instances, revolutionized in ten years.

In ten years concrete mixers have become universal. A short list, in 1905, named all the makers of mixers. Now a complete list contains a score or two of names. Ten years ago the mixer was an appliance justified only on works of size. It was asserted as an axiom that for works of less than 1,000 cu. yds. a mixer was of doubtful economy. Hand mixing competed with machine mixing on a wide range of concrete work. On recent irrigation work, building small, scattered structures, it has been proved that, on good roads, a mixer can economically, compared with hand mixing, be moved one mile to mix 3 cu. yds. of concrete and three miles to mix 5 cu. yds. These are extreme figures but they illustrate well the most notable and important single attainment in ten years of mixer development. The machine mixer has been made a universally economical tool instead of a tool which could be economically employed under certain conditions.

The economic pre-eminence of the machine mixer is due to several co-ordinated improvements. The mounting of the mixer on wheels has made it mobile, and eliminated largely problems of carriage from mixer to work. The provision of power charging devices has eliminated charging inclines and runways, and, largely, other problems of carriage from stock pile to mixer. These improvements have been intensified in mixers for special work—notably in mixers for road work which embody as an integral part mechanism for carrying and placing the mixed concrete. Finally, mixers have become complete units mechanically: the motor, the transmission, the body, and the charging and discharging mechanism have been co-ordinated and combined into a single machine. This perfecting of mechanical design and the specializing of mixer manufacture has permitted the commercial development of a wide range of size and price of mixers. A contractor can today choose from a number of styles a mixer of any size and price that suits his work.

While the development of mixers has been revolutionary, in no process of concrete construction, since 1905, have there developed methods so radically different as in the processes of carrying and placing concrete. Ten years ago concrete universally was carried and placed in containers—in buckets, in cars, in carts and in barrows. These older methods have not disappeared, indeed they have been greatly improved, but new methods have come into use and very general popularity. At least three of these new methods, chuting, belt conveying and pneumatic conveying, are particularly noteworthy additions to the means available to the concrete constructor for conveying and placing concrete. It is believed that their use and their usefulness will increase and that they are destined to modify to a considerable extent the practice of concrete engineering.

Chuting has in the period named gained wide acceptance as a method of conveying and placing concrete. As a system, a definite series of correlated operations, it has been developed entirely within this period. Its use is more common than is the use of perhaps any other one method. By its invention and improvement there have been secured to a greater extent than was possible with any previous method of conveying and placing two desiderata of prime importance. First, the structure is not encumbered by the plant; the tower and the chutes are outside and above the structure. Second, very perfect flexibility and precision in placing are secured without auxiliaries; within the area covered, concrete can be deposited in any place and in any volume and at any rate up to the maximum output speed of the plant.

The development of the belt conveyor for conveying and placing concrete gives the concrete constructor the special advantages of, first, an appliance which without auxiliaries accomplishes both elevation and distance, and of, second, an appliance which permits handling concrete and materials for concrete by one method. In flexibility in placing the belt conveyor is at some disadvantage; combined with chuting it meets well this requirement. As a carrier the belt conveyor has brought the concrete constructor advantages which are impossible to secure so perfectly by any other conveying device. The belt conveyor has demonstrated capacity as a carrier, it works cleanly, and, by relaying, the possible distance of carriage is perhaps greater than by chutes or compressed air.

The "feature" development in 10 years in conveying and placing appliances is the pneumatic mixer and conveyor. The three types of these machines are the grout injector; the concrete or mortar ejector or "gun," and the concrete mixer and conveyor. All three devices accomplish mixing, conveying and placing. All three have demonstrated a high degree of success in operation. The construction advantages which they have brought the engineer are, first, ability to place mechanically a thin coating of cement or mortar or concrete and, second, ability to place these materials in the most constricted and irregular spaces. As pointed out in our issue of Jan. 13, 1915, grouting has become in a few years one of the most valuable construction processes at the command of the engineer, and it is largely to the very perfect development of grouting machines that the successful adaptability of this process is due. Cement coating of structures for finish or protection has been given new possibilities by the cement ejector. The pneumatic mixer and conveyor has extended the economies of machine mixing, carrying and placing to concreting in spaces too confined for any other method except hand work.

Mixing, carrying, placing and shaping are the four construction processes of concrete construction. The one great development of 10 years in shaping concrete is the steel form. Systems of steel forming have been worked out for practically all structural elements of concrete construction—walls, beams, slabs, columns, and conduits. The greatest development and use of steel forms has, however, been for conduits—for sewers, aqueducts and tunnel lining. Here the steel form has attained absolutely first place. This has come about for three principal reasons: First, the high commercial development of the manufacture and leasing of steel forms built to shape and dimensions demanded by the specific work as designed; second, the devising of very perfect unit systems of building up or extending forms; and, third, the providing of complete portability. Next to improved mixing and carrying appliances, the steel form has been the most notable appliance for concrete work developed in 10 years.

The 10 years' record of development in concrete construction processes proper presents one notable attainment. Construction by precast concrete units has established itself firmly in engineering practice since 1905. Molded concrete building blocks, cast concrete pipe and drain tile and molded columns, beams and slabs for building work have all attained general recognition as means available to the engineer and builder. For drainage and irrigation work the precast concrete pipe has reached a very high place. Ornament molding and casting of concrete has also reached an acknowledged position since 1905. Steel molds, block molding machines and pipe molding machines are, therefore prominent among the special concrete construction appliances developed during the decade now ending.

All told the work of the inventor and manufacturer of concrete construction appliances has kept even with the work of the engineer and builder in the remarkable extension of the use of cement products. This is quite as true of the small tools of the concrete worker as of the large construction appliances that have been named. It is especially true as shown in the editorial following of the appliances available to the concrete worker for hauling his materials and supplies. While this development is indisputable, the change for any twelve-months' period of the ten that this account covers has been small. "The Cement Show this year," we often hear said, "is much like the one of last year." It is. But each year adds its quota of improvements and the accretions in time build up a new appliance for or a process of concrete construction.

In 10 years since the American Concrete Institute held its first annual convention concrete construction methods have been revolutionized. The mixers used, the carrying and placing methods practiced, the tools and appliances employed are not the ones that existed in 1905. Hand mixing has become rare. In all processes of mixing, carrying, placing and shaping concrete, manual labor has been lessened. Wages and prices are not the same. The building of a concrete structure today is not a problem to be solved in the same way that it was solved in 1905. These have all come about very largely by means of the appliances and materials which make the cement products exhibition of 1915. With this retrospective vision, the Cement Show of 1915 has an interest beyond that coming from a perfunctory search through many familiar sights to see "something new this year."

Recent Improvements in the Methods of Handling Materials in Concrete Road Construction.

The road construction season of 1915 will see the increased utilization of improved methods in the handling of materials in concrete road building. Several years ago when the construction of concrete roads on a large scale was first begun it was the practice to apply the methods then in vogue in the laying of concrete base in municipal paving work to the construction of rural roads. These methods of handling aggregate, cement and water consisted in the main in hauling the aggregate and piling it in long rows and the use of tank wagons for hauling water to the site of the work.

The most important development, perhaps, has been in the use of power hauling. For the most part for all hauls exceeding about two miles in length team hauling has been abandoned. Traction engines, motor trucks and industrial railways have taken its place. This development is probably due largely to the greater efficiency of power hauling machines, the increased scarcity and unreliability of local teams for hire and the increased size of contracts under which road construction work is accomplished. With the use of mechanical hauling equipment has come increased plant expense and the necessity of exercising greater care in the selection of plant.

In detail, the improvement in traction engine hauling—both steam and gasoline power—has come almost largely through the development of larger and better designed trailers and cars. Heavier construction is used in engines than was formerly employed and the caterpillar type of traction has been subjected to the test of time and is finding its field of usefulness. The development in motor truck hauling has been enormous. The size of trucks has been increased until average loads vary in weight from five to ten tons. Modifications and improvements have been made to adapt the trucks to the strain incident to operation over rough country roads. An increased use of trailers in connection with motor trucks is noted. Industrial railways as applied to the hauling of road materials, with the exception of a few isolated cases, were not used prior to 1914. The economy of their use on large projects has been demonstrated during the past year and the size of project and conditions under which they should be used will be demonstrated more fully during the coming year.

A number of pumping engines for use in connection with the supplying of water for construction and curing purposes, have been developed. Piping details and details of the use of the oxy-acetylene torch in pipe repair are interesting. Car side wagon loading devices for expediting this work and reducing the number of men employed are finding an increased use. These loaders range in type from a power driven plant requiring the attention of but a single man to simple bins loaded by hand and holding a single wagon load.

Perhaps one of the most important developments in connection with the manipulation of the concrete is in the design of striking and tamping or vibrating machines for smoothing and increasing the density of the concrete. In theory these machines by a process of kneading the surface of the concrete road increase the toughness and density of the concrete, thereby improving the quality of the wearing surface. Several roads were constructed during the past season on which these machines were used and service tests will indicate the effectiveness of the process.

In the use of concrete mixers the boom and bucket type of delivery is being used to an increased extent. However, it is contended by many engineers that the use of a spout tends to produce greater uniformity in the concrete placed. Numerous improvements in the traction and methods of controlling the mix have been made, among them the use of a counting device on the drum and the control of the water supply and batch dumping.

The Designing of Details.

Engineers, as well as other men, are inclined to judge the importance of their work by the rate of pay which it commands. As the engineer becomes older and more experienced he realizes that certain kinds of work possess advantages which cannot be measured in dollars and cents. The young engineer, however, is naturally attracted to those lines of work which seem to insure most quickly large returns. It is to be regretted that "detailing" does not at present seem to offer a career to capable young engineers. Unfortunately it is considered merely as a stepping stone to another position, with the result that capable young men are avoiding this kind of work or are remaining in it as short a time as possible. We are just beginning to appreciate the fact that poor details are largely responsible for many failures, also for many unsatisfactory structures, which, even though they have not failed, cannot be relied upon to carry any considerable overload. Engineers, themselves, are largely responsible for this condition, because many of them have considered *detailing*, not as *designing*, but as mechanical, trades-school work. The *designing of details* is an important kind of engineering work, and its problems are often sufficiently difficult to command the highest engineering skill.

We believe it is time for engineers to recognize the importance of detail designing, and to adopt measures which will justify engineers of ability in remaining in this kind of work. Efficient detailing requires a thorough knowledge of the strength of materials, of stresses, and of erection procedure; and the old idea that almost any man who possessed a structural hand-book and a set of drafting instruments could soon qualify as a detailer was an erroneous one. Adequate pay and a proper appreciation of the importance of the work will do much toward attracting and retaining capable detailers.

Generally, the importance of the structural designer's work has been over-rated, as compared with that of the detailer. For structures of medium size it does not take the highest type of engineering ability to compute the stresses and, with the aid of a hand-book, to select the size of the main sections. In bridge work, for example, to obtain the information ordinarily placed on the stress sheet does not often require exceptional ability, in fact the man just out of college may be much more efficient in computing stresses than the experienced engineer. The prevailing notion that the well-paid engineer's work is completed when he finishes the stress sheet is wrong—it is too much to expect that the poorly-paid detailer can complete the design, as the latter is usually a man with little engineering experience.

If our structures are to be equally strong in all their parts and capable of being erected economically there should be little distinction in salary or in technical ability demanded between the designer and the detailer, in fact one high-grade man might well do the work now done by both. The extra cost for efficient work under such a system probably would not be greater than that under the system now in use in our large offices if the cost of the "checker" is taken into consideration. The results of tests of full-size members have shown that the actual strength of a built-up member often is only a small percentage of its computed strength, due mainly to weak and faulty details. Engineers are just beginning to realize that they have little definite information on this important subject. It is hoped that the growing realization of this lack of knowledge will act as an incentive to them to make the designing of details a branch of structural engineering work worthy of the attention of capable and experienced engineers.

ROADS AND STREETS

Practical Kinks in Concrete Road and Pavement Construction.

The success obtained in constructing a concrete road depends largely upon the thoroughness of the construction methods used and the cost of the road depends largely upon the skill with which labor saving methods are employed. In a paper before the Indiana Society of Engineers, C. D. Franks discussed some of the labor saving methods he has employed and his paper is given here.

GRADING.

It is often the case that a concrete roadway or other hard-surfaced road is to be placed upon an old roadway, when the new road is wider than the old roadway has been. Where such a condition exists it will be necessary to loosen thoroughly the old roadway for quite a distance below the desired surface of the finished subgrade, this distance to depend upon soil and other local conditions. The entire fill should then be made and compacted uniformly, the object being to provide a subbase of equal bearing power throughout, for when one part of the foundation of a hard road surface is less apt to settle than another, it is impossible to do away with cracking. A special example may be cited in the case of a hard surfaced road which is to be laid at a greater elevation than the old roadway where the old roadway was on a considerable fill. As the new roadway will rest upon a fill deeper than the old, the width of the fill at the bottom will be proportionately greater. To obtain a uniform bearing surface, therefore, the material in the old fill should be spread out uniformly in a layer from one side of the new slope to the other and the rest of the fill be placed on top of it. It is well to mention in this connection that the greatest care is necessary in building any fill of greater depth than two feet, so as to have it in a thoroughly compacted state before any hard pavement is laid upon it. If absolutely necessary to place the roadway soon after this fill is made, the material should be placed in layers not to exceed one foot in thickness, and should be thoroughly rolled before succeeding layers are placed. If soil conditions permit, it will be well to settle this fill with water in addition to or instead of rolling. By far the better practice would be to build the fill in the fall of the year previous to that in which the roadway itself will be laid. In this manner many unnecessary cracks can be avoided.

There is a simply made tool which can be used to determine the slope of material in a fill. It consists of three boards—one horizontal, one vertical and one inclined, making an angle with the horizontal piece equal to the required slope of the material. From the horizontal board a plumb-bob is hung and vertically below it on the inclined board a mark is made. This gage is placed with the inclined board along the slope. If the side surface of the fill corresponds to the required slope, the plumb-bob will hang directly over the mark on the inclined board.

It should hardly be necessary to state that it is extremely bad practice to make a fill with frozen materials, yet one or two cases of this kind have come to my attention. When frozen material in a fill thaws it compacts greatly under its own weight and the surface of the fill settles considerably; invariably enough so that no hard surfaced road can stand upon it without cracking.

It sometimes becomes necessary, while grading, to set a stake on one side of the roadway at the same level as that on the other side, when a level is not at hand. This can be very simply accomplished by completely filling a piece of hose with water. By holding one end of the hose so that the water showing in it is just level with the top of the stake of known elevation, and setting the stake on the opposite side of the road at the elevation of the water at that end, you can be sure that the second stake is at the same elevation as the first.

This brings to mind a very simple siphon which probably many of you have used. Its use is applicable to street work where there are curbs. Frequently after a rain, water may stand to a depth of 5 or 6 ins. on the subgrade between the curbs. To remove this water lay a piece of hose about 10 ft. in length beneath the surface and be sure that all air is removed from it. Close one end of the hose beneath the water with the hand and place it in a catch basin or other convenient outlet, being sure not to release the outlet end until it is below the surface of the inlet end which is retained under water. When in the position described this hose will act as a siphon and drain off the water from the subgrade as long as its intake is kept below the surface.

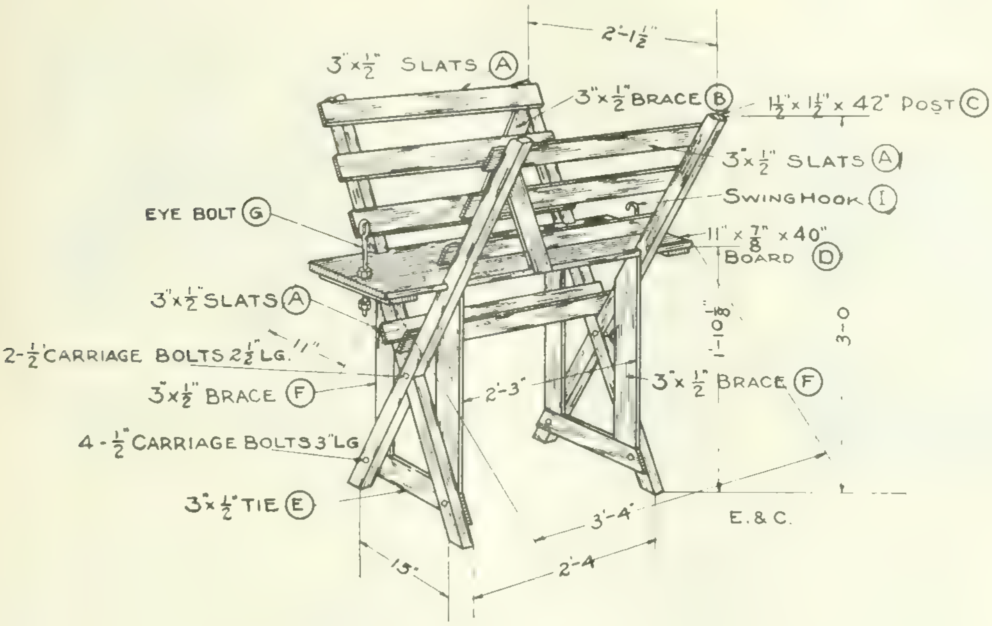


Fig. 1. Rack for Use in Bundling Empty Cement Sacks.

WATER SUPPLY.

The water supply for the construction of a concrete road and pavements is always a problem which must receive much consideration in order to be handled economically and satisfactorily. In this case, as in all others, it will be well for the engineer, when he is planning the work, and the contractor, before he bids upon the job, to have a definite, practical plan made for supplying enough water to the job to carry out the work. The necessity for careful planning and the necessity of an adequate supply may be surmised from the fact that the sprinkling of the subgrade before concrete is laid, the mixing of the concrete and the sprinkling of the finished concrete surface for curing, will require on an average of 13,000 gals. per day, when 500 sq. yds. of concrete pavement are laid. In rainy weather or in the fall of the year the sprinkling may be unnecessary and this amount of water may be materially reduced, but it is unsafe to provide for any smaller amount than 25 to 30 gals. per square yard of concrete laid in the summer months, for an inadequate supply will materially hamper the work, delay the job and increase the contractor's cost.

The volume of water required at the mixer is the same whatever the size of the supply pipe may be. In order to supply the same amount of water the velocity in a small pipe must be greater than in a larger one. But friction increases as the square of the velocity and therefore the loss of head in a small pipe is much greater than in a larger one. In practice it is rarely found advisable to use less than a 2-in. pipe line to supply water to a concrete road or pavement job, and no connections smaller than 2 ins. should be used. Where two sizes of pipe are used, the contractor may have laid his smaller pipe nearest the pump or source of supply before the larger size pipe is secured. He has in one or two instances considered it necessary to place the larger size nearest the supply. This necessitates, of course, that the smaller pipe be carried ahead to the end of the larger pipe, which may be in some instances as much as a mile or two in length. This is unnecessary, as the total friction will be the same whether the larger or the smaller pipe is nearest the supply, though the smaller pipe may be eliminated sooner from the line if it is laid farther from the source.

It frequently becomes necessary to take a section of pipe from the pipe line to remove an obstruction or for another purpose. For this reason unions which will allow one pipe to turn without turning the one next to it should be placed at distances not to exceed 500 ft. apart. Otherwise, the entire pipe line must be turned to remove one section, necessitating the use of unreasonable force. T's and taps should be placed in the line not farther apart than twice the length of hose which will be used to connect the water pipe with the mixer. This hose should be at least one inch in size to reduce friction and should preferably be short for the same reason, so that it will be well to space the T's and taps not farther than 200 ft. apart. Pipe for the water line should be procured in as great lengths as can be economically handled to lessen the labor of connecting.

When the water is taken from a pool or other natural source, the intake should be protected so that sticks and other foreign matter will not be drawn into the pump and pipe line where they will cause trouble. When the water supply is taken from a city main it will sometimes be necessary or advisable to use a booster pump to obtain a sufficient head for the requirements of the job. In many cases it is possible, when constructing pavements in cities or towns, to connect directly by means of a suitable hose to water hydrants. However, it will be found more economical in a great many cases to be provided with a line of pipe, in order to insure at all times the proper delivery and amount of water required to carry on the work satisfactorily.

Some sort of relief valve must be used in the pipe line so as to prevent the breaking of the pipe or the blowing out of the cylinder head in the pump when it is running but no water is being used. Spring relief valves have been used with success, but a simple arrangement may be used to take their place. At one of the T's previously placed in the pipe line near the mixer, insert one or more lengths of pipe vertically upward. The top end of this pipe will be open and this arrangement will act as a relief valve. If the outflow of water at the mixer is stopped the pump, instead of exerting pressure against the water confined in the pipe, can raise the height of water in this improvised standpipe and any excess may be allowed to flow through the upper open end of pipe. This arrangement acts as a relief valve and also assists in procuring a uniform pressure of water at the mixer at all times. This is always desirable and materially helps in obtaining a uniform consistency of concrete delivered by the mixer. This standpipe should be moved frequently so as to be always close to the mixer.

Like all other things, the pipe line will expand and contract with changes in temperature, and unless some provision is made for this expansion and contraction, rupture is apt to occur. For that reason, expansion joints of some kind must be placed in the pipe, preferably at distances not to exceed 2,000 ft. The copper expansion joint is a standard fitting and is often used for this purpose, or a satisfactory expansion joint may be formed by three sets of fittings consisting of two elbows and a nipple, so placed as to make a "V" in the pipe line. Another satisfactory method is to offset the end of one pipe from the other slightly—say a distance of 6 ins. These two ends should then be connected with a rubber

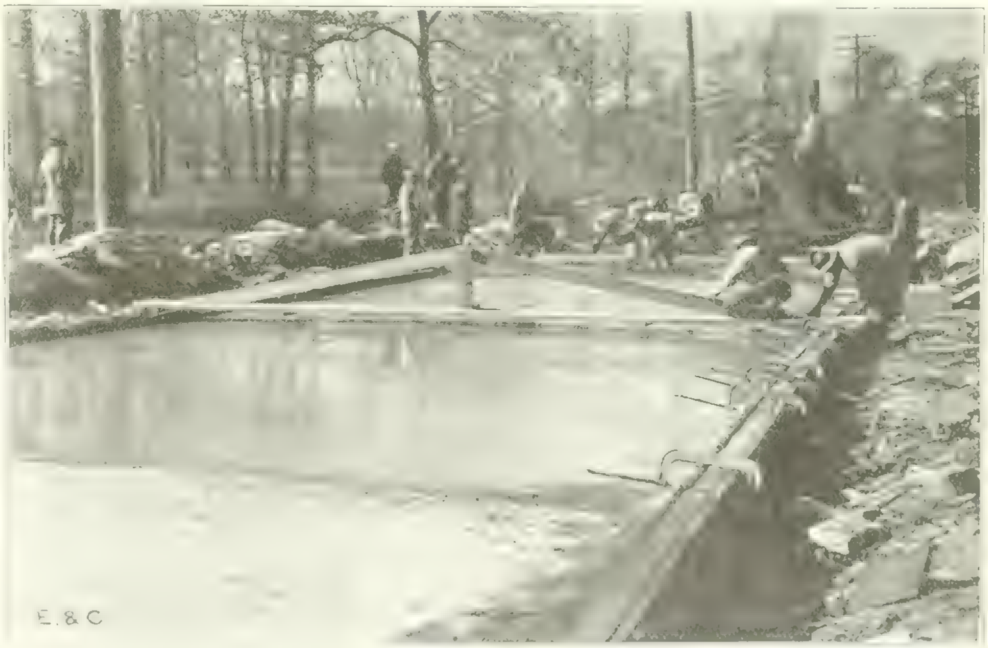


Fig. 2. Integral Curb Construction and a Trussed Finishing Bridge.

hose. Connections of this hose with the pipe must be tightly made in order to prevent leaks and the hose should be of a size at least equal to that of the pipe to reduce friction, which will be naturally greater where the water is forced through any bend. Sufficient hose should be used to provide for a movement in the pipe of 6 ins.

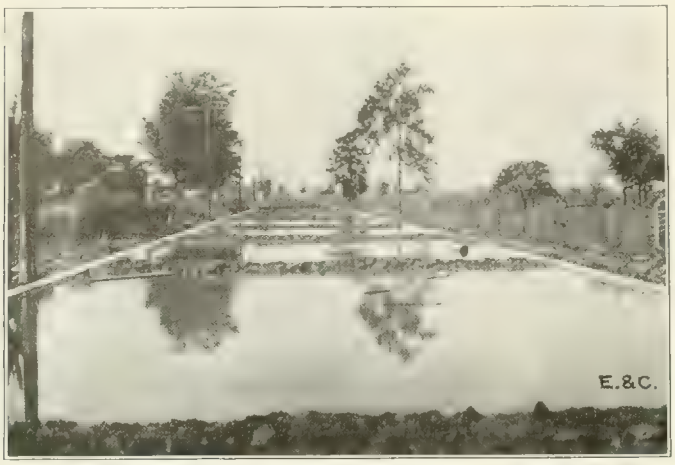


Fig. 3. Curing Concrete Pavement by Flooding.

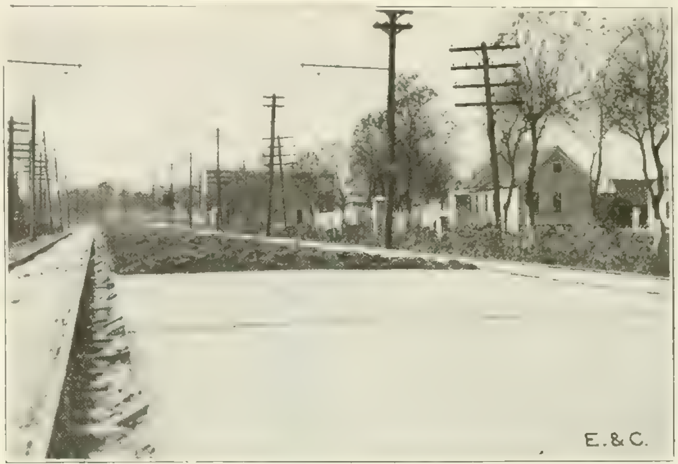


Fig. 4. Earth Protection of Concrete While Curing.

The character of the subgrade for roads or pavements is sometimes such that sprinkling immediately before placing the concrete results in a muddiness which is a detriment to the work. At the same time, if concrete is placed upon such a subgrade without sprinkling, the thin mortar will be withdrawn from the concrete, and thus prevent its hardening or weaken it. Therefore, it may sometimes be necessary to thoroughly sprinkle the subgrade before the aggregates are placed upon it, so that it will be moist but not muddy when concrete is deposited. Necessity for this early sprinkling can only be determined by an investigation and possible experiments with the particular subgrade in question.

One of the things which has required the greatest attention in the past is the water supply to the drum of the mixer so as to obtain a uniform consistency of the concrete. No method should be used which does not automatically supply each batch of materials with the proper amount of water. This makes the use of a measuring device for water, which is positive and quickly adjustable, a necessity. Contractors who are considering the purchase of a mixer, or engineers who are passing upon a mixer to be used upon concrete road work under their supervision, should thoroughly investigate this most important part of the equipment—the automatic measuring tank for water.

MIXING.

One of the most difficult things to provide for in specifications is a thorough mixing, because of the different shapes and positions of the mixing drum and blades, as well as the speeds at which the drums revolve on the different makes of mixers. The only satisfactory way to write a specification that will cover all types of mixers is to specify two minimums; one the minimum number of revolutions per minute and the other the minimum time of mixing to a batch. A recent device for automatically recording the number of revolutions per batch was on exhibition at the Sixth Annual Good Road Show, held in Chicago during December, 1914. An indicator was placed on the side of the mixer which could be set to the specified number of revolutions. When the unmixed materials were placed in the drum, this indicator automatically recorded the revolutions of the mixer and at the proper number a bell would ring, indicating to the man at the discharge end that the batch was ready to be removed from the drum. This device is a great step forward in the proper mixing of concrete, for, by determining the R. P. M. of the drum, setting the indicator proper and following the signal given by it, thorough mixing is insured.

PLACING.

It is customary, to prevent cutting up the subgrade, to lay planks upon it for wheelbarrow runways. These planks are heavy; they become watersoaked, and their thickness makes wheeling up onto them a difficult matter. One contractor was able to procure a large amount of scrap boiler plate which was ¼ to ⅜ in. in thickness. This made excellent runways for the wheelbarrow and reduced the labor of wheeling, and the contractor who used this scheme thought that it saved him considerable money on his job. Such a point might well be worthy of consideration.

All working parts of the concrete mixer such as are liable to cause accidents to the workmen or to have their working interfered with by clogging from cement dust or particles of aggregate should be housed in. Some makers of mixers, especially in the newer models, are providing for such housing, but where this is not provided for some simple covering can be placed around movable parts, which will facilitate the reliable working of the mixer and safeguard the workmen.

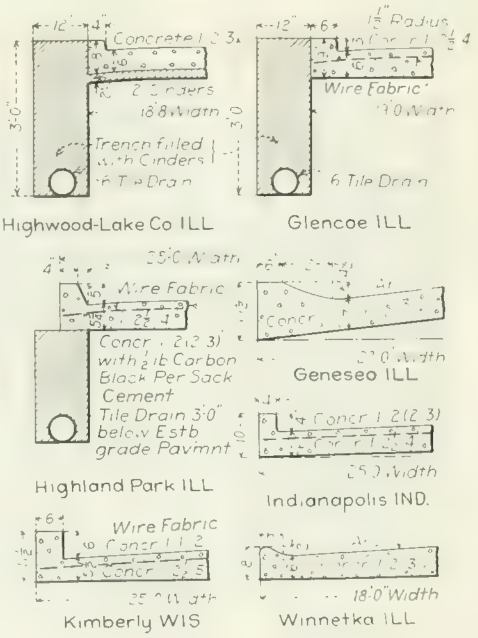


Fig. 5. Types of Concrete Curb Constructed Integral With the Pavement.

FINISHING.

When a concrete pavement is greater than 20 ft. in width, it is difficult to strike off without a specially constructed strikeboard, and this fact has led to the development of strikeboards for this purpose. In a general way, it may be stated that the object in these devices is to lessen the necessary force for pulling the strike-board longitudinally along the pavement. Their development ranges from a simple strike-board which rests upon rollers which ride upon the side forms or curbs, to an adjustable strike-board, which strikes and finishes the surface of the pavement and is propelled by a gasoline engine.

As a rule country roads in Indiana are not over 18 ft. in width. These can be struck off by a 2 or 3-in. plank crowned to the surface of the road and operated by two men, one at either end. The motion should be a combined sawing and forward motion.

After a concrete road or pavement has been struck off, it is necessary to smooth the roughened surface with a wood float, and the finishers should not be allowed to walk in the newly laid concrete, as this injures it. Therefore, some sort of a bridge is necessary from which the workmen can finish the concrete surface. These bridges are easily constructed and are built of many types, but the one shown in this illustration is to be recommended for road work. It consists merely of two 3 x 3-in. angles, a 12 x 12-in. plank, two ½-in. rods with a nut on one end, and two short pieces of 4 x 4-in. lumber. For tightening the iron rods and giving the board the desired arch, it can be placed upside down upon two supports at its ends. One or two men, standing in the middle of this board, will deflect it sufficiently to permit of the rods being placed. It is, perhaps, a little more difficult to build a floaters bridge for the wider pavements. However, this may be economically accomplished by constructing a simple truss which can carry the workmen's platform. The bridge may be easily moved along the curb on wheels properly fastened and braced to the main members of the truss.

HANDLING CEMENT SACKS.

There is no subject upon which the cement manufacturer and the contractor can get so far apart as upon the subject of sacks. Cement is nearly always shipped in cloth sacks, for which the contractor is charged 10 cts. apiece. He is given credit for every sack returned to the mill in condition to make another trip. For every sack that is not returned in good condition the contractor loses 10 cts., and, therefore, it behooves him to take very good care of the sacks.

If a cement sack becomes wet it is worthless; if it is used for any other purpose than that of holding cement, it is likely to become injured so that it can not be used for carrying cement again, and therefore the cement company will not pay the contractor 10 cts. for it. It is required that empty sacks be shipped to the cement mills in bundles of 50, and the illustration, Fig. 1, indicates the dimensions in inches of a home-made sack bundler and the details of its construction. It may be built of either pine or oak, but the latter is preferable because of its strength. Reasonably good wormanship should produce a bundler that should last long enough to pay for its cost many times over.

The 50 sacks are placed on the table between the two sideboards with two wires under the pile and one long wire running lengthwise on top of the pile. One end of an iron bar is placed through the "I" bolt, as shown at G, and the other end of the iron bar is hooked under the swing hook "I." This operation results in the sacks being held together very tightly and in an easy position to tie. The operator then ties the short wires over the sacks, thus bundling the sacks over the long wire. The bundle is then released by withdrawing the iron bar. The operator then brings the long wire around the ends of the bundle and takes a hitch with the long wire around the two short ones that have already been tied. The long wire is then turned around the middle of the bundle and tied tightly, thus forming a tight, compact bundle of sacks. The bundle is so tied as to insure practically every sack getting to its destination. Tarred twine has been used with success instead of wire for tying up a bundle of sacks. This twine must be at least 3/16-in. thick to conform to the rules of the railway companies.

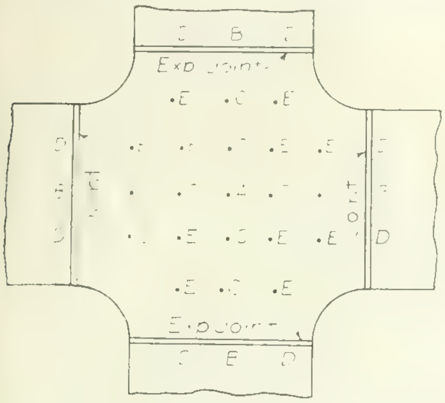


Fig. 6. Method of Setting Stakes at Street Intersections.

STORING CEMENT.

It has just been shown why it is advisable to keep cement sacks from getting wet. The same applies in a greater degree to the storing of cement on the job before using. It should never be laid directly on the ground, but should, in all cases, be placed upon planks blocked up off the ground and adequately covered against rain, dew, etc. A very convenient arrangement is a cement table near the skip of the mixer. The laborer carries the cement from the sack pile to this table in a wheelbarrow. The table is at a convenient height for the man who opens the sack and dumps it into the mixer. A bar may be attached to the skip of the mixer at the same height as the cement table, which will assist the laborer in dumping the cement into each batch.

INTEGRAL CURBS.

The use of an integral curb with concrete pavements is by no means a new thing. It has frequently been used in connection with the construction of concrete driveways, but its use with public roads and streets of concrete has not been developed materially until the year 1914. An integral curb, if properly constructed, should serve all the purposes of a curb constructed separately from the pavement itself. Its cost will, of course, be materially less. The shape of these curbs may be and have been of various types to comply with special conditions which were to be met with. Curbs may be formed by shaping the end of the strike-board to form the curbing. These types are applicable only to boulevards, park systems and light work where no definite curb is desired and yet a waterway is necessary. The extra material required for such curbs is so small that its cost is negligible, and it is doubtful if the cost of the pavement proper is increased to any appreciable extent thereby. The cost of the integral curb on 34th St., Indianapolis, was 3 cts. per square yard of pavement surface, which made the cost of the curbing 4½ cts. per linear foot. It is proved every day that no hard surfaced pavement can stand successfully unless the subgrade is thoroughly drained. The best place to put this drain is outside of the pavement itself, so as to intercept the ground water and prevent it accumulating under the pavement where it will later cause trouble.

The illustration shows a detail of the integral curb constructed with the concrete pavement on Sheridan Road, Highland Park, Illinois, this year. This pavement was of the two-course type. The outside form was placed with its top at the elevation of the top of the proposed curb and the pavement was then struck off. Afterward a board was suspended from the outside form and rested upon the concrete pavement surface to form the inside form for the curb. The space for the curb was then filled with the concrete material for the top course, which was a mixture of 1:2, the aggregate ranging from ½ in. down. This is a very pretty job of integral curb work and seems to be entirely satisfactory.

In laying concrete pavements in hot weather where a rich top surface of a rather wet consistency is used, it will be found that shrinkage cracks may develop before the concrete has hardened sufficiently to receive an earth cover unless some other provision for covering is made. The best method to prevent shrinkage cracks is to cover the freshly laid concrete with canvas and keep this wet if it is found that it will not alone prevent the formation of these cracks.

TOOLS.

Of all the tools used on concrete roads, probably none should be of more interest to this audience than the split float, because of the fact that in some cases roads and pavements are built without protection at expansion joints. When expansion joints are built without protection plates, it is always advisable to allow the expansion material, usually tarred felt, to extend a short distance above the finished surface of the pavement so that later it will iron out over the joint and protect the edges of the concrete.

Those of you who have seen concrete roads or pavements constructed in this way, have no doubt found that it is difficult for the average workman to finish the concrete on both sides of the tarred felt at the same level where this felt extends from ¼ to 2 ins. above the finished surface of the pavement. To obviate this difficulty the split float as shown in the illustration was designed. It consists of two small wooden floats spread about ½ in. and connected by the handle. The tarred felt is allowed to extend between the two parts of the float and it is moved transversely across the pavement in line with the felt. In this way it is very easy to finish the concrete on both sides to the same level. This is a simple and economical tool and may easily be home-made. It has been my experience that a very convenient tool for concrete paving work is the lute. I refer to the tool which is in common use to smooth out the sand cushion with brick paving work. Those of you who have finished a concrete pavement from a finishing bridge will realize that my suggestions of knee pads for the finisher is of interest.

There are a number of types of commercial metal forms for road construction, each having its own "kinks," which are applicable in most cases only to their own particular case. Therefore, I will not take up such special cases for undoubtedly the contractor who purchases metal forms will obtain with them all necessary information for their operation, which, of course, must be satisfactory to the engineer.

PROTECTION PLATES

When protection plates at tranverse expansion joints are used the plates do not always arrive on the job in satisfactory condition, for the rough handling they receive in shipping will sometimes bend them out of shape. For this reason some suggestions may be found of value when installing protection plates in concrete pavements. To bend out the shear anchors of steel plates, use a 36-in. length of 1½-in. pipe. It is a good idea to give the prongs a half turn after they are bent up—a monkey wrench is a convenient tool to use for this purpose. For wide pavements the installing device will sag a certain amount so that in making up a joint, three "horses" may be necessary and when the workmen set the "T" installing bar on them, they should stretch a chalk line over the ends and raise or lower the center horse until the crown at the center of the bar is correct. The workmen can then proceed to fit the steel plates to the "T" bar and know that when they fit they are correct for the crown.

Plates as they come from the factory are not always uniformly curved and must be "pened" out with a hammer. A 3-lb. ball pene or machine rammer is most satisfactory and a small anvil or length of railway rail is convenient. Very often when the plates are placed on the "T" bar they touch it in several spots only throughout its length. Hammering down the edge of the plate will have no effect whatsoever on the Baker type, but if the plate is laid flat on an anvil and the ball end of the hammer is used to strike at the points where the plate does not touch the bar, the plate will be expanded at those places and so will conform to the proper curve with one or two trials. It is important to have this done, as otherwise the steel will catch on the strike-board in places and leave hollows in others, will look very bad and will not provide adequate protection.

No matter how carefully the protection plates are prepared, they are certain to gap open in places after the "T" bar is stripped, so that it is a good idea for the workman to run a light (16-gage) wire through the felt at points about 36 ins. apart, passing one end of it through the holes left by the shear prongs, and the other over the top of the plates. These two ends are then twisted up and hold the plates closely together after the installation bar is stripped. They are on the surface of the pavement, but as they do no harm can be left in place.

In placing a joint on a wide street with a "T" bar installation there will be some sag at the center. This may be prevented by the use of a pin having a lug upon one side. The pin is driven and the lug is set by measuring from a line stretched from one side of the pavement to the other over the forms or curbs so that it will be at the exact elevation desired for the surface of the finished pavement. The "T" bar, when set in place, rests upon the lug. It may be necessary to use three of these pins, one at the center of the street and one at each of the quarterpoints. Wooden stakes are often forgotten and left in the pavement. The iron stake can be given a quarter turn to release the shoulder and will never be forgotten because it projects above the concrete.

In case of pavement construction provided with curb it sometimes occurs that the top of the curb is uneven so that the installing bar is not set to give exactly the proper depth of protection plates below the top of the curb. Therefore, it may be necessary to place a shim under the handles of the installing bar resting upon the curbs. In all cases extreme care should be used to set the protection plates so that they will conform to the surface of the finished pavement exactly, and care should be used in finishing to obtain the same results as expansion joints set high or low are very objectionable.

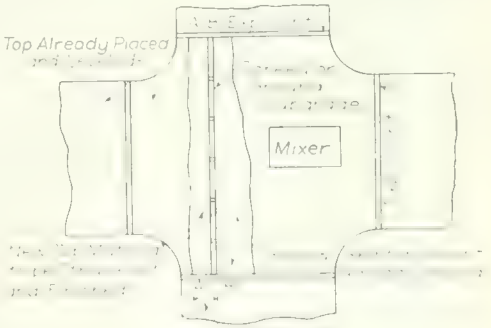


Fig. 7. Sketch Showing Procedure for Striking of Intersections by the Use of Ground and Straight Edge.

At dead ends of concrete pavement or

where concrete pavement abuts another pavement already in place, one protection plate should be used to protect the edge from the traffic that it will receive.

The installation of unprotected joints is undoubtedy simpler, and any arrangement that will hold the felt in its proper position until concrete is placed on both sides is satisfactory. However, a method that will keep the felt in plain view at all times would seem to be desirable, therefore, a piece of 2-in. plank with handles which will support it upon the side forms and to which a number of wing nuts are attached to hold the felt in position has been found to be one of the most satisfactory methods of installation. The concrete is placed on both sides of this installing device, and when a sufficient distance back of the board has been reached, the wing nuts are turned, releasing the felt and the installing device is removed. Care must necessarily be exercised to remove this installing device before the concrete begins to harden.

The placing of intersections entails a small amount of special construction, for the strikeboard or template used on straight of way work will not be of service here.

STREET INTERSECTIONS.

Figure 6 shows a rough sketch of the street intersection. The surest way to get a true surface is to have stakes driven into the subgrade with their tops at the proper level of the finished pavement. The conditions existing on the particular job in question will determine the number of stakes necessary to use. On concrete streets where the crown is low it has been found good practice to raise the center of the intersection about one inch above what it would be were the crown to run through on a straight line. This insures that there will be no unsightly sag in the intersection and that it will shed water readily. The pavement at the three wings will usually be in place, but if not, the points "B" and "D" should first be set. The stake "A" at the center of the intersection may be set from a straight line stretched between curbs or forms at opposite corners. Stakes "C" may be set from a straight line between "A" and points "B." Finish by setting stakes "E" from lines stretched between two opposite points "D" in any direction. All these stakes are, of course, established to show the true surface proposed for the pavement. It is convenient to drive a spike in the top of each stake so that it will not become lost and be left in the pavement after concrete is placed.

There are a number of ways of placing concreate at intersections, but where sufficient stakes can be set it is satisfactory to finish the concrete with the use, preferably, of knee boards and short-handled float or by the use of a long-handled float. The concrete is brought to the surface required before finishing by the use of a lute. Bear in mind that walking in the concrete after it has been put in place is always a bad feature.

PROTECTION WHILE CURING.

It sometimes occurs that a sudden storm will arise when a considerable amount of finished concrete pavement has been placed but has not had sufficient time to harden. Rain on the surface of a pavement in this condition will pit it. Sufficient canvas should always be at hand to cover all unhardened work, but where this is not at hand pitting may be prevented by sprinkling the unhardened concrete surface with a light layer of fine sand.

You are all undoubtedly familiar with the custom of covering the finished concrete surface with a layer of earth, sawdust, straw, shavings, or other material, which is kept wet to prevent the drying out of the concrete. One ingenious contractor developed an idea which has been considerably adopted as a substitute for the use of an earth cover. Earth dams, about 8 x 8 ins. are placed at the sides of the pavement longitudinally and occasionally transversely. The pavement is then flooded with water to a depth of 2 or 3 ins. If the dams are properly made with a good clay soil, the water will not have to be renewed for five or six days. This method is not feasible on slopes greater than 2 per cent. Some comparative cost data is at hand on placing an earth cover and sprinkling, as against ponding. These figures are the average cost of 17 days' work. The average cost of placing an earth covering and sprinkling was found to be $10 per day. The average cost of ponding was found to be $4.50 per day.

It is a good plan to protect the unhardened surface of concrete pavement from dogs, chickens, etc., when leaving the job at night, and a small amount of wire fencing roughly supported at its edge will satisfactorily accomplish this purpose on most jobs.

The placing of any concrete work in weather which is, or is liable to fall to, freezing or below, requires precautionary methods. The usual specifications require that no concrete be placed when the temperature is, or in the opinion of the engineer, will, within 24 hrs., fall below 35° F. When there is any question about the temperature, the pavement surface should be protected against a temperature drop before the work is left at night. Extensive experiments which have recently been conducted show that a generous layer of straw covered with canvas is the best protection of those generally used, to the pavement against low temperature. Canvas supported above the surface of the pavement and closed at the sides, under which steam from the boiler of the mixer is turned, has been used and, of course, with success, but I do not believe that this method will commend itself, for economical reasons, to many contractors and engineers who are building concrete highways.

It may be well to give just a word of warning about opening the concrete pavement to traffic. The time of opening under the most favorable conditions for hardening should not be less than two weeks and where the weather is cool and rainy this time should be lengthened considerably. The best time can only be determined by one familiar with weather conditions, but it is a good plan to play safe when in doubt, for several examples may be cited of pavements which have been destroyed by turning traffic upon them too soon.

HAULING MATERIALS.

The hauling cost is a large part of the cost of any paving construction and a careful study to find the best method of handling this proposition will generally effect a great economy in the work. On some large jobs industrial railways have been used with excellent results and there is a talk on this subject on the program for tomorrow which will, no doubt, give some valuable information on this subject. From year to year the automobile truck is taking the place of teams and wagons. It does not seem that at the present time this method of hauling is adopted to all lengths and kinds of haul, but I have some cost data on hauling by auto trucks which I will give you. On Route 1, of the State Aid Road in Kane County, Illinois, aggregate was supplied by the contractors by the Essen Sand Co., of Chicago, with a 5-cu. yd. auto truck. When they had a 2½-mile haul over an old macadam road, one truck carrying 5 cu. yds. made 13 trips in 10 hrs. This truck was loaded from bins.

On Section A, Route 1, of Dupage County, Illinois, a 5-cu. yd. auto truck made 9 trips in 10 hrs., each trip being 6 miles in length. The truck on this day's service consumed 27 gals. of gasoline. An exhibitor at the Sixth Good Road Show in Chicago during December, 1914, had on exhibition an auto truck for which he claimed that the power is automatically shifted to any of the four wheels so that if three of the wheels are in the mud and the fourth is out, the power will be transmitted to that wheel and the truck will pull through.

Methods and Cost of Concrete Road Construction by Day Labor Under the Supervision of the Illinois Highway Commission.

More than 60,000 sq. yds. of concrete roads have been constructed by day labor under the supervision of the Illinois Highway Commission. In a paper before the Illinois Society of Engineers and Surveyors, A. H. Hunter, a division engineer of the Commission, discussed the details of this work, and his paper is given here.

Before entering into a discussion of concrete roads built by day labor under the supervision of the Illinois Highway Department, I wish to call attention to the many large subjects which may be included under this heading. The subjects of excavation, drainage, aggregate, mixture and expansion, with perhaps others, are each sufficiently large to supply material for an article of considerable length. However, I will give only an outline of our method of handling this work and devote some space to the vital points of concrete road construction.

THE ILLINOIS HIGHWAY COMMISSION.

The State Highway Commission was created by an act of the Illinois General Assembly in February, 1905. One of the duties imposed by this act was that an investigation in road building should be made in which different methods of construction, kinds of material and system of drainage should be employed in order to determine, if possible, the character of road best suited to the various sections and soil conditions of the state. It was also required that a complete record of all cost should be kept and that standards for the construction of highways should be developed. Even under the law enacted two years ago, this condition remains much the same as in the original bill. To carry out such an undertaking as this, money was necessary and each session of the legislature has seen fit to make appropriations ranging from $25,000 per year in 1905 to $100,000 per year at the present time. However, in the construction of experimental roads, the cost has been borne largely by the local authorities, either directly through appropriations of the road authorities or by private subscriptions, or a combination of the two.

The construction of experimental concrete roads was first undertaken by the Illinois Highway Commission in the summer of 1912. from that time until the present, more than 60,000 sq. yds. of concrete surface has been laid under our plans and supervision, not to mention several pieces let by contract, for which plans and inspection were furnished, but which will not be considered in this article.

SURVEYS AND PLANS.

Upon receipt of application for an experimental road from the local authorities and the selection of the road, a survey is made by engineers from our office. A transit line is run, usually in the center of the old road, and all angles and turns noted, with stakes set every 100 ft. in the fence line. Cross sections are taken at each station, B.M.'s established and checked. (Care is taken to provide good drainage and inspection is made of all bridges and culverts included in the work.) The notes are platted on return to the office, grade line established, quantities computed and balanced, allowing about 25 per cent excess of cuts over fills to provide for waste and shrinkage. This percentage of excess is an average value for Illinois conditions, but in very heavy cuts it can very well be reduced to 15 per cent. In very light excavation an excess as high as 35 per cent has worked well. It must be kept in mind that construction stakes are required on concrete roads and no guessing at the grade permitted.

The question of grade for concrete roads in Illinois is not serious, due to the nature of the land. However, concrete surfaces have been placed on 7 per cent grades and are proving very satisfactory.

SUPERVISION AND EQUIPMENT.

On commencing construction a resident engineer from the office of the State Highway Department is given complete charge of the work. He is assisted by one or more foremen, a timekeeper and such other assistance as may be required. In many instances one of the local highway commissioners is employed as foreman, for it has been found that local men are better acquainted with the local conditions and their assistance in securing labor and materials has been valuable. The state supplies a 10-ton roller and a concrete mixer and incidental equipment. In some instances a scarifier, car dumps and wheel scrapers have been furnished. To operate concrete machinery to advantage, experienced men are required. To secure such help it has been the policy of our department to supply two machinery operators. These men are on the payroll of the state and the local people are at no expense for their services. In the early period of construction the operators are busy in assembling the machinery or rolling the subgrade, while later they are employed in operating the concrete mixer.

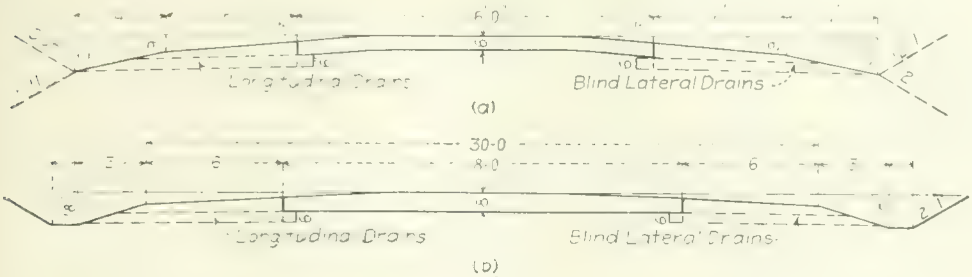


Fig. 1. Cross Sections Used on Experimental Concrete Roads in Illinois.

EXCAVATION.

The excavation is carried on well in advance of the placing of materials, so as to permit the proper rolling and surfacing of the subgrade. In a level country where there is light excavation, the center can be shaped with a grader, the sides and ditches being left until after the construction of the improved roadway. Heavy cuts may be handled by slips, wheelers or wagons, depending on the length of haul. The large fills must be deposited in thin layers and thoroughly rolled, so as to prevent settlement. Experience has proven that no amount of rolling can compact dry or slightly moist earth, so water should be applied to such places or the fill remain exposed to the weather for a long time previous to the placing of the concrete slab. The safest method for heavy fills is to place the earth one season and withhold the road surface until the following year. Very little rock excavation has been encountered, and on only one road constructed in 1914 did the excavation of rock reach 1,200 cu. yds.

SUBGRADE.

The advantages of concrete roads, their thickness, character f the mixture and their length of service are questions attracting the attention of many road engineers today. The success of a concrete road depends largely upon the closely related questions of subgrade and drainage. No concrete road of whatever mix and economic thickness of concrete can ever prove ultimately successful unless the subgrade has been properly constructed and provision made for disposal of the surface water.

It seems that each individual has his own idea as to what comprises subgrade. To secure uniformity in our cost data, subgrade was defined as that work required to shape the last 3 ins. of earth material necessary to produce the required elevation of the earth base. In all cost data hereinafter referred to the above meaning of subgrade shall be understood. In some experimental roads the subgrade was completed by hand in order to secure a uniform base, care being taken not to permit any excavation or furrows below the plane of the base. In concrete roads, it is highly desirable to have the earth sub-base uniform, as soft spots and hard lumps are equally harmful. When the hand work has been completed the earth should be rolled until firm. As a matter of economy the subgrade should conform to the cross section and grades so that additional concrete, which is expensive, may be avoided. As a detail of construction, it is equally important that thin places in the concrete be avoided for such places give conditions sure to develop cracks. Cracks are undesirable in a concrete road so every effort should be made to eliminate them or at least reduce their number to a minimum.

CROSS SECTION.

Figure 1 (a) is a standard cross section used in construction of the earlier concrete roads. The subgrade was crowned 3 ins. in roads 16 ft. wide, while in 9 or 10 ft. roads it was crowned 1 in. Drainage was provided by means of two sets of ditches, filled with coarse aggregate, namely: longitudinal and lateral drains. The former consists of a 6x8-in. trench under the outer edge of the concrete continuing for the entire length of the road. The latter extends from the longitudinal drain to the side ditch and is of the same manner of construction as the first. They are usually placed opposite the end of each expansion joint, and at such other places as the character of the soil seems to warrant. The purpose of such drains is to prevent the collecting of water underneath the slab. This water, if not removed, would make possible serious frost action resulting in longitudinal cracks. The efficiency of these drains has been much questioned, but they were employed in the season of 1914, in the manner shown in Fig. 2 (b). On examining Fig. 2 (b) note that the subgrade becomes flat. In explanation of this change I will say that it has been found that a longitudinal crack developed in many of the slabs of concrete road that had been made according to Fig. 1 (a), this crack almost always appearing well within the middle third. Since these cracks, very undesirable, were common, it seemed probable to us that they could be eliminated by strengthening this portion of the road. This was readily accomplished by a reduction of the crown of the earth sub-base and a corresponding increase in thickness of the concrete. In addition, these cracks were found to widen rapidly, much increasing the seriousness of their occurrence. We reasoned that the action of gravity would slowly separate one section from the other, and these sections of slab once cracked longitudinally, acted as separate units, contracting and expanding in proportion to the change in temperature, permitting the refuse and earth on the road surface to drop in the opening and eventually prevent its return to the original position. How much of this theory is practical we cannot say, as this section in Fig. 2 (b) was employed only in 1914, and longitudinal cracks have not as yet had time to develop.

Attention is called to a comparison of (a) and (b) in Fig. 1, in which you will find that the crown of the pavement has been changed from 3 to 2 ins. Assuming that a flat subgrade was desired, it would be necessary to make the thickness of the concrete at the center 9 ins. in order to maintain a thickness of 6 ins. at the edges. We did not feel that a thickness of 9 ins. was required at the center, but were convinced that 6 ins. was the minimum thickness for the concrete at the edge, so the dimensions given in Fig. 1 (b) were adopted.

SELECTION OF AGGREGATE.

Attention should be given to the selection of the aggregate. In our first experimental construction, it was specified that the coarse aggregate should be hard, durable material, passing a 1-in. screen, and should include all sizes down to sand grains. From this it would seem that a well graded pit-run gravel would be highly satisfactory. In practice, however, it was found that such material of ideal mixture could scarcely be obtained. In our later specifications, the material is separated into coarse and fine aggregate with the per cent of material passing several screens given. Table I gives the requirements of our specifications in regard to gradation of aggregates.

TABLE I—TABLES OF GRADATION OF AGGREGATE.

Course Aggregate.

Size of screen.	Allowable limits of percentage passing through.
1½ in. round mesh	100.
¾ in. round mesh	Not less than 40 nor more than 70.
¼ in. round mesh	Not to exceed 5.

Fine Aggregate.

Size of screen.	Allowable limits of percentage passing through.
1-4 in. sq. mesh	95 to 100.
1-16 in. sq. mesh	Not less than 30 nor more than 75.
1-50 in. sq. mesh	Not more than 15.
1-100 in. sq. mesh	Not more than 5.

MIXING.

Previous to the building of our first concrete road, several concrete roads had been constructed and we endeavored to profit by the experiments of those before us. It has been pretty well established that lean mixtures such as 1-2½-5, 1-3-5 or 1-3-6, are unsuited to concrete pavement work. The past and present practice of the Illinois Highway Commission has been a mixture of 1-2-3½. This proportion of material insures a slight excess of mortar. Failures of many concrete road surfaces are probably due to a lack of mortar in the concrete as much as to the lack of cement in the mortar.

Water is employed to construct the earth sub-base, the concrete slab, and to effect the proper curing of the concrete slab after it is laid. Probably a fair amount of water required to construct and cure a cubic yard of concrete when placed in a road, would amount to 75 gals.; although in the dry fall or summer considerably more is required.

The problem that confronted our resident engineers was to deliver this water in sufficient quantity to the desired place. When a road adjoined a city having a water system, good results were obtained by joining a pipe line to a hydrant and placing T's at frequent intervals in the line so that connection could be made to the mixer or to a sprinkling hose. In sections of isolated country road, a pressure pump operated by a gasoline engine was employed. On one road water was secured from a temporary reservoir formed by damming a stream, while in another it was secured from the Illinois River.

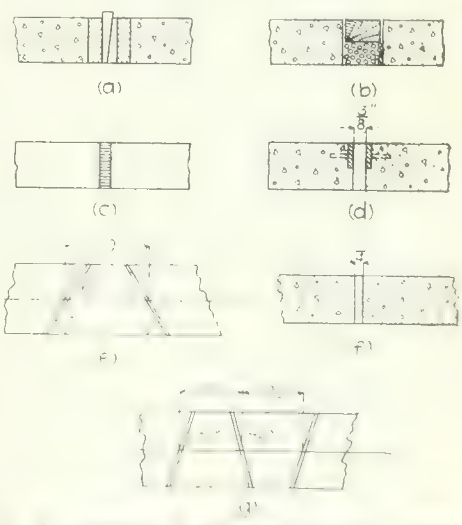


Fig. 2. Details of Expansion Joints Used on Concrete Roads in Illinois.

It has been our practice to mix in a batch mixer, having a capacity of 12 cu. ft., the material per batch being measured by volume and two sacks of cement were taken as the unit.

The materials are dumped into the mixer and water added in sufficient quantity to produce a plastic mass. The amount of water necessary to obtain the desired consistency can be secured only by experiment. Any variation in the quality of aggregate, the amount of moisture it contains, makes necessary a variation in the amount of water required. The mixed batch should have only sufficient

TABLE II.—UNIT COST OF SEVERAL CONCRETE ROADS BUILT BY DAY LABOR UNDER THE SUPERVISION OF THE ILLINOIS HIGHWAY COMMISSION.

	1912				1913				1914.	
	McLean.	DeKalb.	Springfield.	Carlinville.	Jacksonville.	La Salle.	Springfield.	Highland.	Aurora.	
Amt. pvt. laid, sq. yds...	5,000	7,334	5,594	7,111	2,148	10,663	8,566	6,680	2,942	Total sq. yds., 56,038.
Thickness of pvt., ins....	6	6½	7	6½	6	6½	6-7	6	7	Av. thickness, 6½ ins.
Width of pvt., ft.........	45	12	18	16	18	20	9-18	9	18	
Length of haul, miles....	⅕	½	⅛	*1½-†½	1½	¾	⅜	4	¼	Av. haul., .91 mile.
Cost of cem., per bbl.....	$1.02-$1.06	$0.55	$1.02½	$0.98	$1.285	$1.06	$1.02½	$1.40	$1.12	Av. cost cem., $1.05 bbl.
Cem. per sq. yd. pvt., bbl.	$0.29	$0.31	$0.29	$0.33	$0.28	$0.29	$0.30	$0.29	$0.36	30 bbls. cem. sq. yd. pvt.
Price labor, M. & T., cts.	20-40	22½-45	25-45	20-40	22¼-44½	35-62½	25.50	20.40	35-62½	
				Cost of Labor and Supplies.						
Superintendence	$ 140.00	$ 200.00	$ 202.00	$ 157.50	$ 87.00	$ 240.00	$ 405.00	$ 202.00	$ 225.00	
Exc., shaping road bed, trimming shoulders.....	307.41	1,042.37	443.82	700.43	231.94	1,682.60	2,490.07	1,427.50	354.80	
Loading and hauling sand and stone	267.34	596.02	603.50	795.05	229.94	1,798.98	1,482.46	1,480.00	325.70	
Mixing and placing conc.	414.63	746.65	644.25	700.58	231.37	1,415.40	1,245.07	656.35	442.00	
Covering and seasoning.	......	......	......	......	......	260.00	......	45.88	80.00	
Watchman and misc.....	155.14	374.48	383.75	131.46	112.46	978.50	567.28	234.45	50.00	
Cost of sand and stone, f. o. b.	1,017.63	1,671.00	1,622.01	741.00	573.17	3,352.45	2,582.05	2,182.32	1,154.40	
Cost of cement, f. o. b...	1,547.15	1,250.00	1,551.17	2,307.90	833.08	3,301.00	3,055.71	2,794.32	1,193.92	
Expansion joints.........	48.67	160.13	206.74	112.40	28.00	299.00	253.28	248.32	109.68	
Reinforcing steel.........	......	......	......	100.00	5.00	......	......	......	......	
Coal and oil for mixer...	30.75	32.00	119.19	25.00	21.10	224.49	98.47	99.54	15.00	
Forms and other lumber.	35.00	119.77	18.33	31.75	16.61	79.74	61.80	40.35	40.00	
Total	$3,964.02	$6,194.42	$5,794.76	$5,803.07	$2,369.67	$13,632.16	$12,241.46	$9,413.03	$3,990.50	Total cost.......$63,403.09
				Unit Cost Per Square Yard.						
Superintendence	$0.028	$0.027	$0.036	$0.022	$0.040	$0.023	$0.047	$0.030	$0.076	Av. cost sq. yd.....$0.036
Excavation, etc..........	.061	.142	.079	.099	.108	.158	.291	.214	.121	Av. cost sq. yd..... .142
Loading and hauling sand, stone and conc...	.053	.081	.108	.112	.107	.169	.173	.222	.111	Av. cost sq. yd..... .126
Mixing and placing conc..	.083	.102	.115	.099	.108	.133	.145	.098	.150	Av. cost sq. yd..... .115
Covering and seasoning..	....	....	....	....	....	.024	....	.007	.027	Av. cost sq. yd..... .004
Watchman, etc.	.032	.026	.068	.018	.052	.092	.066	.035	.017	Av. cost sq. yd..... .045
Cost of sand and stone, f. o. b.	.204	.228	.290	.105	.269	.314	.301	.326	.392	Av. cost sq. yd..... .270
Cost of cement, f. o. b...	.309	.170	.277	.325	.388	.310	.357	.418	.406	Av. cost sq. yd..... .329
Expansion joints.........	.010	.022	.037	.016	.013	.028	.030	.037	.037	Av. cost sq. yd..... .025
Reinforcing steel.........	....	....	....	.014	.002	....	....	....	....	Av. cost sq. yd..... .002
Coal and oil for mixer...	.006	.005	.022	.003	.009	.021	.012	.015	.005	Av. cost sq. yd..... .011
Forms and other lumber	.007	.016	.003	.005	.008	.008	.007	.006	.014	Av. cost sq. yd..... .008
Total	$0.793	$0.819	$1.035	$0.818	$1.104	$1.280	$1.429	$1.408	$1.356	Av. cost sq. yd.....$1.118

*Sand. †Stone.

water to give a plastic mass from which the cement and sand will not separate when placed in the road. Any mixture which shows a marked separation of coarse aggregate, is too wet. It was found that wet concrete possessed two disadvantages: (1) That the separated coarse aggregate collected in pockets and was frequently lacking in mortar to fill its voids; (2) as a consequence of pockets of coarse aggregate, other pockets of mortar existed. The disadvantage of this condition was that such spots, when exposed to heavy traffic wore rapidly, resulting in a wavy surface.

FINISHING.

The concrete placed between the forms was cut off to the desired crown by means of a steel-shod template, cut to the crown of the road. This template was pulled along the side forms with a combined pulling and sawing motion.

The surface of all roads was not finished smooth, but left slightly rough. A wood float was found to give good results and in a few instances the surface after being brought to grade was brushed lightly with a street broom. One or two finishing devices have been employed, but have not given satisfaction, so the finishing remains to be done by hand. On the concrete roads constructed in Wayne County, Michigan, some experiments were conducted with mechanical finishing devices in the summer of 1914, but these do not seem to have proven satisfactory. A novel method of concrete road finishing has recently been employed in the state of Oregon. A machine was designed to perform the two duties of striking off and compacting the newly-placed concrete. This machine is self-propelling and consists of a roller and a cutting edge set in a frame, supported at the ends by the side forms. It seems to have been successful in striking off and compacting the concrete, but the finishing seemingly remained imperfect for men with wood floats were still required to secure the desired surface. This method of rolling, while entirely new, may be of considerable importance and seems worthy of investigation in the future.

CURING.

Many inferior concrete pavements result from the improper curing of the concrete slab. Shrinkage cracks occur if the concrete has not been covered and kept thoroughly moist for a period of 10 days. The writer recalls one instance on a concrete road when many cracks appeared while the concrete was still so soft that your finger could be pushed into it. As prevention for such damage a canvas is placed on the newly constructed road as soon as the concrete has set sufficiently. This canvas is kept moist until the concrete is hard enough to permit of an earth covering. This earth covering is kept thoroughly wet for a period of 10 days.

SPACING OF JOINTS.

A concrete pavement presents many characteristics totally unlike any other form of pavement in general use. It is practically a monolithic surface, rigid and entirely lacking in any resilient qualities. Owing to the action of temperature, there is a tendency for the concrete to lengthen on a hot day and shorten on a cold day. It is evident that cracks appear on cold days, while at the other extreme of temperature the concrete will be stressed under compression. If the formation of haphazard contraction cracks are to be prevented it would seem necessary to provide joints close enough together that there will be sufficient strength in the concrete to drag one-half its length between joints. In the first expansion joints constructed, the length of slab between joints was taken as 50 ft. On the basis of the assumption that each slab must drag one-half its length between joints and assuming the coefficient of friction of concrete and sub-soil as one, the tensile strength developed would be approximately 25 lbs. per square inch. However, many contraction cracks have occurred even when the above precautions were taken.

TYPES OF JOINTS USED.

In Figure 2, (a) to (g) inclusive, are shown the character and general method employed to provide for expansion and contraction. Fig. 2 (a) is a section of joint showing two 2 by 6-in. boards on edge held apart by wedges while the concrete was being placed. When the concrete had set slightly the wedges were loosened and the two by sixes removed. The lower part of this slot was then filled with gravel, while the top was closed by placing creosoted wood blocks on edge as shown in the plan of Fig. 2 (c). The blocks were carefully placed, thoroughly tamped and left with their upper surface about ¼ in. above the concrete surface. This joint was employed on the first concrete road built and it is not proving up to expectations. The gravel or sand slowly settled permitting the wood blocks to sink below the concrete surface.

Figure 2 (d) shows a section of completed expansion joint, in which the concrete edges were protected by means of Baker plates. The ⅜-in. space shown is filled with a bituminous filler. To obtain this space, sections of steel plates were used which separated the pavement for its entire depth. The protection plates and the plates for making the expansion joint were held in place by a patented holder, shaped to the crown of the pavement and supported at the ends by the side forms. The concrete was then poured and struck off with the template. The concrete was permitted to take an initial set, the holder loosened and removed, and the steel plates removed, leaving the space to be filled with tar or asphalt later. This joint was employed in the latter part of 1912 and the season of 1913. It has not proven entirely satisfactory. In the first place, its cost is 12 cts. per foot of joint, exclusive of labor. In the second place, it was found difficult to place on a very wide roadway, resulting in slight lumps or depressions. To relieve the jolt thus occurring to a wagon it was decided to place the joint at an angle of 60° with the center line of the roadway, as is shown in Fig. 2 (e). By placing the joint at this angle, only one wheel was jolted at a time and the body of the carriage not so much disturbed. Again it was found desirable not to place successive joints parallel; that is, one joint should be swung 60° in one direction and the succeeding joint swung 60° in the opposite direction. It was found that vibrations caused by joints so placed were compensating rather than accumulating. This angle of joints was found undesirable as cracks frequently developed as shown at C, Fig. 2 (e). The most recent joint constructed is shown by Fig. 2, (f) and (g). Expansion is provided in the ¼ in. of tar felt.

COST DATA.

The cost data in Table II was compiled from a daily cost record kept by our resident engineer. No allowance has been made for depreciation, overhead charges or profit.

The concrete roads built by day labor have served a triple purpose: (1) To determine what modifications were necessary in the methods of concrete road construction to adapt it to conditions encountered in Illinois. In other words, they were experimental. (2) They have served the more important purpose of demonstrating in many places in this state the economic value of improved highways. (3) They have supplied data valuable for the preparation of estimates for contract work.

BRIDGES

Design Features of the Various Types of Reinforced Concrete Bridges Along the Columbia Highway in Oregon.

Contributed by K. P. Billner, Civil Engineer, Portland, Ore.

The Columbia Highway, which is being constructed along the course of the Columbia River as it stretches east and north from Portland, Ore., is intended to be a masterpiece of highway construction. The scenic features of the route, the expert location and rigid requirements, and the results obtained on that part of the road which is now completed give promise that the high hopes of those in charge of the work will be realized. Special care has been exercised in the design and construction of the bridges and viaducts along this highway, and the results accomplished are gratifying.

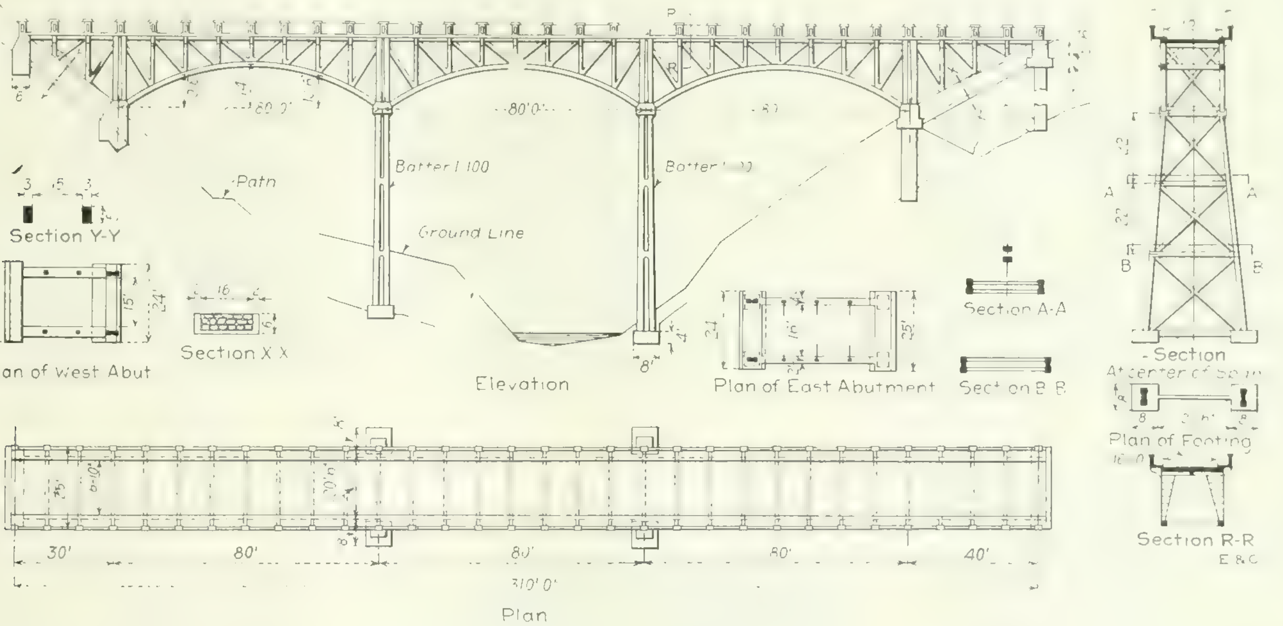


Fig. 1. Plan, Elevation and Cross Sections of Latourelle Bridge on Columbia Highway, Multnomah County, Oregon.

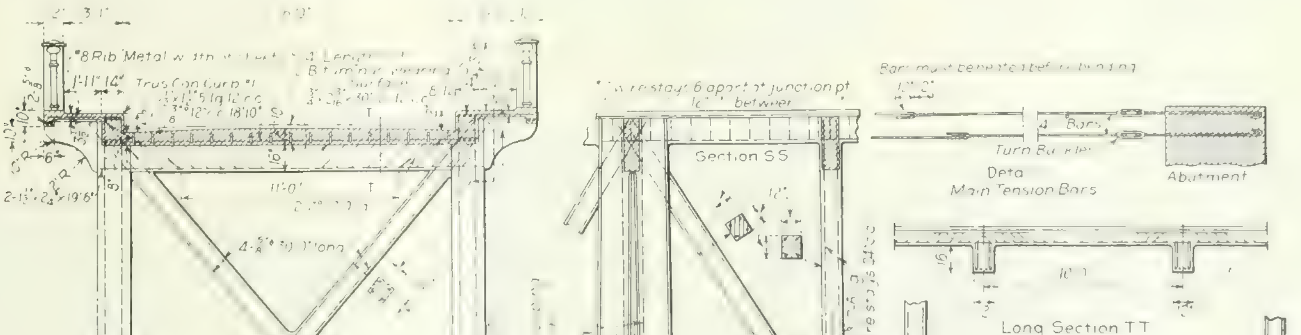


Fig. 2. Details of Arch, Floor System and Bracing of Latourelle Bridge.

The Columbia River flows in a gorge of greath depth, the cliffs along which are of basalt. The steepness of these cliffs, together with the numerous entering canyons cut by the bordering cataracts, gave the locators of this road many difficult problems, and at the same time large possibilities. The character of the country made necessary a large number of bridges. The bridge work described in this article is located in Multnomah County, in which there have already been constructed 9 concrete bridges and about 30 culverts, while the designs have been completed for 4 more bridges. The total length of the completed structures is approximately 2,500 ft. The purpose of this article is to describe those features of the bridge work which are considered of greatest interest.

The factors which have been foremost in the construction of the bridges are safety and low cost. At the same time there has been a constant aim toward the artistic and an effort to reach a state of harmony with the surroundings. The latter consideration made the adoption of a standard type impossible.

THE LATOURELLE BRIDGE.

Immediately below the graceful Latourelle Falls, there has been constructed a bridge of original design whose principal characteristic is an entire absence of the massive. This bridge is thought by its designer to be the lightest concrete structure of its dimensions in this country. It is 312 ft. long and 95 ft. high, to the grade of the roadbed, and contains only 560 cu. yds. of concrete above ground. The bridge has a 16-ft. 10-in. driveway and a total width, including two cantilevered sidewalks and railings, of 25 ft. The extra cost of the formwork for this structure was more than paid for by the saving of materials. The principles of design used are those developed by the late M. Considère.

This light structure was made desirable by the difficulty experienced in securing firm foundations. On one side of the canyon there was encountered silt and boulders to a depth of 25 ft., while on the other side drift sand had accumulated to a depth of nearly 50 ft. The cost of penetrating these materials for the abutments and piers of a heavy type of bridge evidently would have been very high.

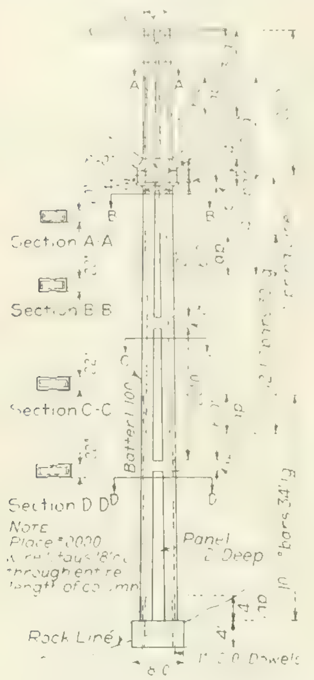


Fig. 3. Details of Columns Supporting Intermediate Spans of Latourelle Bridge.

The divided abutment at one end of the bridge was founded on bed-rock, as were the two central braced bents (see Fig. 1). The other abutment is carried on four columns, two of which are 4 ft. square, and the other two 5 ft. square. These columns extend to rock. The thrusts of the arches are transmitted to the rock foundations by inclined struts, which connect the tops of the 5-ft. columns with the bottoms of the 4-ft. ones, as shown in Fig. 1. This drawing gives the general dimensions of the bridge and illustrates the design features of various parts of it.

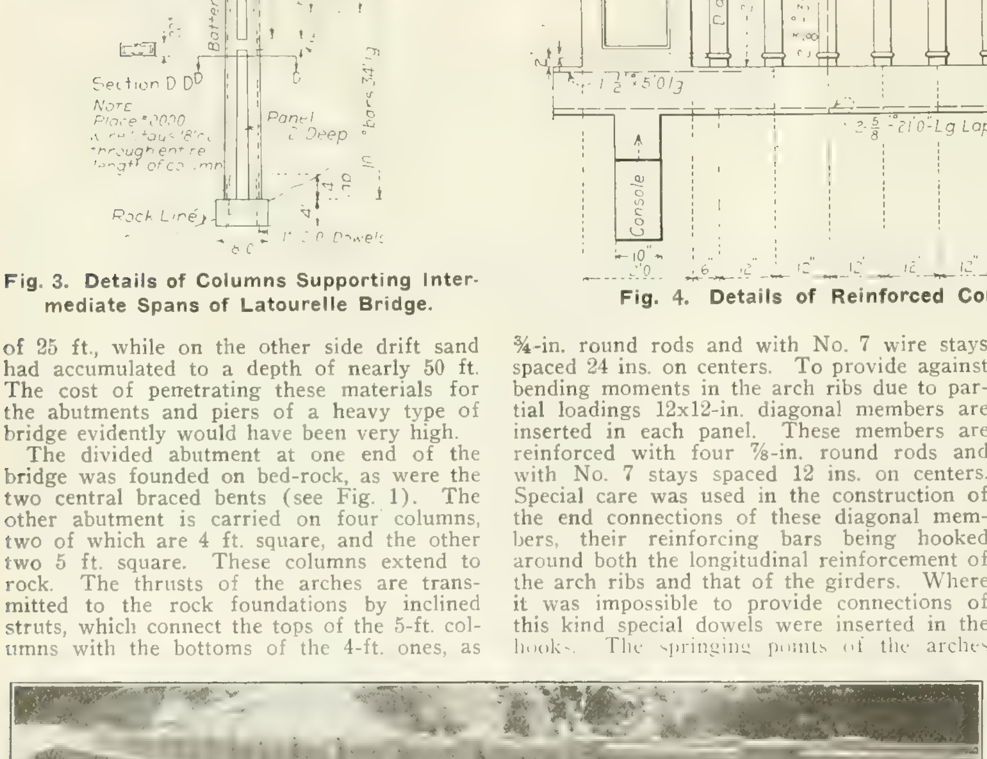


Fig. 5. Completed Latourelle Bridge, Showing Type of Construction.

In computing the stresses in the Latourelle Bridge and in the other structures, the following loads were used:

Uniform load, 100 lbs. per square foot.
Concentrated load, 15-ton traction engine.
Impact allowance, 25 per cent.

The allowable stresses were as follows:

Steel in tension, 16,000 lbs. per square inch.
Concrete in compression, 600 lbs. per square inch.
Concrete in hooped members, 750 lbs. per square inch.

The ends of the bridge consist of two girders, each of which carries sets of columns and struts on which the roadway is erected. As shown in Fig. 1 the main portion of the bridge consists of three 80-ft. parabolic arch spans, the roadway of each span being supported by two arch ribs. These arch ribs (see Fig. 2) are 20 ins. square and are reinforced with eight longitudinal 1-in. square bars and with No. 0000 hooping wound to 18 ins. in diameter and a 2-in. pitch. The vertical columns, which carry the weight of the deck and its superimposed load to the arch rings, have a section of 14x12 ins. and are reinforced with four ¾-in. round rods and with No. 7 wire stays spaced 24 ins. on centers. To provide against bending moments in the arch ribs due to partial loadings 12x12-in. diagonal members are inserted in each panel. These members are reinforced with four ⅞-in. round rods and with No. 7 stays spaced 12 ins. on centers. Special care was used in the construction of the end connections of these diagonal members, their reinforcing bars being hooked around both the longitudinal reinforcement of the arch ribs and that of the girders. Where it was impossible to provide connections of this kind special dowels were inserted in the hooks. The springing points of the arches are restrained by making the main columns serve as beams, by means of double reinforcement.

Figures 1, 2 and 3 show details of the intermediate bents which support the 80-ft. spans, together with the system of bracing used between the arches and the floor system.

Details of the floor system and railing are shown in Figs. 3 and 4. The clear width of the roadway is 16 ft. 10 ins. and that of each sidewalk 3 ft. 1 in. The railing extends 3 ft. 6 ins. above the surface of the sidewalk.

The bridge was erected on falsework, a tower at each end and a cableway being used to erect the falsework. Before the concreting of the superstructure was started all of the forms were built and braced. The main 90-ft. columns were poured in sections, several hours elapsing between pourings. The arch ribs were poured simultaneously, commencing at the spring lines and working toward the crowns. The 250 cu. yds. of concrete in the deck were poured in one continuous 20-hour operation, this work being done after the arches had set for twelve days. The arch centers were struck six weeks later.

Figure 5 shows a view of the completed structure, and indicates the character of the country traversed.

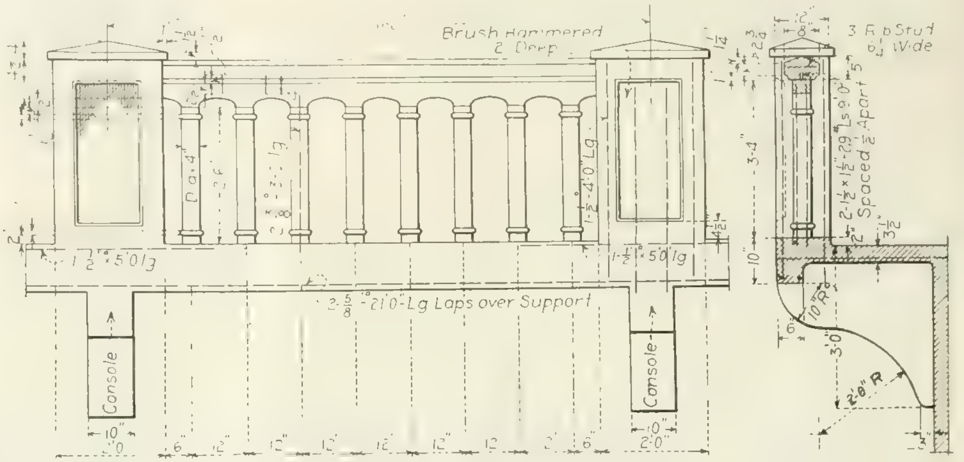


Fig. 4. Details of Reinforced Concrete Railing of Latourelle Bridge.

OTHER STRUCTURES IN MULTNOMAH COUNTY.

Bridges Near Multnomah Falls.—Two long concrete viaducts, which stand against the hillside like steps, solved the problems existing near Multnomah Falls. Here the Oregon-Washington Railway & Navigation Co.'s road occupied all of the available space along the river. The cost of excavating a 24-ft. roadway along this railroad, and of carrying the excavated material across the track to the river, was practically prohibitive. Figure 6 is a view of the 860-ft. viaduct located east of Multnomah Falls. The West Multnomah Viaduct is similar to that shown in Fig. 6. In the West Multnomah Viaduct, however, the railing extends along the masonry retaining wall.

The roadways of these viaducts are carried on two parallel lines of columns spaced 17 ft. 6 ins. on centers. The longitudinal spacing of these columns is 20 ft. As a protection against possible settlement of the upper columns, inclined struts, following the slope of the hill, are placed between the upper and lower columns, these struts being capable of carrying the weight of the structure. A railing, consisting of cement mortar on metal lath reinforcement, is placed along the railroad side only (see Fig. 6).

Figure 7 shows two bridges of the arch type at Multnomah Falls. This view also shows the falls, which is one of the scenic attractions along the highway.

Crown Point Viaduct.—At Crown Point there is an abrupt cliff rising to a height of about 700 ft. In rounding the turn above the river the road follows a curve of 110-ft. radius through an angle of 225°. A 7-ft. concrete sidewalk and railing crowns this cliff. Surmounting the 4-ft. solid railing there are electric lights, at 20-ft. intervals, which are visible from the transcontinental trains and from the river boats below. A high curb protects this walk from the traffic on the road. Figure 8 is a view of the concrete construction at Crown Point.

Shepherd's Dell Bridge.—An arch bridge carries the roadway over a 150-ft. chasm at Shepherd's Dell. The two parabolic arch ribs of this bridge have a span of 100 ft. The clear width of the roadway is 16 ft. 10 ins.

and that of each contilevered sidewalk 3 ft. 1 in. The spandrels are reinforced to act as girders and are capable of sustaining the bending moment over one-half of the span; they will therefore distribute the load to the arches. In determining the dimensions of the arches the reinforcement of the spandrels has not been taken into consideration. Figure 9 is a view of the bridge at Shepherd's Dell showing the type of construction used.

Bridge at Bridal Veil.—In bridging the creek at Bridal Veil it also was necessary to carry the roadway across three flumes. The lumber company owning these flumes required that a 6-ft. clearance be maintained over each of them. To meet these conditions a set of skew girders was found to be the most adaptable form of construction. To avoid interfering with the flumes some of the columns were set at an angle of 30° with the vertical, as shown in Fig. 10. The parapets of this bridge carry the loads to the columns, these parapets being computed as elastic beams resting on several supports. The total length of this bridge is 110 ft., the footings of which rest on solid rock.

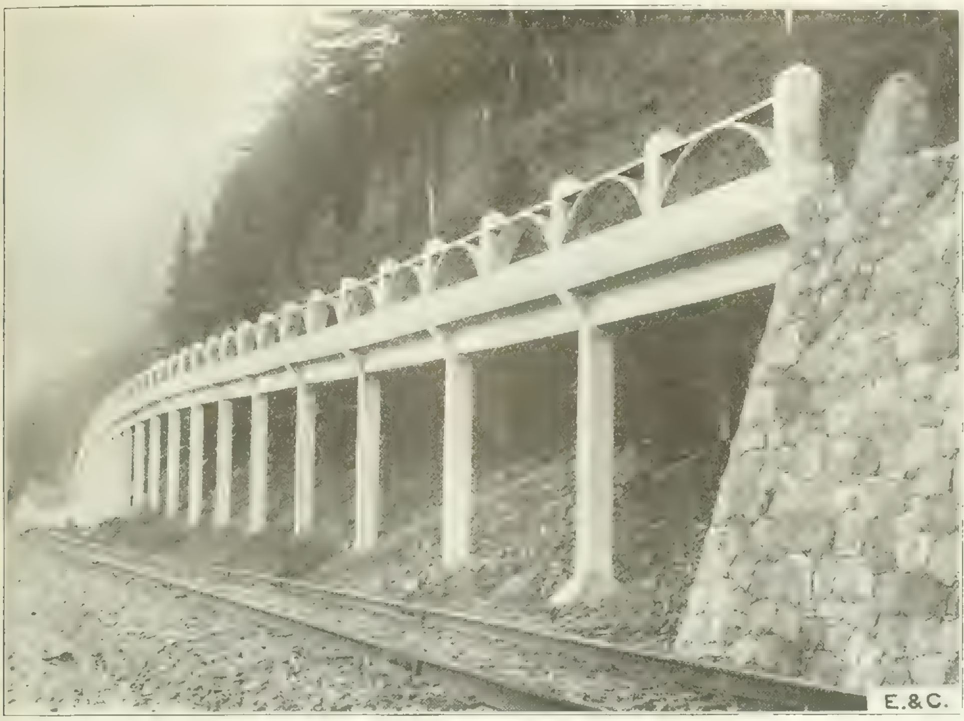


Fig. 6. Reinforced Concrete Viaduct East of Multnomah Falls—Note Type of Railing Used.

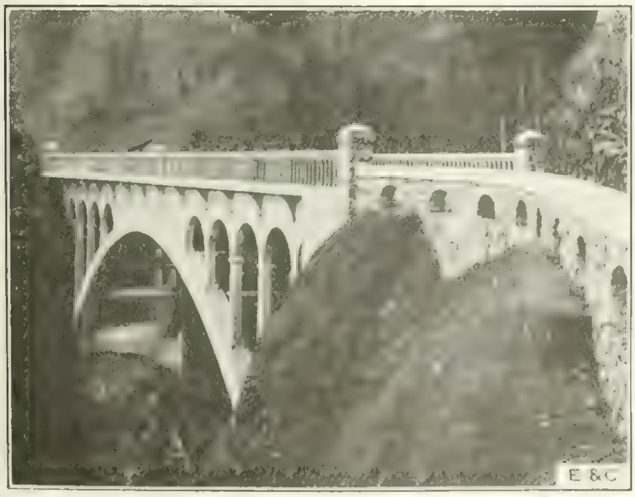


Fig. 9. Shepherd's Dell Bridge and Approach on Columbia Highway, Multnomah County, Oregon.

PERSONNEL.

The portion of the highway lying in Multnomah County was located, and its construction supervised, by Samuel C. Lancaster, consulting engineer and assistant state highway engineer, under the direction of H. L. Bowlby, state highway engineer. The bridge work covered in this article was designed, and its construction supervised, by the writer. The Latourelle Bridge was constructed by George Battersby, of Portland. The other structures were built by the Pacific Bridge Co., of Portland.

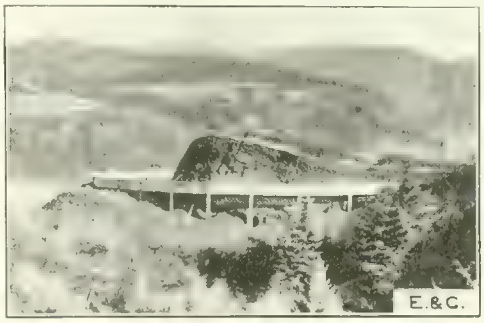


Fig. 8. Roadway Encircling Crown Point, Multnomah County, Oregon.

Estimating Curves for Standard Bridges of the Illinois Highway Department.

The necessity of preparing quickly estimates of the quantities of materials in various types of highway bridges is appreciated by engineers and contractors engaged in this kind of work. The preparation of standard bridge plans by the various highway departments has made it possible to construct curves which greatly facilitate the estimating work. The following data and diagrams were prepared mainly to assist the field engineer in making reliable estimates of bridges designed by the Illinois Highway Department. They were taken from a paper by G. F. Burch, assistant bridge engineer, Illinois Highway Department, presented before the recent meeting of the Illinois Society of Engineers and Surveyors.

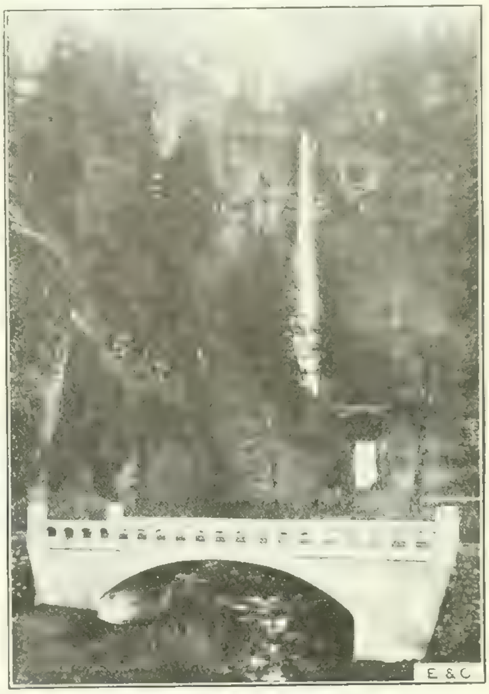


Fig. 7. Arch Bridges at Multnomah Falls, Multnomah County, Oregon.

In any organized system of bridge work it is found that the major part of the work lies between certain limits. The range of the work, and the determination of the limits within which the great bulk of the work is confined, are dependent upon the organization and the class of work handled.

In highway bridge work the length of spans required ranges from a lower limit of about 6 ft. to an upper limit of perhaps 150 to 160

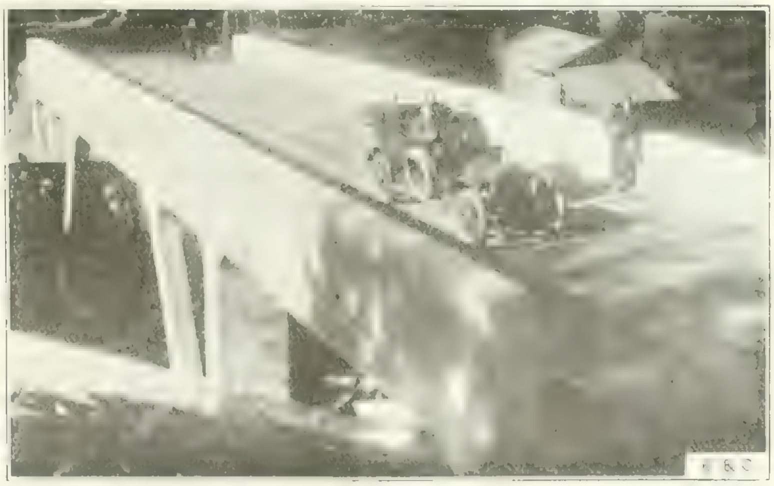


Fig. 10. Reinforced Concrete Bridge at Bridal Veil on Columbia Highway—Bridge Here Crosses Three Flumes.

ft. Abutments of several different types are required, ranging in height from 8 to 30 ft. There are, of course, many bridges having a total length of more than 160 ft., but most of them are made up of a number of spans which fall within the limits before mentioned.

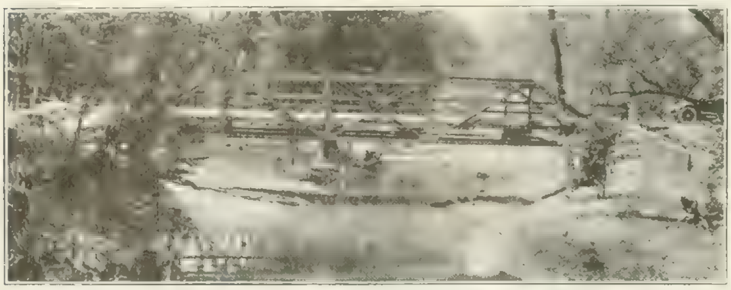


Fig. 1. Typical Riveted Pony Truss With Concrete Floor, Designed by Illinois Highway Department.

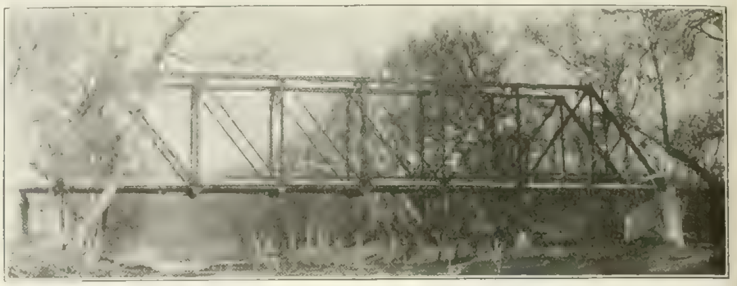


Fig. 2. Typical Riveted Through Pratt Truss Span With Concrete Floor, Designed by Illinois Highway Department.

A number of modern highway organizations have adopted so-called standard plans of bridges, and, so far as possible, have plans for all span lengths and heights of abutments ordinarily required within the range of work undertaken.

The adoption of standard plans greatly facilitates the process of preparing estimates. Having a standard basis upon which to work, the field man and the office man work more nearly in harmony with each other, and the personal equation, which always is to be reckoned with when many men are working on one project, is controlled to such an extent that uniform results are obtained.

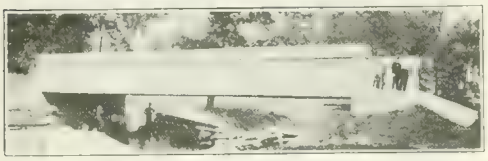


Fig. 4. Typical Reinforced Concrete Through Girder—Span, 60 Ft.; Roadway, 18 Ft.—Designed by Illinois Highway Department.

The preparation of estimates is of equal importance both to the field man and to the office man, but it is the field man who most needs convenient and reasonably accurate data upon which to base his estimates. He is often called upon to prepare an estimate on short notice, upon the accuracy of which a great deal may depend. On the other hand, the office man usually has more leisure in preparing his estimates, and he has the office files at hand upon which to check his judgment.

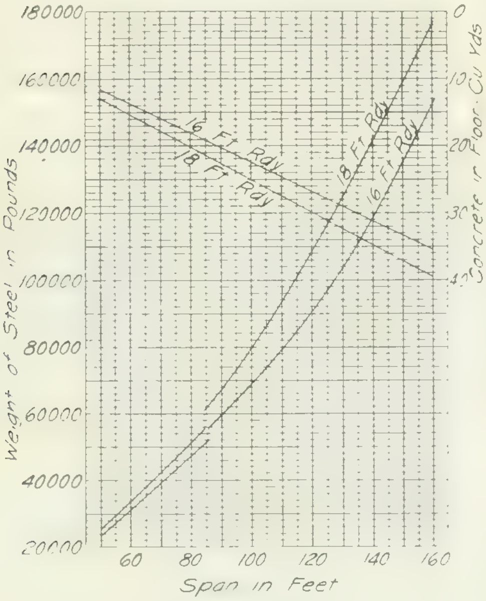


Fig. 3. Curves for Estimating Weight of Steel in Steel-Truss Superstructures and Quantity of Concrete in Floor Systems of Same.

The cost of labor and materials must be determined for each job, and it cannot be estimated by any set rule. But the quantities of materials required for any job can be estimated very closely by means of tables or curves, especially if the plans are standardized.

The curves given in this paper deal with quantities only, and are intended primarily for use in the field. The data on which these curves are based were compiled from the bridge plans prepared by the Illinois Highway Department during the past eight years. About 450 plotted points were used in preparing the curves, each point representing a standard plan, or a plan based on a standard type of construction. When these curves are used for plans based on the Illinois Highway Department standards the maximum error for superstructures is only about 3½ per cent, and for substructures about 5 per cent.

SUPERSTRUCTURES.

In all of the superstructure curves, the span length is plotted directly against the weight of steel and the quantity of concrete.

Steel Trusses.—The steel truss superstructures are of the ordinary Pratt-truss type with parallel chords. All connections are riveted, and the designs provide for a 4-in. concrete floor, with a wearing surface, or pavement, assumed to weigh not less than 50 lbs. per square foot. On account of the weight and rigidity of the concrete floor, no allowance is made for impact. Floor systems are designed to carry a 15-ton traction engine in addition to the dead load. Trusses are designed for a uniform live load of 100 lbs. per square foot of roadway surface for spans of from 50 to 150 ft., and for a uniform load of 85 lbs. per square foot for spans over 150 ft. Tension members are designed for a stress of 16,000 lbs. per square inch, and compression members for a stress of $16{,}000-70\frac{l}{r}$ but not to exceed 14,000 lbs. per square inch. Pony trusses are used for spans from 50 to 85 ft. and through trusses for spans from 90 to 160 ft.

Figure 1 illustrates a typical pony truss with a concrete floor on reinforced concrete abutments, and Fig. 2 illustrates a through Pratt truss having a span of 150. Figure 3 gives the curves for the weight of structural steel and the quantity of concrete in floors having 16-ft. and 18-ft. roadways. The break in the steel curves is at the point where the change is made from low trusses to high trusses.

Reinforced Concrete Through Girders.—Reinforced concrete through girders are used for spans from 30 to 60 ft. This type of structure is designed to carry either a uniform load of 125 lbs. per square foot or an engine load of 24 tons. The design provides for a wearing surface weighing 50 lbs. per square foot. Figure 4 illustrates a 60-ft., reinforced concrete through plate girder span having an 18-ft. roadway.

As free expansion and contraction are provided for by the cast-iron rockers placed under each girder at one end of the span, the allowable unit stresses used are quite high. Designs are computed for a tension of 16,000 lbs. per square inch in the reinforcing steel and a compression of approximately 1,000 lbs. per square inch in the concrete. A maximum shear of 120 lbs. per square inch is allowed. Stirrups are provided in all cases where the shear is in excess of 40 lbs. per square inch. The curves of Fig. 5 give the quantities of concrete and reinforcing steel for 16, 18 and 20-ft. roadways.

Reinforced Concrete Slabs.—For spans less than 30 ft. the slab type of construction has been found to be somewhat cheaper than the girder type. This is due to the fact that the arrangement of the steel is much simpler and that less steel is used per cubic yard of concrete. It has not been found practicable to make provision for free expansion of slabs. Accordingly, a stress in the steel of 12,000 lbs. per square inch is allowed for dead and live load stresses. The allowable concrete stress is 800 lbs. per square inch. Slabs are designed for the same live loads as girders. Figure 6 illustrates a typical reinforced slab bridge with tied-back walls. Figure 7 gives quantities of concrete and steel in slabs having clear roadways of 16, 18, 20 and 24 ft., for spans from 5 to 30 ft.

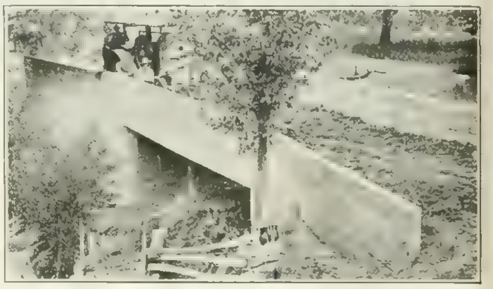


Fig. 6. Typical Reinforced Concrete Slab Bridge With Tied-Back Wings, Designed by Illinois Highway Department.

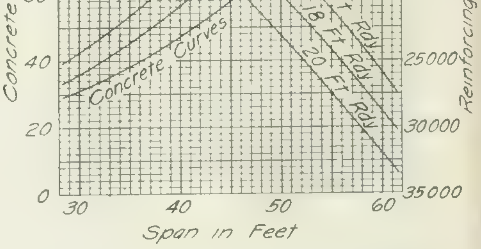


Fig. 5. Curves for Estimating Quantities of Concrete and Reinforcing Steel in Superstructures of Reinforced Concrete Through Girder Spans.

SUBSTRUCTURES.

In preparing curves to show the quantities in abutments it was found that there were many variables which might be considered but which, if used, would produce so complex a formula as to make the curves of little use in the field. It was found that curves giving reliable results might be obtained by plotting the number of cubic yards of concrete in two abutments against a formula which represents a measure of the quantities desired. The variables in this formula are: H, the height of abutments from bottom of foundations to top of roadway; R, the clear width of roadway on the superstructure; and W, the length of the average wing wall. For plain concrete abutments the best results were obtained by using the formula, $H^2 (R + 2W)$, and for reinforced abutments the formula, $H (R + 2W)$.

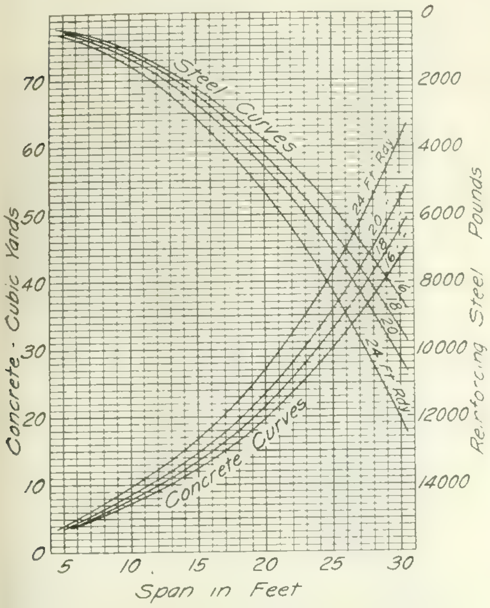


Fig. 7. Curves for Estimating Quantities of Concrete and Steel in Reinforced Concrete Slab Superstructures.

Plain Concrete Abutments.—Plain concrete abutments for steel bridges are designed with a footing width of one-third of the height over all. The thickness of the footing is 18 ins. The width of the base of the abutment and wing-walls at the top of the footing is made approximately one-quarter of the height of the walls. The back of the abutment wall is vertical and the face of the wall is battered to a top width of from 30 to 38 ins. The wing-walls are battered on both sides, and have a top width of 12 ins. Figure 8 is a diagram from which the yardage of plain concrete abutments for steel bridges may be obtained. When field measurements are made to determine the necessary height of abutments, and the width of roadway is decided upon, it is an easy matter to estimate the length of wing-walls which will be required. These values are used in the formula $H^2 (R + 2W)$, and the yardage of concrete is read directly from the diagram.

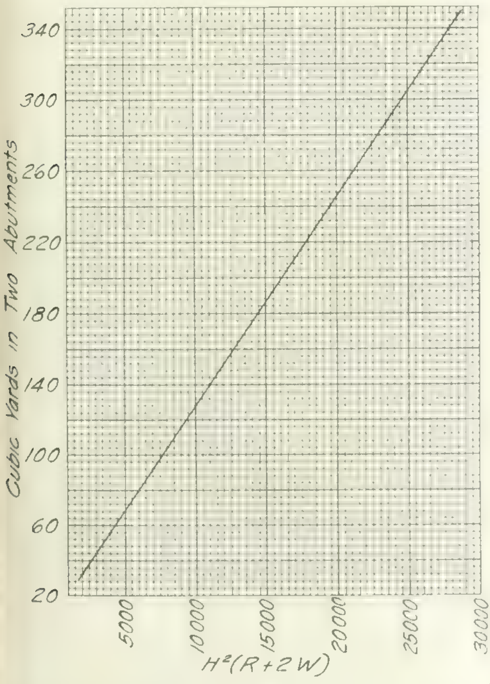


Fig. 8. Diagram for Estimating Quantity of Concrete in Two Plain Concrete Abutments for Steel Spans.

(In this diagram and in those given in Figs. 9 to 13, inclusive, H = height of abutments from bottom of foundations to top of roadway; R = clear width of roadway, and W = length of average wing-wall.)

The design of plain concrete abutments for girder bridges is similar to the design for steel bridges, except that the wing-walls are battered on the face only, and the top width of the abutment wall is 18 ins. Figure 9 is a diagram from which quantities for this type of abutment may be obtained.

Plain concrete abutments for slab bridges differ slightly from the design described. The width of footing on the abutment wall is limited only by the safe bearing capacity of the soil, with a minimum of 3 ft. This width may sometimes be less than one-third of the height over all. This is deemed to be safe on account of the restraining effect of the superstructure. The top width of the abutment is 12 ins. The curve for estimating yardage is shown in Fig. 10.

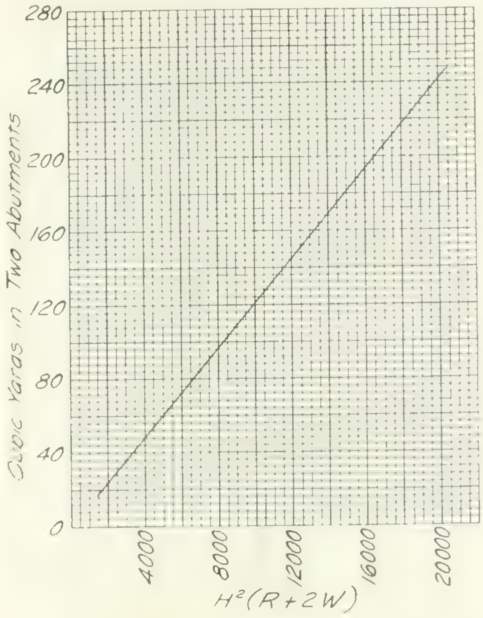


Fig. 9. Diagram for Estimating Quantity of Concrete in Two Plain Concrete Abutments for Concrete Girder Spans.

Reinforced Concrete Abutments.—In reinforced concrete abutments for steel bridges the abutments and wing-walls are designed as self-supporting walls of the cantilever type. An equivalent fluid pressure of 15 lbs. per cubic foot is assumed in designing, and, to correspond with the fluid pressure, the width of footings is made one-third of the height over all. The thickness of footings is made the same as the thickness of the walls at the top of the footings, with a minimum of 18 ins. Abutment and wing-walls are constructed with a vertical back. The bottom thickness varies from 15 to 24 ins., and the face of the wall is battered uniformly to a top width of 12 ins. on wing-walls and 10 ins. on abutments. The allowable stress in the reinforcing steel is 16,000 lbs. per square inch. On account of the difficulty of placing steel in substructure work the percentage of steel used is very low, varying from 0.3 to 0.5 per cent, with a correspondingly low concrete stress.

To provide sufficient bearing area for the shoes of the steel span the thickness of the wall at the juncture of the wing and abutment is increased to give a post effect. Between the posts, on which the shoes rest, and at the proper elevation, there is constructed a reinforced slab on which the end joists of the span are supported. As in all other reinforced abutments horizontal steel is provided in the walls to take temperature stresses, and to insure mutual support between wing-walls and the abutments. One-half inch square bars spaced 12 ins. on centers are provided for this purpose. Figure 11 is a diagram for obtaining the number of cubic yards of concrete in two abutments, the yardage being plotted against the formula, $H (R + 2W)$.

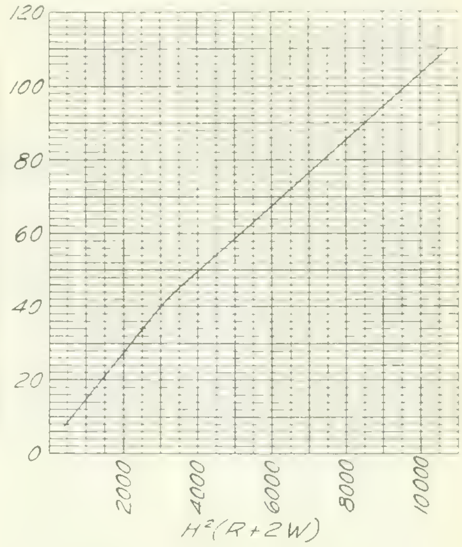


Fig. 10. Diagram for Estimating Quantity of Concrete in Two Plain Concrete Abutments for Slab Spans.

For girder bridges, two new types of reinforced abutments have been developed in the last few years. In both types the abutment wall is designed as a horizontal slab supported by the wings. The main reinforcement is placed horizontally near the stream side of the wall, and is securely anchored in the wings. The temperature steel in this case is placed vertically. The thickness of the wall varies with the height and width of the roadway, and

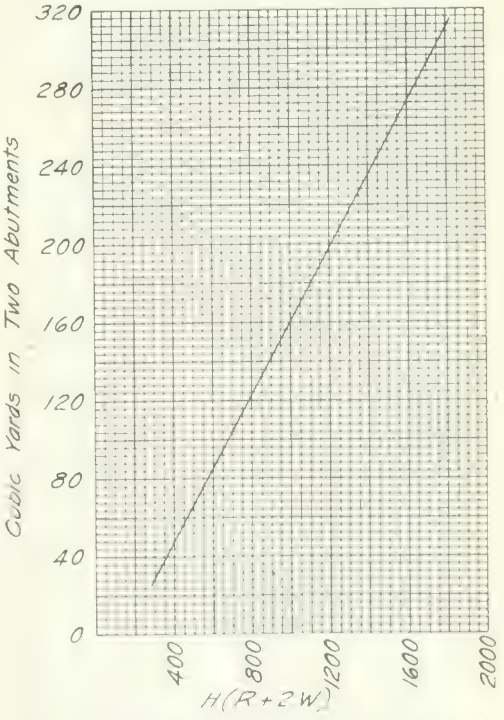


Fig. 11. Diagram for Estimating Quantity of Concrete in Two Reinforced Concrete Abutments for Steel Spans.

it ranges from 12 to 18 ins. The width of footing is proportional to the load supported. Pockets are built in one abutment wall to receive the rockers which allow free movement of the superstructure. In one type of construction the wing-walls are designed as self-supporting cantilevers to withstand a fluid pressure of 15 lbs. The main reinforcement is placed vertically near the back of the walls and also near the top of the footings.

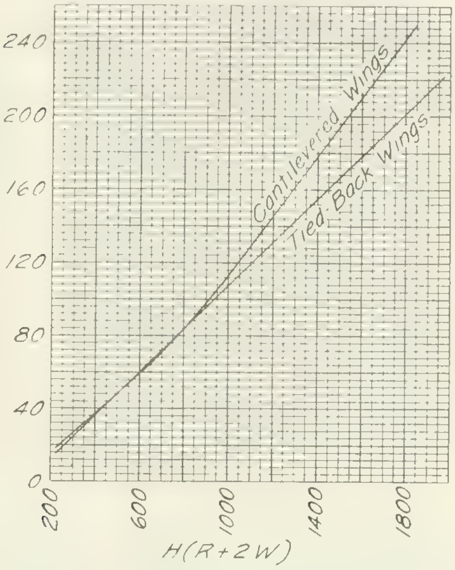


Fig. 12. Curves for Estimating Quantities of Concrete in Two Reinforced Concrete Abutments for Girder Spans With Cantilevered Wing-Walls and With Tied-Back Wing-Walls.

In the other type of reinforced abutments for girder bridges the wing-walls, which make only a slight angle with the axis of the road, are designed as vertical slabs. The bottom of the wall is restrained by the earth, and the top by struts, which connect one wing-wall to the other across the roadway. The principal reinforcement is vertical, and is placed near the side of the wall opposite to the fill. Stress is transmitted from the vertical slab to the struts through a horizontal T-beam in the wing-wall, at the elevation of the struts. The steel in the struts is hooked around the T-beam steel. The thickness of the wing-walls ranges from 12 to 24 ins., according to the height. Figure 12 shows curves for estimating the yardage in these two types of abutments.

In comparing the amount of concrete required in these two types of abutments it must be remembered that, for any particular case ,the length of wing-walls required for the tied-back type is greater than is required for the cantilever type; due to the fact that the earth slope is all on the outside of the wing.

For slab bridges there are also two distinct types of reinforced abutments. The wing-walls are of the same construction as those described for girder bridges. As no provision is made for movement between the superstructure and the substructure of slab bridges, due to temperature changes, the restraining effect of the superstructure load is taken into account in the design of the abutment wall. The wall is designed as a vertical slab with the main reinforcement placed near the stream face of the wall. The thickness of wall ranges from 12 to 24 ins. The footing is designed to distribute the load over the foundation without exceeding the safe bearing capacity of the soil. Figure 13 shows curves for obtaining the number of cubic yards of concrete in each of the two types of abutments.

Example.—To illustrate the use of the estimating curves, suppose that upon measuring up the site for a new bridge it is found that a clear span of 50 ft. will provide adequate waterway. Also assume that the height from the finished roadway to the bed of the stream is 8 ft. and that by carrying the footings 4 ft. below the bed of the stream good foundation material is encountered. This makes the height over all, from finished roadway to bottom of footings, 12 ft. Also assume that the traffic on the road demands a 20-ft. roadway, and that good gravel can be obtained at a reasonable cost one-half mile from the site. By referring to Figure 5 we find that a reinforced concrete through girder superstructure having a 50-ft. span and a 20-ft. roadway contains about 96 cu. yds. of concrete and 23,000 lbs. of steel.

As the abutments are comparatively low, and the cost of gravel very reasonable, it is probably safe to assume that plain concrete abutments will be cheaper than reinforced abutments. By referring to Figure 9 it will be noted that in order to use the curve we must first determine the value given by the formula, $H^2(R+2W)$. In this case, H, the height over all, is known to be 12 ft., and R, the width of roadway, is 20 ft. We will assume that the wings should make an angle of 45° with the face of the abutment; also that the toe of the earth slope around the wing must stop at the elevation of the stream bed, and must be in line with the face of the abutment. As the height, from the finished roadway to the bed of the stream, is 8 ft., a wing-wall 8 ft. long will be sufficient to protect the roadway with an earth slope of 1½ to 1. Substituting these values for H, R, and W we find that $H^2(R+2W)$ equals 5,184. Using the diagram of Fig. 9 we find that there are about 62 cu. yds. of concrete in the abutments.

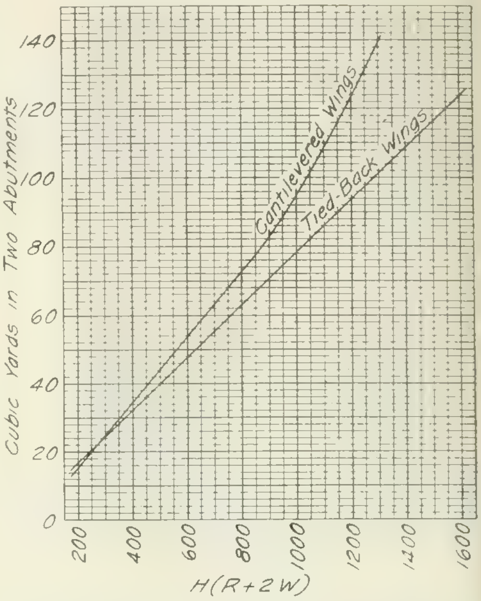


Fig. 13. Curves for Estimating Quantities of Concrete in Two Reinforced Concrete Abutments for Slab Spans With Cantilevered Wing-Walls and With Tied-Back Wing-Walls.

The total quantity of concrete in the bridge is therefore 158 cu. yds., and the total weight of the steel is 23,000 lbs. Upon ascertaining the local prices for labor and materials an estimate can be made of the cost of the job which will compare very favorably with an estimate made after the complete plans are prepared.

SEWERAGE AND SANITATION

Proposed Method of Enclosing a Stream in Reinforced Concrete Conduit Through Mansfield, Ohio.

Mansfield, Ohio, is among the highest places in the state; despite this natural advantage, however, the city's drainage problems are not solved by natural conditions. During all the years of the city's development nature has been imposed upon to such an extent that flood conditions have now become a source of alarm. Losses from flood waters have been suffered by hundreds of property owners, including many manufacturers.

As a result of these losses, in January, 1913, a petition, headed by a manufacturer's organization, was presented to the County Commissioners for a comprehensive flood relief and drainage improvement. Supplemental petitions and requests were added until, to carry out the entire plan, the total cost would exceed an expenditure of over $375,000. In view of the many complications encountered in the varying interpretation of the present county ditch laws of Ohio, the difficulties of apportioning the sum of $375,000 among the benefited properties according to actual benefits received can be appreciated. This phase of the subject is here discussed after considering the physical features of the project. Our information is taken from a paper by Mr. Charles L. Bushey, County Surveyor of Richland County, Mansfield, Ohio, before the recent annual meeting of the Ohio Engineering Society.

The city of Mansfield has a natural drainage into the Rocky Fork and two of its tributaries. The county commissioners were asked to improve these by straightening, deepening and widening or enclosing watercourses where necessary. One of the tributaries, known as Ritter's Run, has been partially enclosed for a number of years, and the straightening and enclosing of the lower part of this channel forms a part of this petition.

The other branch through the north part of the city, called Touby's Run, is the one which furnished a number of difficulties, and is the main one to which reference is here made. About 4,200 acres of land west of the city are drained by this run and the slope of the whole water-shed is so great that the water is rushed rapidly into the city.

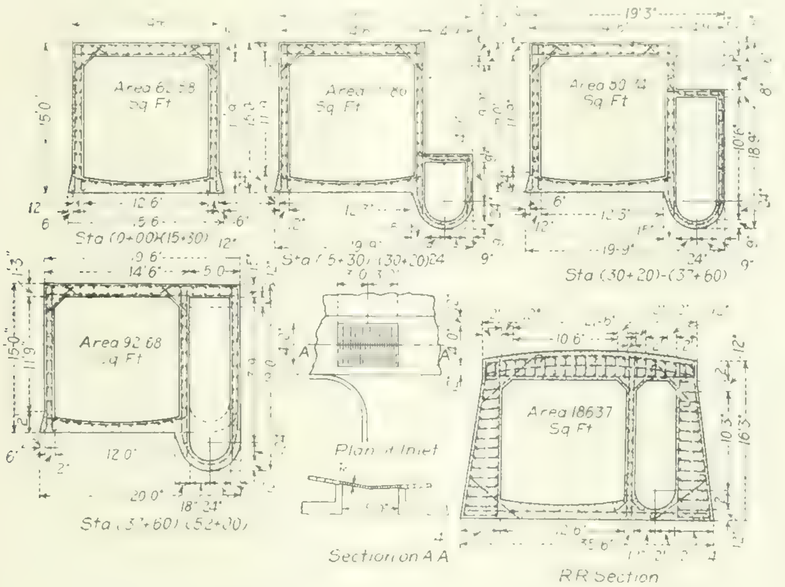
That part of the water-shed within the city limits contains 1,200 acres, nearly all of which is closely built up and with streets well paved. The slope of the area is steep, some of the streets having grades as high as 10 per cent. The part of the stream that runs through the city is not so steep as the part immediately upstream and is quite irregular as to line and section. Five railway bridges, only one of which is square with the stream, retard the velocity greatly. There are eight street crossings, four of which are double arches of a waterway area of about 160 sq. ft. The stream must make a right angle turn to enter two of these arches and in the time of excessive high water the arch on the inner side of the turn invariably fills one-third full of gravel and stone.

The stream has been greatly encroached upon by foundations and walls until the capacity is greatly diminished. Running as it does through the lower residence and factory section of the city, the channel becomes virtually an open sewer and is often made a dumping place, hence the unsightly and unsanitary condition which exists.

The overflowing of Touby's Run is a thing of regular occurrence and the overflow must find its way across the city by way of the lower streets and lots. A railway embankment, without adequate waterways, runs near the Rocky Fork and parallel to it. This holds back the overflow from Touby's Run and in time of excessive floods the flood grade on the upper side of the railroad embankment is sometimes 2 ft. higher than that of the Rocky Fork, less than 300 ft. away.

A survey was ordered on Sept. 10, 1913. To avoid needless expenditure in construction a number of projects were investigated. The construction of flood reservoirs above the city was found to be impractical, mainly because of the steep grades of the streams which form Touby's Run. The popular sentiment was for cleaning out, widening and straightening the section through the city. This was carefully investigated in making the preliminary surveys. The single item of replacing the old double brick arches with single span bridges was the first obstacle encountered. The cost of a right of way for a straighter open channel would have been such as to prohibit so great an expenditure without getting complete relief.

In the absence of any inexpensive method of improvement that would be of permanent value, the theory of enclosing the stream on an entirely new line was investigated. The line determined upon for the conduit is one mile long and, except for the curve at the outlet, the greatest deflection is less than 18°.



Conduit Enclosing Touby's Run Through Mansfield, Ohio.

The distance the water must travel in the old course from the inlet of the proposed conduit to its outlet is 4,700 ft. farther than the distance along the new line. A part of this gain is by reason of the new outlet into the Rocky Fork being 2,000 ft. farther down stream than the present outlet. This shortened distance will enable the engineers to get an average fall of over 0.6 per cent for the conduit.

Everything possible has been done to accelerate the velocity. Touby's Run for a distance of one-half mile above the intake is quite straight and has a fall of 32 ft. Part of this section is already lined with concrete. Natural conditions aided in making the intake. A high bank on one side and a railroad embankment on the other make it possible to secure a head of over 8 ft. if ever necessary.

The inside dimensions of the conduit are 12½ ft. x 12½ ft. and in order to accelerate the velocity and more accurately determine the same, no inlets are provided throughout the entire length to disturb the current. An additional reason for not making openings into the main conduit is that the middle section where the main inlets would be needed has a flatter grade than the upper part and in case of a pressure from within the inlets would not serve their purpose and the water would be forced out over the surface. It is anticipated that the velocity will exceed 20 ft. per second.

A high velocity was also necessary in order to reduce the size of the box on account of the limited width of the right of way. The right of way has been so located that the damages have all, with one exception, been settled for a sum not exceeding $1,500. This low cost is much better than had been anticipated at the outset.

The surface and storm water along the line is provided for by means of a side box or compartment which increases in size according to the needs as shown in the accompanying figure. The size at the outlet is 4 ft. wide by 12½ ft. high, which is the height of the main box. Only two inlets are required for the territory to the north and these can be carried beneath the big conduit where the side box is lowered. By using a flatter grade, the two boxes gradually assume the same elevation.

The City Council asked to have two sublaterals included in the general improvement. These would serve mainly to collect the water from the streets and carry it to the improved channels. This has added $40,000 to the cost, but may be omitted in the final order on account of legal complications.

The boxes are of reinforced concrete, the side walls being 1 ft. thick and the top 15 ins.

One unfortunate condition is the large angle at which the main stream is met. The outlet is on a curve of 80 ft. radius and in order to prevent the erosion of the banks the main stream will be lined with concrete for a distance of about 700 ft.

A question has been raised concerning the possibility of a gravel deposit forming on the inner side of the curve at the outlet and in front of the opening of the smaller box. As the gravel will only be brought down in time of heavy rains it is considered that the velocity will be such in both boxes as to carry the deposits into the main channel, where it can be accessible for removal if necessary.

A criticism has been raised regarding the high velocity that will be attained, in that the gravel, of which there will be considerable, will be carried along at such a rate as to wear the concrete. While we do not anticipate any danger from this source, yet if ever necessary the floor could be lined with vitrified brick at any time at no great cost.

The total cost of the conduit, including the intake and the concrete lining in the main stream below the outlet, is estimated at $248,004. While the planning of an improvement involving so much expense was accompanied by considerable anxiety and hard study, this dwindled into insignificance when the work of apportioning the cost was undertaken. The city officials agreed to assume over 60 per cent of the total cost of the whole improvement. The benefit to the county is comparatively small and a sum of over $150,000 had to be apportioned among railroads, factories, farms, business blocks and city properties. A total of 940 properties are included in the benefited area and each was to receive its apportionment according to actual benefit. The great difficulty was in dealing with properties in so many different classes. The comparison of benefit to a damaged farm with that of a flooded factory, a lumber yard, a city lot, a railroad, a street railroad, are exceedingly difficult of determination.

The division among the city property was done by arranging the lots within the affected district into numerical order showing the ownership and the taxable valuation.

A number of deputies went over the territory with these lists and by inquiry into each individual property, were able to compile information as to just how it was affected.

This list was then taken out over the territory with a map and comparisons were made according to the best judgment of the engineers. Valuations were taken into consideration largely, but could not be the absolute basis. Loss of property by the last great flood could be considered, but could not be a basis in all cases. A single comparison will show some of the difficulties. At the time of the big flood a large three-story building, valued at $36,800 and used for the manufacture of cigars, had its cellar flooded for the first time and the owners sustained a loss of over $10,000 in damaged goods. Another large business block of three stories valued at $22,500, had the cellar equally flooded with a damage to goods of only several hundred dollars, but gets back-water through sewer every flood. The former accepted an apportionment of $2,410 and the latter strenuously objected to $600.

Nearly all objections to damage and compensation claims have been adjusted except with two of the three railroad companies, and these are in a fair way to a compromise. Unless some unforseen complication arises the improvement will be ordered within the present year. The plan proposed has been submitted to the Sherman Engineering Co. of Toledo and has been approved, and credit is given that company for valuable suggestions relative to the design.

Design and Construction of the Market Street Flood Channel, Burlington, Ia.

Contributed by Carl T. Bowen, Assistant City Engineer, Burlington, Ia.

A flood channel is now being constructed in Market street in Burlington, Iowa. Its purpose is to relieve the present 5-ft. brick sewer and act as an overflow to the sewer to which it is connected at its upper end by a 3-ft. pipe.

The new structure is 2,200 ft. long and has an internal cross-section of 67 sq. ft. It begins at the Mississippi river in Market street and follows that street to a point 1,200 ft. west, where it turns northwesterly with the Chicago, Burlington & Quincy Railway right of way. Due to existing conditions at one point a 6° curve was found most practical. The right of way at the curve is so limited that the piling is within 3 ft. of wall foundations on one side, and on the other side a main line track had to be moved.

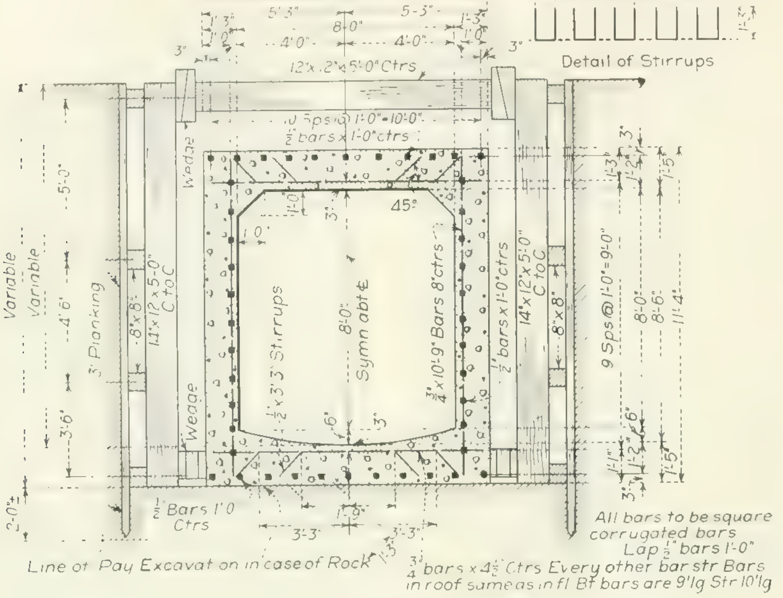
Market street follows the course of an old ravine over which the C., B. & Q. Ry. tracks were formerly carried on wooden trestles. The ravine was filled about 40 years ago with almost every available material from excavations, including sand, clay and loam. This variety of soils accompanied by an occasional buried trestle piling and the brick sewer makes pile driving and excavation uncertain.

The excavation is done by two Browning steam cranes equipped with Owen buckets. Two similar cranes equipped with 1,500-lb. steam hammers are used to drive the piling. The plans call for 3-in. plank shoring or its equivalent, with wailing spaced at 3 ft. and 6 ins. When 7-in. Lackawanna steel sheet piling is used it was found necessary to space the wailing at 2 ft. The piling is driven just to sub-grade and in one place the weight of the cranes and material cars caused the ground outside the shoring to sink, and rise in the excavation pit.

The drainage area of the flood-way includes

400 acres with a population of 5,000 people. The overflow from the connecting sewer has a maximum discharge of 84 cu. ft. per second, hence the maximum probable load is approximately 500 cu. ft. per second, which is but little over half the maximum capacity of the flood channel.

The discharge of the present sewer is at its minimum at this time of the year. There is a 12-in. clay pipe laid with invert at sub-grade to carry away the discharge of the old sewer and when that is not sufficient a 3-in. rotary pump discharges into the finished sewer.



Cross Section of Market Street Flood Channel, Burlington, Ia., Showing Method of Shoring During Construction.

The concrete mixture is of uniform consistency throughout and contains one part cement, two parts sand and four parts gravel. The sand is pumped from the Mississippi river and is thoroughly washed. The gravel must be such that 50 per cent will pass a ½-in. screen and be retained on a ¼-in. screen, and 50 per cent must pass a 1-in. screen and be caught on a ½-in. screen. Square corrugated bars are used for reinforcing, as shown in the cross-section herewith shown. The sewer was designed for 2 cu. yds. of concrete per linear foot and there are 200 lbs. of reinforcing per linear foot.

The labor force is divided into two crews as follows:

1 superintendent for the entire job.
Concrete Gang—
  1 foreman.
  1 team and driver.
  1 fireman.
  2 men on mixer.
  4 men supplying sand.
  7 men supplying gravel.
  4 men spreading concrete.
Excavation Gang—
  1 crane foreman.
  4 engineers.
  4 firemen.
  6 helpers.
One timekeeper.
One waterboy.

This force has averaged 8 ft. of completed channel per day. The difficulties encountered in carrying on the work arise largely from the limited width of right of way, the temperature at which concreting is done, the disposal of the discharge of the present sewer, the obstruction to the use of steel forms by steam and water mains, and the necessity of tunneling under street railway tracks.

PERSONNEL.

The channel here described was designed by Mr. H. G. Vollmer, City Engineer. The writer acted as inspector on construction.

The United States army engineers have used the following mixture in waterproofing cement: One part cement, 2 parts sand, ¾ lb. of dry powder alum to each cubic foot of sand. Mix dry, and add water in which ¾ lb. of soap has been dissolved to each gallon.

Cost of Depositing Concrete in Bags Under Water.

Contributed by H. R. Ferriss, Victoria, B. C.

A 20-in. cast iron outfall, Fig. 1, was laid from a point on shore to a distance of 720 ft. out from shore, at which point the end was in 18 ft. depth and a swift off shore current. The outfall follows a channel between high rock reefs, and the pipe for its entire distance—with the exception of 120 ft. of the outfall end—is laid in a ditch dredged in clean sand. At the outfall end, the floor of the sea falls away somewhat faster than the grade of the pipe, and advantage is taken of this to hold the end of the pipe line off the floor of the sea. It was considered advisable by the engineer in charge to rest the pipe on concrete deposited in bags, and the outermost end, owing to the swift current and heavy winter storms, is heavily anchored with concrete in bags.

A 1:3:6 mixture was used. A scow was anchored near the outfall end, and aboard it the concrete was mixed and sacked dry. The sacks of concrete were then lowered in a sling, and placed one at a time, by the diver, who afterwards ripped them open with a knife as placed. The concrete showed no sign of setting up for two days. After the seventh day it was fairly well bonded. It is now, after one year, a fairly good mass of concrete, which shows no damage, either from the swift current or from storms, from whose action, except the fiercest, however, it is probably protected by its depth.

It will be noted that the costs of labor only are given, and they depend considerably on locality and weather, which in this instance was exceptionally fine. The costs of materials are easily ascertained for any locality. The costs for the use of scows, engines, etc., will depend entirely on locality and weather conditions. The amount of concrete deposited was 80 cu. yds. and it cost as follows:

	Total.	Per cu. yd.
Sacking and Mixing Concrete:		
Foreman, 19 hrs. at 35 cts.	$ 6.65	$0.082
Labor, 400 hrs. at 30 cts.	120.00	1.500
Placing:		
Diver, 120 hrs. at $1.00	120.00	1.500
Tender, 120 hrs. at $0.50	60.00	0.750
Compressor eng., 60 hrs. at $0.40	24.00	0.300
Labor, 250 hrs. at $0.30	75.00	0.938
Total	$405.65	$5.070

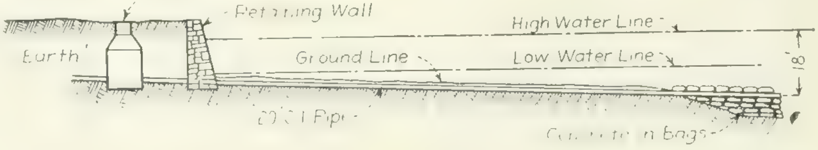


Fig. 1. Anchorage of Concrete in Bags for Submerged Outfall.

Design and Construction Features of Reinforced Concrete Sewer Siphons Under New York Subways.

The building of subways in city streets necessitates material changes in the location of existing sewers along the line of the subway. Generally the sewers can be passed either above or below the subway structure by altering the general gradient of the sewer, or by rebuilding the sewer at a considerably lower level than before, either of which is a simple operation. It sometimes happens that the existing sewer has its invert elevation at or below high tide level and the subway structure lies in the same horizontal plane. Then, it being impracticable to raise the sewer, it is necessary to lower it, thus making a radical break in the original gradient and resulting in an inverted siphon.

To avoid these inverted siphons it would be necessary to make the subway the dividing line between drainage areas, or else to lower the subway sufficiently to allow the sewer to pass over its roof. To effect the former, it would be necessary to replace the existing sewers over a large area at a cost which has generally been considered prohibitory. To lower the subway sufficiently to allow the sewer to pass over it would add greatly to the cost of construction, besides in some instances, inconvenience to the public in requiring the station platforms to be built at an unusual depth below the street surface, or changing the location of the station. Thus several inverted siphons have been built in the New York sewers in connection with subway construction. The design and construction features of the chief ones of these are here described from information taken from a paper by Thad. L. Wilson before the Brooklyn Engineers' Club. Some notes on operation also are given.

Conditions admittedly requiring a siphon were first encountered in 1902 during the construction of the old subway in the Bronx, at 149th St. and Railroad Ave. The old sewer in Railroad Ave., 5 ft. in diameter, has its invert elevation about 2 ft. below mean high tide. To pass this sewer under the subway it was necessary to lower it about 10 ft.

Mr. E. W. Clarke was in charge of the sewer work on this section of the subway at the time, under the Rapid Transit Commission, and designed and supervised the construction of this first siphon. It may be said that it was by his persistent and convincing argument and faith in his design, against much opposition, that its construction was finally authorized. Gaging and velocity tests by floats were taken by Clarke at night at low tide and it was found that a 14-in. iron pipe would carry the normal flow at a velocity sufficient, it was believed, to keep this pipe free from accumulated sediment. Two 42-in. storm water pipes were provided on either side of the small pipe, calculated to have a capacity equal to the old sewer when running full.

This siphon was put in commission in the early winter of 1903, and has since been performing its functions satisfactorily. In passing judgment upon the efficiency of this siphon it should be borne in mind that it has worked as was intended without additional cost to the borough for maintenance.

In Brooklyn on the Fourth Ave. route siphons have been built at Hudson Ave. and Fulton St., Dean St. and Fourth Ave. and at Butler and at 35th Sts.

The Hudson Ave. siphon connects a 4.5-ft. by 3 ft. egg-shaped sewer at an elevation of 10 ft. above high tide, the drop being 22 ft. to pass below the subway. A 10-in. pipe is provided for the normal flow and a 24-in. pipe for the storm water, the discharge end being at an elevation sufficient to eliminate all tidal effect. Such siphons have a great advantage over those at or below tide water level. As a relief in case of emergency a 14-in. by 4-ft. conduit, built in the roof, passes transversely across the subway at an elevation 4 ft. above the invert of the sewer.

The Dean St. siphon connects a 6-ft. circular sewer, the drop being 14 ft. and the discharge end of the siphon being 12 ft. above high tide. This siphon is working well and will probably prove one of the most satisfactory built. An 18-in. cast iron pipe carries the normal flow at a good velocity. Two 48-in. pipes are provided for storm water.

Resort to siphons seems inadvisable to Mr. Wilson unless the volume of sewage is sufficient to effect a minimum velocity of 2 ft. per second in a 12-in. pipe.

The construction of the Lexington Ave. subway required siphons at 106th and 110th Sts., the former serving a drainage area of 109 acres with an estimated maximum run off of 250 cu. ft. per second and a minimum of 9 cu. ft. and the latter an area of 227 acres with a maximum of 356 cu. ft. per second and a minimum of 29 cu. ft.

To avoid these siphons it would have been necessary to lower the base of rail in the subway 12 ft. to allow the sewers to pass over the roof, or to build a trunk sewer in Park Ave. from 110th St. south to 96th St., and thence east in 96th St. to the East River. To lower the subway for about eight city blocks would have added to the cost of construction probably $1,000,000 and would have necessitated the placing of the station platforms at an inconvenient depth below the surface of the street, or changing the location of the stations to points off from the main lines of crosstown travel. To build a new sewer in Park Ave. and 96th St. with the necessary laterals would have cost probably over $1,500,000 which was considered prohibitory.

It was the intent in designing these siphons to make the dams controlling the flow through the dry weather pipes at an elevation a little above mean high tide, thus confining the entire normal flow to the smaller pipes and obtaining in them the greatest average velocity without raising the water in the sewer up stream from the siphons higher than it had been rising previously at high tide. This is the material difference in design from the Railroad Ave. siphon previously referred to. In the Railroad Ave. siphon all pipes are submerged and obtain some velocity twice daily, while these siphons rarely take storm water in the larger pipes except during storm at high tide, the dry weather pipe being adequate to carry an ordinary rain storm, at ebb or low tide obtaining of course great velocity.

Another feature introduced with these siphons is the by-pass to facilitate cleaning the dry weather pipe should it become necessary. This consists of a circular conduit of the diameter of the small pipe and passing from the chamber on a level with the invert of the sewer, through the dam and into one of the storm water pipes at each end of the siphon. A sluice gate in each chamber when closed renders the passageway inoperative, but by opening the gates the flow freely passes into the storm water pipe to the full capacity of the dry weather pipe. A temporary dam of sandbags may easily be constructed across the chamber between the end of the dry weather pipe and the by-pass conduit in each chamber, which will direct all flow through the storm pipe, thus rendering the dry weather pipe inoperative, without raising the water in the sewer. This appears to be the only device so far that will prove really helpful in cleaning the small pipe. Another use to which this device could be put would be to open these gates in time of storm, thus doubling the capacity of the dry weather pipe and securing a velocity in the storm pipe sufficient to keep it open, if not free from sediment, besides holding the water in the sewer during storms to the same level as prevailed before the siphons were built. It would require a storm of unusual intensity to overtax these two pipes except at high tide. Study along this line may lead to further improvement in design.

These siphons are provided with clean-out manholes for the small pipes at each side of the subway structure, entrance to the pipes from the bottom of the manholes to be obtained by removing the upper part of the pipe. The pipe at these manholes are special castings, the flanges milled and bolted together, lead gaskets being used. The construction of these manholes was the most annoying part of the work and they are of doubtful utility.

The 106th St. siphon connects a 5.25-ft. circular sewer, the invert of which is 2 ft. below mean high tide and has a drop of 14 ft. This siphon, as also the one at 110th St., was built by the Oscar Daniels Co., contractor for section 12 of the Lexington Ave. subway, during the summer and fall of 1912. The construction was carried out according to plan and without incident. The flow during construction was carried in a wooden flume 6 ft. deep and 5 ft. wide. Excavation below the subgrade of the subway was in practically impervious clay.

The 110th St. siphon, having a drop of 16 ft., connects a horseshoe-shaped sewer 12 ft. wide by 8 ft. deep with a flow line elevation 3 ft. below mean high tide. The old sewer was built of brick upon timber grillage, consisting of two courses of 4-in. by 8-in. spruce crossed diagonally. The material excavated below the subway was sand and clay, very wet. For about half the distance across the subway, rock was encountered at about 2 ft. above subgrade.

A wooden flume, 7 ft. wide by 6.5 ft. deep was first built north of the siphon trench which carried the flow during construction without overflowing. It may be of interest to note that the highest point to which the water in the sewer has risen since the beginning of this work was 3 ft. 6 ins. above mean high tide or 6.5 ft. above the flow line. This was at night during high tide and a violent rain storm, the water rising in the flume to within 4 ins. of overflowing.

This siphon has a 42-in. cast iron pipe for the normal flow and two reinforced concrete circular pipes 6.5 ft. inner diameter, and required a trench 22 ft. wide.

As the excavation progressed a sump was carried down outside the sheeting to a depth of 4 ft. below subgrade, from which a 6-in. electrically driven centrifugal pump controlled the water. Then 24-in. I-beams 32 ft. long were placed across the siphon trench 10 ft. apart and doubled under the roadway of Lexington Ave., strongly supported outside the trench at each end and by posting in the center. These I-beams carried the surface and sub-surface loads, giving room for bracing and sheeting the trench below the subgrade of the subway in the usual way without difficulty. Tongue and groove 3-in. sheeting was used, the timbers being generally 12 ins. by 12 ins. When the excavation was completed, 6 ins. to 8 ins. of concrete was placed in the bottom and banked somewhat on the sides to hold the toe of the sheeting as well as to afford a solid working floor. The reinforcing rods were then assembled, wired and supported in place, and inside of these the forms were placed and concrete was poured. Collapsible steel forms were used. The 42-in. pipe was then set and caulked, after which the centers, the same forms as used for invert, were placed, the remaining reinforcing rods assembled and the remainder of concrete poured.

On Sept. 22, 1912, water was turned into the 106th St. siphon and on Jan. 7, 1913, into the 110th St. siphon, since which time each has been working satisfactorily.

In discussing Mr. Wilson's paper, Mr. James F. Fouhy added a few words regarding a siphon which didn't work, though on the same sewer line and in approximately the same position as the Dean St. siphon above mentioned. Prior to the construction of the Fourth Ave. subway the Dean St. sewer was supposed to empty during storms into the 15-ft. storm sewer on the west side of Fourth Ave. The dry weather flow was arranged to flow into an 8-in. cast iron pipe siphon. About 230 ft. east of Fourth Ave. an 18-in. depressed invert was cut into the Dean St. sewer at a horizontal angle of 45°. This served as an entrance to the 18-in. pipe which then continued parallel with the Dean St. sewer until it reached Fourth Ave., when it began to drop so as to pass under the 15-ft. storm sewer, which was several feet lower than the Dean St. sewer. It then rose again and emptied into a continuation of the Dean St. sewer. During construction the 18-in. cast iron pipe in Fourth Ave. was found to be completely filled with hard muck, while the portion east of Fourth Ave. was comparatively clean. The cause is easily found. The water took the path of least resistance and emptied into the 15-ft. sewer. All of which tends to show the necessity of compelling the sanitary flow to travel through the dry weather pipe, thereby increasing the velocity and making the pipe self-cleaning. This is accomplished by means of a reducer. Mr. Fouhy, who has had considerable experience of this type, believes the reducer to be an absolute necessity.

Design, Construction and Cost of New Sanitary Sewerage System at Alton, Ill.

A sanitary sewerage system, 13½ miles in length, has just been completed in Alton, Illinois. The area served by this system, known as Upper Alton, is residential in character and has a population of about 4,000 people. It lies about two miles from the Mississippi river and is about 125 ft. above the river. The present article describes the design and construction of this new sewerage system and gives some unit cost and output data. Our information is from a paper by Mr. J. E. Schwaab, city engineer of Alton, before the 30th annual meeting of the Illinois Society of Engineers and Surveyors.

In designing the sewer a contour map was first made and, on account of a long route to the Mississippi river for an outlet, it was considered at one time advisable to construct a septic tank, the effluent from which would discharge into Wood river, which has a drainage area of 121 square miles. The estimated cost to construct an outlet sewer to the Mississippi river was about $10,000 more than the cost of the septic tank project. While the first cost of disposal by dilution was the greater it was decided that it would be the best and the cheapest in the long run.

The citizens of the territory offered several objections on account of the size of the pipe, and kind of sewer; some of them wanted a combined sewer system. They appointed a committee who secured the advice of Mr. W. S. Shields, Consulting Engineer, of Chicago, who advised them that a sanitary sewer system would be adequate and would meet with their requirements if constructed according to the plans. It was not necessary to install a storm water sewer as the natural contour of the ground gives the storm water an opportunity to drain off very quickly into small ravines which form natural outlets. This seemed to change the public opinion and made the citizens more favorable towards the construction of this type of a sewer. However, several citizens made up an objectors' committee, employed attorneys, and made objections to the special assessment in the court, and the lawyers for the objectors took the matter up on a writ of error before the State Supreme Court, but the sewer case was finally confirmed.

The sewer system consists of 13½ miles of main sewer, two miles of an outlet sewer; the size of pipe ranges from 8 ins. to 16 ins. in diameter. There are five miles of 6-in. stubs, connected to 6-in. Y's in the main sewer and running to the curb line, for house connections. These were placed in the street in order to avoid future tearing up of pavements. Manholes were built of brick and plastered with cement. All junction manholes were made 4 ft. by 4 ft., and line manholes were 3 ft. by 4 ft. Manholes were placed at all grade changes, angles, and at all street intersections, at an approximate distance of 400 ft. apart; 157 manholes were installed. Miller automatic siphon flush tanks, with interior bents, were used and connected with the water main. Flush tanks were equipped with I X L flush tank regulators and are regulated to flush every twelve hours. These flush tanks were placed at all dead ends excepting where the grade was greater than .5 per cent and not more than 1,000 ft. in length. A total of 21 flush tanks were used.

A total of 13,760 ft. of the sewer was laid in paved streets which necessitated the tearing up and repaving of portions of certain streets. In replacing the pavement a 5-in. concrete base (extending 1 ft. on each side of the excavated ditch, thus securing a more secure bearing) was laid. Bricks were laid on a 2-in. sand cushion and grouted with a 1 to 1 cement grout.

The grade of the sewer within the district ranged from 0.35 per cent to 5 per cent and from 0.2 per cent to 1 per cent on the outlet sewer.

In the construction of this system there were used one small 00 Austin gasoline ditching machine which excavated a ditch 24 ins. wide. The following out-put data were furnished by Mr. G. M. Johnson, of the Lillie Construction Co., sub-contractors, and owner of this machine:

Total amount of work done, lin. ft.	19,800
No. of working days	90
Average cut per day, lin. ft.	220
Maximum cut per day, lin. ft.	800
Average cost per day for operation	$30

Average Cost Per Foot for Laying Pipe.

	Cts.
Average cost per foot for operation of machine	13.6
Incidentals	1.4
Total cost per foot for excavation	15.0
Cost per foot for laying pipe	4.0
Cost per foot for refilling	3.0
Cost per foot for excavating, laying pipe, and refilling trench	22.0

Depth of trench averaged 11 ft., with a maximum of 22 ft. and a minimum of 4 ft.

There was also used a Parson's steam ditching machine with backfiller, which excavated a ditch 28 ins. wide. The following figures as to the work done by this machine were computed by the writer and are only approximate:

Total amount of work done, lin. ft.	18,000
Number of working days	90
Average cut per day, lin. ft.	200
Average cost per day for operation, laying pipe, and backfilling	$45.00
Average depth of trench excavated, ft.	11½

The balance of the main line sewer, where conditions were unfavorable for the use of excavating machines, and all laterals were put in by hand gangs.

OUTLET TUNNEL CONSTRUCTION.

The outlet necessitated the construction of 1,000 ft. of tunnel through a ridge. The grade of the tunnel varied from 20 ft. to 39 ft. below the natural surface of the ground. In this tunnel 12-in. cast-iron pipe was laid to the proper grade. Shafts were sunk every 200 ft. These shafts were made 4 ft. by 8 ft. in dimension and were properly braced with oak timbers. The 8-ft. side was parallel to the center line of the sewer. On each side of the shaft plumb bobs were dropped and were used to line the tunnel driving; this method proved sufficiently accurate to keep the tunnel in alignment. Clay was removed from the tunnel by the use of 5 cu. ft. wooden buckets which were raised and lowered into the shafts by the means of an ordinary hoisting engine and swinging boom. This equipment was also used for lowering the 12-in. cast-iron pipe into the shaft and for dragging it along the tunnel. When pipes were placed in the proper position they were yarned and calked with lead. At the bottom of the shaft the heading was driven in both directions for a distance of 100 ft. at the same time. The sides and top were sheeted with 3-in. oak planking as the tunnel was being driven. To operate one shaft there were five men in the tunnel—one man to hook the cable onto the buckets, two men at the headings, and two men wheeling muck to the shaft. On the top there were three men, one man unhooking the bucket and emptying it, and one man with team and scraper to remove the earth from the shaft, and one man to cut timber.

One difficulty experienced was the lack of ventilation. It was impossible to keep a light burning in the tunnel so that the men could see. The air became foul, thus preventing the men from remaining in the tunnel. This obstacle was overcome by the use of an ordinary blower fan operated by a 1½-HP. gasoline engine. To the discharge end of the blower fan 3-in. spouting was connected and run down into the shaft and each way into the headings. This fan furnished sufficient air to enable the men to work in the tunnel without experiencing any discomfort as regards ventilation.

The time required to complete this tunnel was 60 days, average progress being 17½ ft. per day. The maximum progress was 34 ft. per day. The total cost, including labor, material and lumber, was $10,000.

Following are the wages paid for the labor for constructing the tunnel. Each shift consisted of:

One foreman, per month	$75.00
One engineer, per hour	0.25
Two diggers, per hour	0.30
Five laborers, per hour	0.25
One team, per hour	0.50
One water boy, per day	1.00

Eight hours constituted a day's work for each shift; at times there were three shifts working in the 24 hours.

The material through which the tunnel was driven was wet, sandy clay excepting 50 ft. of small gravel and quicksand. The elevation of ground water was 13 ft. below the natural ground surface. The men at the headings used ordinary round pointed spades; picks were used when gravel was encountered.

The 12-in. cast-iron pipe was used in the tunnel so as to avoid any chance of accident by breakage in such a deep cut. Ordinary sewer tile was used throughout the balance of the outlet excepting where the outlet was below high water mark. In this place 16-in. cast-iron pipe was used on account of the river backing up in the pipe during high water. Cast-iron pipe will also afford greater protection against the frost throwing the sewer out of alignment and grade as the pipe was only 3 ft. below the surface of the ground.

CONTRACT PRICES.

	Quantity, lin. ft.	Average cut, ft.	Contract price per lin. ft.
6-in. vitrified clay pipe	24,800	8.0	$0.50
8-in. vitrified clay pipe	37,151	10.7	0.72
10-in. vitrified clay pipe	13,953	12.0	0.90
12-in. vitrified clay pipe	6,556	10.0	0.78
15-in. vitrified clay pipe	4,482	7.2	0.90
16-in. cast iron pipe	1,479	4.7	4.00
12-in. cast iron pipe	1,511	26.5	5.00
Manholes, each			$40.00
Flush tanks, each			75.00

The actual construction work was performed by the Public Service Construction Co. of Omaha, Nebraska, who were associated with Chas. E. Van Wormer of Springfield, Ill., Bertrand Weiss having actual charge of the work. Work was commenced on June 22, 1914, and was completed on Nov. 1, 1914.

DRAINAGE AND IRRIGATION

Methods and Costs of Constructing Concrete Lining for Twenty Irrigation Canals.

The design and structural features of concrete lining for irrigation canals were discussed in our issue of Jan. 27 from a report by Samuel Fortier, Chief of Irrigation Investigations, U. S. Department of Agriculture. From the same report there follow some 20 examples giving methods and costs of constructing concrete lining:

In submitting the following data an effort has been made to show as fully as possible what constitutes current practice throughout the West in the lining of old and new canals. The lack of space prevents taking up many of these features in detail, but it has been the aim to select representative work in the various localities, and to point out not only the good features of such work, but to call attention to doubtful practices in order to assist the engineer in the design and execution of similar construction elsewhere.

Patterson Land & Water Co., Patterson, Cal.—About three years ago a series of pumping plants was installed to raise water from the San Joaquin River to irrigate a tract of 14,000 acres, comprising the bulk of what is locally known as the Patterson ranch. To prevent the loss of water by seepage the canals of this system were lined with a 3-in. layer of concrete and finished with a ¼-in. plaster coat. The main canal at the river end has a bottom width of 7 ft., a vertical depth of 5½ ft., side slopes of 1½ to 1, and a capacity of about 110 sec.-ft. Its capacity is reduced at various points along its length, and at a distance of 2½ miles from the intake the bottom width is 4½ ft. After the excavation of each division the main canal was filled with water and allowed to soak for from six to nine days. It was then trimmed and lined in 12 ft. sections. The gasoline-driven concrete mixer had a capacity of 75 cu. yds. per day, which provided material to line 300 lin. ft. The position of this mixer when operated and the methods employed in elevating the material and delivering the concrete are shown in Fig. 1. The concrete used was a mixture of 1 part cement to 6 or 6½ parts of sand and gravel. The plaster coat was proportioned 1:2 cement and river sand.

East Contra Costa Irrigation Project, Brentwood, Cal.—This enterprise, although much larger, is similar in design, purpose, and scope to that at Patterson. Mr. A. Kempkey, the engineer in charge, in writing of this project claims that some improvements have been introduced in the lining as planned over the lining used on the Patterson project. One of these is the insertion of two expansion joints at the toe of each slope and parallel to the canal axis. It is also proposed to apply the mortar coat by means of a cement gun, at an estimated cost of 1 ct. per square foot of surface. The expansion joint used on both projects is shown in detail in Fig. 3, page 73 (Eng. Contg., Jan. 27, 1915). It has given good satisfaction wherever used in both canal and reservoir lining. A medium grade of asphalt, applied warm enough to flow readily but not smoking hot, is considered best to fill the joints. In using this joint it is not necessary to place the lining in alternate sections, as a tapering strip of wood may be inserted between adjoining sections. These strips can be afterwards removed and the joints formed by pouring asphalt into the grooves and applying a ½-in. coat of plaster on top of the asphalt. Figure 2 shows the work of lining this canal in progress.

North Side Twin Falls Land & Water Co., Milner, Idaho.—This company lined 8,400 ft. of its main canal to increase its capacity. The canal is carried for several hundred feet along a rough lava rock cliff and is 60 ft. above low water in the river. The outer bank through this section is a concrete retaining wall. The remainder of the lined section is excavated almost wholly in solid lava. The grade varies from 0.001 in narrow places to 0.0002 and 0.00025 in the wider sections. The canal was emptied Oct. 10, 1909, and the work of preparing it for the concrete was commenced as soon as the channel had dried sufficiently. In places for several hundred feet from the headgates the canal bed was considerably below grade. The rock projecting into the canal section in the sides and bottom was blasted and smoothed, the low places being filled to subgrade, with broken stone and puddled earth. An 8-in. thickness of concrete was applied to the sides of the rock, sections and a 6-in. thickness to the bottom. The sides of the rougher rock sections were riprapped to secure a better alignment and to save concrete. Cavities and large irregularities were back-filled with stones and puddled earth. It seems to the writer that the 6-in. thickness laid on the bottom of rock sections might have been reduced to 3 or 4 ins. if the bed had been better prepared by the placing of finely crushed stone, compressing this material by rolling to secure an even surface and uniform grade, as is done in macadamized road construction.

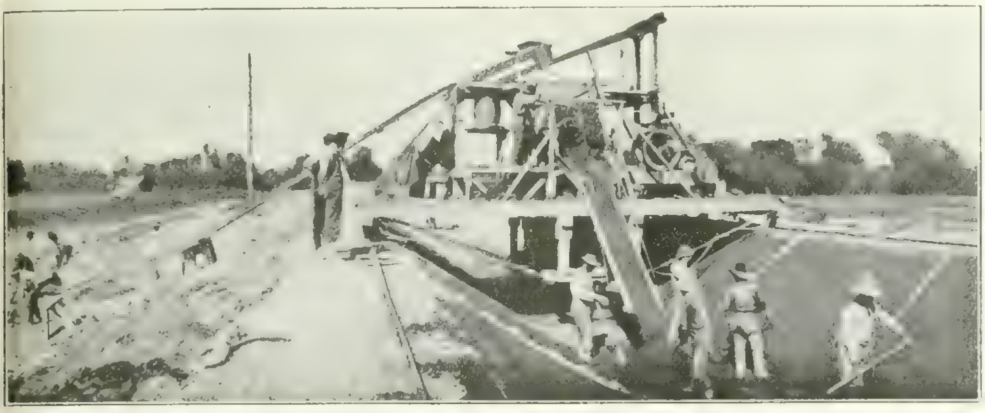


Fig. 1. Constructing Concrete Lining in Main Canal, Patterson Land & Water Co., Patterson, Cal.

The concrete was composed of a 1:3:6 cement, sand, and crushed stone mixture, but whenever a well-graded crushed stone could be secured sand was omitted and the concrete was made of 1 part cement to 6 parts crushed stone from which all particles over 1½ ins. in diameter had been excluded.

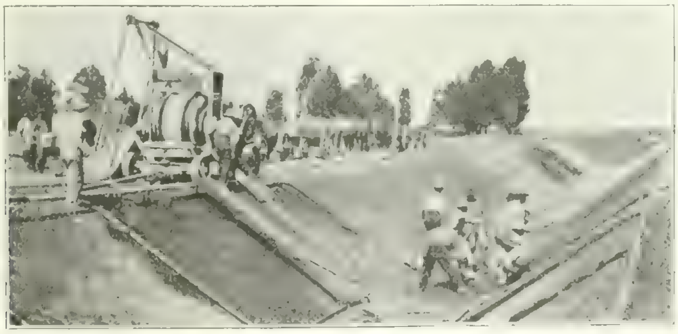


Fig. 2. Laying Concrete Lining in Canal of East Contra Costa Irrigation Project, Brentwood, Cal.

In earth sections the lining of the sides and bottom was 4 ins. thick and had side slopes of 1¾ to 1. Expansion joints of corrugated iron were inserted every 16 to 20 ft. along the sides and bottom except in the bottom of the rock sections. These joints consisted of pieces of corrugated iron cut into strips 4 ins. wide containing 1½ corrugations, these being designed to lock the edges of adjacent sections and to prevent slipping. (See Fig. 2, *c*, p. 72, E. & C., Jan. 27, 1915.)

The side walls in the rock sections were supposed to have a slope of 1 to 4; but in many places where this would have necessitated the blasting of large amounts of rock, walls were made almost vertical. Heavy, collapsible forms of 2-in. lumber were used in placing concrete for the walls which approached the vertical. The concrete was wheeled directly from the mixers and spread in uniform layers 4 ins. thick over the bottom and on the sides of the easier slopes in earth sections. Concrete placed within forms made of 4x4-in. lumber was compacted by tamping and finished by working 24-ft. floats made of 2x6-in. timbers back and forth over the upper surface of the forms. Sixty cubic yards of concrete per day were sometimes laid in this way by one gang working under favorable conditions. The sides and slopes were finished with a coat of cement mortar whenever the surface was rough enough to warrant it.

The unusually high cost of this work was largely due to the difficulty of preparing the rock cut for the lining and to the absence of sand and gravel, which made it necessary to crush rock for the concrete. However, a greater factor than either of these was the added expense due to the necessity of prosecuting the work during severe winter weather. To do this the canal was roofed over for a distance of 2,000 ft. and the inclosed space warmed by specially constructed heaters, using sagebrush for fuel. The cost of labor and material was as follows:

Laborers, per day of 10 hrs.	$ 2.50
Drillers, per day of 10 hrs.	2.75-3.00
Engineers (steam), per day	3.00-4.00
Man and team, per day	5.00
Coal per ton, f. o. b. Milner	6.50
Cement per barrel, f. o. b. Milner	2.59-2.89
Cost of crushing rock, per cu. yd.	1.10
Cost of labor for placing concrete, per cu. yd.	2.25
Complete cost of material, mixing and placing concrete for form work only, per cu. yd.	8.00
Same without forms	7.00
Cost of rock excavation (light cuts from 0.4 to 2 feet), per cu. yd.	5.00
Cost of placing riprap 1 foot thick, per cu. yd.	2.00
Total cost of preparing 8,400 lin. ft. of canal for concrete	75,000.00
Gross cost of lining 8,400 lin. ft. of canal	250,000.00
Average cost of concrete, per cu. yd.	8.00

Main South Side, or New York Canal, United States Reclamation Service, Boise, Idaho.—This canal is designed essentially to carry flood water from a point on the Boise River, nine miles above Boise, to the Deer Flat reservoir, a distance of 36 miles. Seventy thousand acres of land is also watered from the canal before the reservoir is reached. About 6½ miles of the canal was lined to prevent seepage, increase the carrying capacity, and for the safety of sidehill sections where breaks frequently occurred. The canal is an old one, originally built with side slopes of 1½ to 1, but the change and filling up of the section common to old canals necessitated considerable preliminary work in the removal of very gravelly earth and in shaping the sides before the concrete could be laid. The lined section has a grade of 0.00025 to 0.00032 and slopes of 1½ to 1. Forms of 4x4-in. lumber were placed upon the slopes and aligned, after which the surface between the forms was smoothed and thoroughly hand compacted. A uniform layer of concrete 4 ins. thick was then applied.

After heavy stripping, a good natural mixture of sand and gravel was secured adjacent to the canal. This was hauled by slip scrapers up a runway and dumped into the mixers, which were placed high enough to permit discharging the concrete directly into one-horse carts. The concrete was a 1:3:6 mixture of Portland cement, sand, and gravel. It was laid in sections measuring 8x16 ft. on the slopes and 8x16 or 16x16 ft. on the bottom. The lining was laid in alternate sections to make room for the workmen, and the upper sections were usually the first completed. As soon as the concrete of the first sections had set, the forms were removed and the intermediate sections filled in. Expansion joints of one thickness of tar paper were used between sections in part of the work.

After being dumped from the cars, the concrete was worked down and later smoothed by drawing long floats made of 2x6-in. timbers back and forth across the forms. In order to get a smooth face, the surface was painted with a 1 to 2 finishing coat of cement mortar as soon as the concrete was placed and set. The lining was kept wet by sprinkling for a period of seven days after being laid. It was protected from nightly freezes during the early part of the work by covering with a layer of straw, and during some freezing weather in the latter part of the work some concrete was laid under large tents heated by stoves. Some of the cost items are as follows:

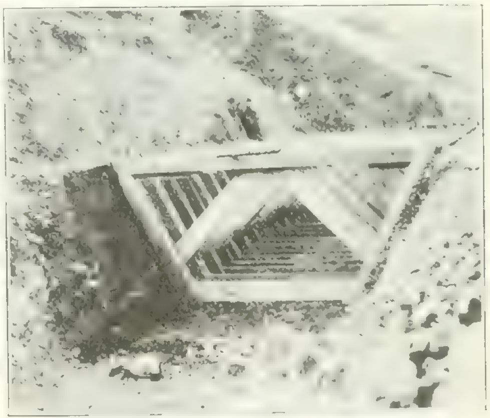


Fig. 3. Forms Used for Backfilling With Puddled Earth to Prepare Canal for Concrete Lining, Fruitlands Irrigation & Power Co. (Ltd.), Kamloops, British Columbia.

Preparing canal section for lining, per lin. ft., approximately	$2.80
Hauling gravel to mixers, per cu. yd.	1.14
Mixing and placing concrete, per cu. yd	2.20
Total cost of concrete, including cement, per cu. yd.	7.70

Total cost of concrete in place, per lin. ft.	9.64
Cement per barrel, f.o. b. Boise	2.27-2.50
Common labor, per day	2.50
Man and team, per day	5.00

Fruitland Irrigation & Power Co. (Ltd.), Kamloops, British Columbia.—This company has lined some six miles of its main canal. The upper bank is quite generally in excavation and the lower bank is partly in excavation and partly in fill. There appear to be more curves than the nature of the ground warrants, but A. E. Meighans, the company engineer, stated that the lined canal follows an old location for a ditch built before this company acquired the property.

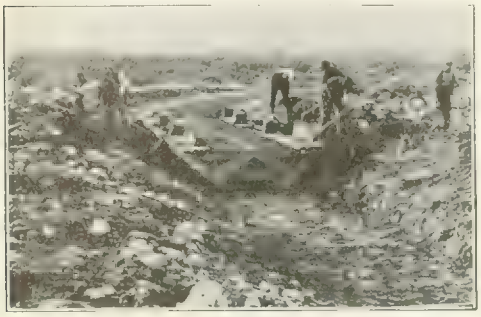


Fig. 4. Preparing Earthen Canal Sections for Concrete Lining, Northern Pacific Irrigation Co., Kennewick, Wash.

Some slight injury to the lining has resulted from earth settlement. Lining the sides of the curves required the use of short forms, which were also used on tangents, resulting in a much larger number of joints on the straight portions than good practice warrants. The joints were spaced 6 ft. apart, and an attempt has been made to cover the seams with a coating of cement mortar. It is claimed, however, that these will eventually become filled with sediment, but the daily and seasonal contraction and expansion usually tend to enlarge rather than to decrease their width. Figure 3, shows the forms used for back-filling with puddled earth to prepare this canal for concrete lining.

Northern Pacific Irrigation Co., Kennewick, Wash.—During the winter of 1910-11 this company lined 22,500 ft. of ditches on the "Highlands" at Kennewick to eliminate heavy seepage losses. The soil through which these ditches are built is principally a fine sandy loam overlying gravel at a depth of 18 ins. to 2 ft. One ditch 10,800 ft. long, 3 ft. wide on the bottom, with side slopes of ½ to 1 and a vertical depth of 26 ins., is designed to carry 18 sec.-ft. Another ditch having in part a bottom width of 3½ ft., side slopes of ½ to 1, and a vertical depth of 19½ ins. is designed to carry 14 sec.-ft. This ditch is reduced to a bottom width of 2½ ft., but with the same side slopes and depth as the upper part. The concrete used was a 1:3:4 mixture of cement, sand, and crushed rock.

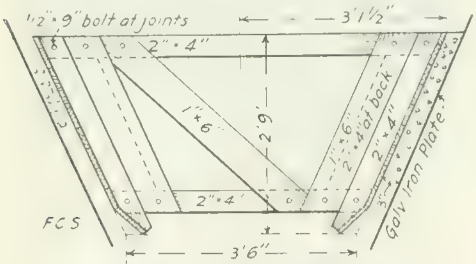


Fig. 7. Section of Form Used in Placing Concrete Lining, Belgo-Canadian Fruit Lands, Kelowna, British Columbia.

In preparation for lining, center grade stakes were set and the bottom of the ditch brought to grade. Scantlings 2x4 ins. were then placed across the bottom of the ditch at 12-ft. intervals at right angles to the center line and flush with the subgrade. Three forms 12 ft. long (Fig. 4) were then set in the ditch on the cross strips and centered. Earth was shoveled and tamped behind the forms to secure the desired section. There were 14 men in a crew on this work.

After the earth sections were prepared in this way, 2x2-in. screeds (Fig. 5) were placed at intervals of 5 ft. 8 ins. and upon them forms 6 ft. long were set on every other space. The concrete was mixed with a one-third yard mixer, wheeled to place and dumped on planks laid on top of the forms. It was then shoveled behind the forms and lightly tamped. Strips of sheet iron were inserted behind the forms to protect the slope while the concrete was being put in and also to prevent a too rapid loss of water from the mixture by its contact with the drier earth. These strips were raised as the filling progressed. Two crews of 5 men each placed the concrete behind the forms, 2 men wheeled to each crew, and about 5 men were employed to move forms, etc. About 6 men were in the mixing crew and 2 others plastered rough places in the lining. Water kept in the finished ditch a few hundred feet in the rear of the work was pumped ahead to the mixer with a small gasoline engine.

The engineer stated that in one hour a crew could place about six sections, or 34 lin. ft., of the lining in the ditch having a 3-foot bottom. On some of this work done during freezing weather, canvas covers were placed over the ditch. Under these covers iron pipes were laid through which steam was run from a steam boiler during the night. Rock gathered from various places within the locality was crushed and hauled from 1 to 1½ miles. Six men collected the rock, 4 men operated the crusher, and about 7 teams hauled the crushed rock to the place of use. The cost of the crushed rock was not obtainable, but other items of expense were as follows:

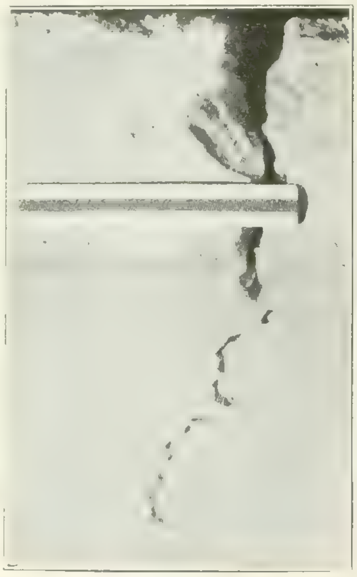


Fig. 6. Showing Fractures in Concrete Lining of Truckee-Carson Canal, Nevada.

Cement per barrel delivered at works, approximately	$3.00
Sand delivered by contract, per cu. yd.	1.75
Laborers per hour, without board	.25
Teams per hour, without feed	.35

Truckee-Carson Project, Nevada.—A part of the main lower Truckee Canal, constructed in 1904 and 1905 by the United States Reclamation Service, was lined with concrete. Much of this lining was placed without the use of expansion and contraction joints. In November, 1911, about six years after the lining was completed, Mr. F. L. Peterson, irrigation engineer, made a careful examination of the lined portions of this canal to determine if possible the effect produced by the lack of joints. Opposite the railroad siding at Gilpin, Nev., the canal is excavated for the most part in solid rock and lined with 4 ins. of concrete; Fig. 6 gives a close view of one of many fractures found.

The placing of the concrete lining against the uneven rock surface served to anchor the lining and prevent contraction, and ruptures have occurred at intervals of 28 ft. or more throughout the lining. The seams created by these ruptures varied in width from 1/12 to ½ in. or more at a time when the temperature of the air was 50° and that of the water in the canal was 42° F.

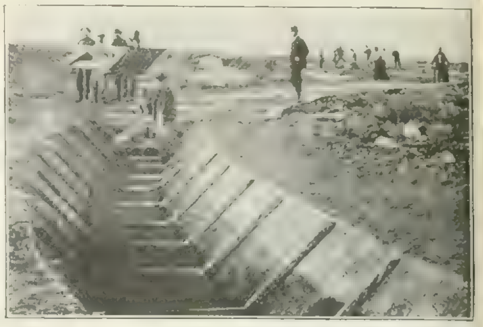


Fig. 5. Setting Forms Preparatory to Construction of Concrete Lining, Northern Pacific Irrigation Co., Kennewick, Wash.

Lower Yakima Irrigation Co., Richland, Wash.—The canal of this company parallels the Yakima River for several miles, where the earth sections run mainly through coarse gravel, boulders, or shattered basaltic rock. The remainder of the system is very largely built through sand. In the unlined channel the seepage losses were excessive, and through the sand it was also difficult to maintain the ditch owing to its tendency to fill up both by drifting and on account of the flat side slopes which the sand naturally assumed under the action of water. The lining was intended, therefore, not only to reduce the loss of water, but to increase the carrying capacity of the ditch and render it more stable and easy to maintain. About five miles of the ditch was lined in 1910. The company furnished all materials used and prepared the channel for lining, but the other work was done by contract.

In preparing the ditch, center stakes were set about 1½ ins. above grade, to which the excavating was roughly done with teams and scrapers. At intervals of about 25 ft. along the bottom of the side slopes stakes were set to grade, and from these the top slope stakes were set by the use of a slope triangle. Nails were driven into the grade stakes and chalk lines were stretched on them parallel to the ditch. Trimming to these lines was done then with square-pointed shovels and the slopes and bottom scraped to smooth surfaces with straight edges. The sides and bottom were tamped lightly with wooden tampers and sprinkled before the lining was applied. The section lined has a bottom width of 11½ ft., side slopes of 1½ to 1, and a wetted perimeter of 26½ ft.

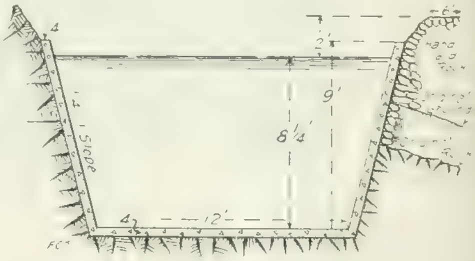


Fig. 8. Section of Concrete Lined Canal in Rock, Central Oregon Irrigation Co., Deschutes, Oreg.

The three mixers used were operated on planks in the bottom of the ditch in advance of the work. With each mixer there was a crew of about 25 men and in addition a finishing crew of 5 or 6 men to dress the earth surfaces immediately ahead of the mixer. One rock crusher was also operated, the crushed rock being hauled an average of 2 miles. Most of the sand was procured from pits along the line of the canal and was used without screening. The lining was laid in 8-ft. sections 1¾ ins. thick, with strips of building paper in the joints between the sections. Four hundred feet of lining was considered a good day's work for a crew. A 1:3:4 mixture of concrete was used for most of the lining, but on one section a 1:4 mortar applied 1 in. thick was considered just as good as the thicker lining of concrete, besides being much easier to apply.

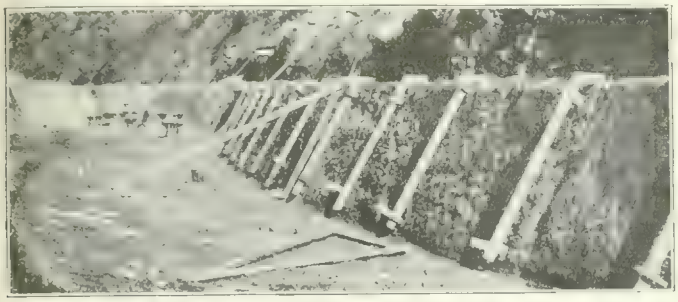


Fig. 10. Methods Used in Construction of Concrete Lining, Davis and Weber Counties Canal, Ogden, Utah.

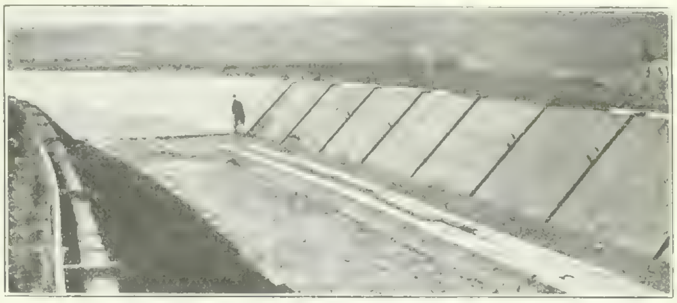


Fig. 11. Methods Used in Construction of Concrete Lining, Davis and Weber Counties Canal, Ogden, Utah.

The lining in gravel sections leaked considerably the first season, presumably because allowed to dry too rapidly on account of lack of water for keeping it moist after laying. In work that was done the following year this difficulty was obviated by allowing a small amount of water to flow in the ditch soon after lining, using check dams to prevent its interference with construction. Men wearing rubber boots then waded along and with shovels or buckets threw water upon the side slopes at frequent intervals to keep the concrete wet while setting. Where lining had been placed on moistened sand, the results were better than in the sections through gravel, there being no perceptible leakage. Conditions in the gravel portion improved with the first year's use of the lined section, after which the seepage was considerably lessened. The various items of cost secured are as follows:

Laborers per day of 10 hours, without board	$ 2.50
Man and team per day, without board.	4.50
Contract price per sq. ft. for mixing and laying concrete	.025
Cement per barrel*	3.10
Sand per cu. yd., approximately	.50
Total cost of lining, per sq. ft.	.065
Total cost of lining	9,064.49

*This does not include an 8-mile haul over heavy roads.

During February and March, 1911, the company placed additional lining, using practically the same methods above described, except that all work was done by force account. The prices for labor and material indicate that the work was done considerably cheaper than in the previous year. Laborers were procured for $2 per day without board and men with teams for $4 per day each. Cement cost $2.95 per barrel delivered at the work.

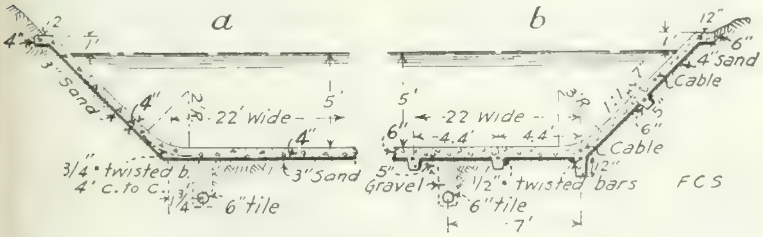


Fig. 9. (a) General Type of Concrete Lining Construction Used for Davis and Weber Counties Canal, Ogden, Utah. (b) Type of Concrete Used for Weak Foundations on Same Canal.

Belgo-Canadian Fruit Lands, Kelowna, British Columbia.—About 3,000 ft. of this company's main canal, 11 miles long, and about 4 miles of its lateral ditches have been lined with concrete to prevent seepage losses in a porous soil. On the main canal a 3-in. thickness of lining has been used for a finished section having a bottom width of 3.5 ft., depth 3.75 ft., and side slopes of ½ to 1. Lateral linings are 2½ to 3 ins. thick on slopes, with a 3-in. thickness on bottoms which vary in width from 9 ins. to 2 ft.

After excavating the channel to be lined, a drain filled with loose rock or gravel was made beneath the bed. Cross drains from this through the lower bank were placed at 500-ft. intervals. The forms shown in Fig. 7 were then set and bolted together. Galvanized-iron plates placed outside the forms were spaced with pieces of lumber, and after the earth was back-filled and tamped behind the plates concrete was poured between them and the forms. The galvanized plates and spacing pieces were withdrawn as the space was filled with concrete. The bottom of the ditch was then floated in and the edges smoothed, using for this purpose the excess concrete which had passed over the forms. The forms were left in place 48 hours.

Curves were made by using special short forms having the outer edge superelevated ½ to 1 in. according to the degree of curvature. In placing the concrete around sharp curves, special galvanized plates were used to close the gap at the outer edge of the forms.

No cost data could be secured on the lining of the main canal. The cost of lining laterals per square foot and exclusive of excavation varied from $0.118 in the larger to $0.142 in the smaller ones. These costs include excavation, back-filling, rock drains, and supervision. The work was done late in the fall when protection against frost increased the cost. Cement cost $3.75 per barrel delivered, common labor $2.75 per day, and skilled labor $4 per day.

Tucson Farms Co., Tucson, Ariz.—The water for this project is obtained by pumping from numerous wells. During the winter and spring of 1912-13 a reinforced concrete lining was placed in about 2½ miles of the new main canal for the prevention of seepage losses through a sandy and gravelly soil. The canal has a trapezodial cross section entirely in excavation and as lined is capable of carrying a 2.9-ft. depth of water. The bottom width ranges from 2 to 4¾ ft. and the side slopes are 1 to 1. The greater part of the concrete used in this construction is a 1:4:4 mixture and the lining is 3 ins. thick throughout.

In grading the channel for lining, a framed template was used to get a true section. The reinforcement is made of round steel bars intersecting at right angles and wired together. Four longitudinal bars, 5/16 in. diameter, were placed one on each side of the bottom for the lining floor and one on each side near the top of the side walls. Then at right angles to these, as stated, ¼-in. crossbars were spaced 12 ins. apart. Each crossbar was continuous and extended from the top of the lining on one side through the lining to the top of it on the opposite side of the canal. When it was not possible to obtain the ¼-in. bars, 5/16-in. bars were substituted and spaced 18 ins. apart.

Wooden-framed forms built in 12-ft. sections were then set in position over the steel reinforcement, blocked to place, and the adjoining ends bolted together. Then ⅛-in. steel backing plates, 2 ft. wide and long enough to reach to the bottom of the earth section, were slipped behind the forms and under the reinforcement. Before placing the concrete, wooden spreader-strips, 2x3 ins. were set between the wooden forms and the backing plates. Each spreader contained a staple driven almost full length into its side near the bottom, and in setting the spreader the staple loop was slipped over the end of the crossbar and the spreader was then slid into position. In this way the bar was carefully held in position while the concrete was being placed in the forms. A spreader was set beside each crossbar, and as the concrete for the side lining was tamped and puddled into place the spreaders were gradually removed, leaving the crossbars firmly embedded in the concrete. The steel plates likewise were withdrawn as the walls were built up. When the side forms were filled with concrete to within 3 ins. of the top, the longitudinal bars were placed and wired to the crossbars. The remaining concrete was then placed and smoothed with an edging trowel.

Expansion joints were provided by setting 1x3-in. wooden strips in the middle of each form in the same manner as the spreaders, except that no staples were used and the joint strips were not removed afterwards. To keep them in position while concrete was being deposited, each one was lightly nailed to the side of the form, and before the latter was removed the nails were withdrawn. The forms were left intact for a period of 8 hours at least, and they usually remained undisturbed over night during a period of 14 to 20 hours. After their removal any defects in the wall surface were "picked" out and the cavities smoothly plastered with a 1:1½ or 2 cement mortar.

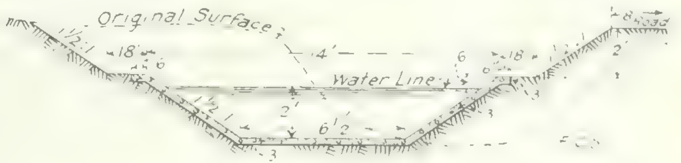


Fig. 12. Cross Section of Concrete-Lined Canal, Burbank Power & Water Co., Burbank, Wash.

The canal bottom was then carefully cleared of litter, its surface smoothed, and solidly tamped. All reinforcement bars that may have become bent were straightened. The bottom piece of the expansion joint was fitted to the two side pieces and its top carefully laid to grade. The concrete for the floor lining was then tamped and puddled into place, and when it had reached the required thickness the surface was easily brought to grade and smoothed by the use of a straightedge resting on the bottom joint strips as guides. The entire lining was kept wet by continual sprinkling during a period of three to five days. After this was discontinued a wash coat of neat cement mortar was applied to the surface with a brush.

A 1:4:4 mixture of concrete was used on all the work except for about 1,000 ft. of bottom where there was excessive external water pressure. In this portion of the canal a 1:3.2:3.2 mixture was used. As a further protection in one very wet and miry place, additional reinforcement was used in the bottom. Extending over a length of about 5,000 ft. of the largest canal section near the Santa Cruz River bed, "weep holes" were formed in the bottom to relieve external water pressure. Two-inch tapering plugs extending entirely through the lining floor were set in the freshly laid concrete and these plugs were later removed as soon as the concrete had set sufficiently to retain its shape. Two rows of these holes were made 2½ ft. apart and spaced 4 ft. longitudinally. During construction a considerable portion of the canal was drained. A line of 8-in. tiling was laid in the bottom and pumps attached thereto were installed at intervals of about 1,000 ft. to withdraw the accumulated water.

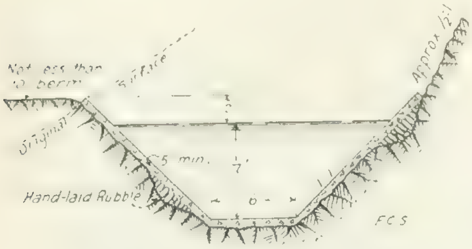


Fig. 13. Cross Section of Concrete-Lined Canal, Medina Valley Irrigation Co., San Antonio, Texas.

The contractor received $12.50 per cubic yard for the finished concrete lining, using slab measurement. This included all costs except the original purchase price of the steel reinforcement. However, no excavation was included and the company paid extra for the wash coat. The contractor rented a rock crusher and delivered the rock. Sand was obtained from the river bed.

All concrete was mixed by hand and transported in wheelbarrows. The work was performed with gangs of about 30 men, paid for a 9-hour day, as follows:

1 foreman	$4.00
Mixing boss and 2 plasterers	2.50
2 water boys	1.00
25 men	2.00

The gang was used in the following manner: Eight men on mixing board, 2 tampers, 2 men pulling plates and spreaders, 2 men setting forms and putting in expansion joints, 2 men laying steel reinforcement, 14 men transporting and depositing materials and concrete, finishing, screening sand, etc. The forms were usually all moved at one time and the whole force engaged on that work. It required this gang 21 days to place lining in 3,000 ft. of canal in dry excavation having a bottom width of 3 ft. The cost to the contractor was distributed as follows:

Labor, including the building of forms	$1,297.83
1,712 sacks of cement, at $0.81 each	1,386.72
232 cu. yds. of rock, at $1.75 per cu. yd.	406.00
232 cu. yds. of sand, at $0.75 per cu. yd	174.00
Lumber in 15 sections of 12-ft. forms, 3,900 ft. B. M., at $30 per M.	117.00
Lumber for expansion joints, 750 ft. B. M., at $30 per M.	22.50
Lumber for spreaders, runways, etc., 750 ft. B. M., at $30 per M.	22.50
Water purchased from the city of Tucson, 21 days at $2	42.00
Hauling steel reinforcement	10.00
Depreciation of plant, breakage of tools, etc.	20.00
Office expenses and expenses of contractor and superintendent, amounting to about $2 per day for this gang, 21 days	42.00
Total	$3,540.55

Computations made on the above basis for 298.9 cu. yds., the cost was $11.845 per cubic yard. However, there were in addition the following costs to the Tucson Farms Co.:

9,300 lbs. of steel, at $0.04	$372.00
One coat of cement wash, 34,500 sq. ft., at $0.0025	86.25
Engineering, about 5 per cent	195.00
Total	$653.25

On this basis the actual cost of the completed lining was $14.03 per cubic yard.

Central Oregon Irrigation Co., Deschutes, Ore.—The north canal of this company is concrete lined and diverts water from the Deschutes River, a short distance below Bend, Ore. A 1:4:5 mixture of Portland cement, sand, and crushed rock was used on this work, the extra amount of sand being required to replace a considerable portion of the grout lost in the dry wall back of the lining. In preparation for lining the earth slopes, made 1¼ to 1 to avoid the necessity for forms, were finished to within 4 ins. of the inner surface of the completed work. The rock slopes, however, were so badly broken that it was necessary to fill cavities with hand-laid dry walls (Fig. 8). Sectional forms made of shiplap were used repeatedly on the 6,300 lin. ft. of canal through rock, but no forms were used on the 1,000 lin. ft. of canal in earth. Expansion joints spaced at 12-ft. intervals along the sides and bottom were made of ¼x4-in. wooden strips left in the finished concrete.

Davis & Weber Counties Canal Co., Ogden, Utah.—During the years 1909 and 1910 this company enlarged and concrete lined 9½ miles of its main canal. When the canal was built in the eighties it carried less than 100 sec.-ft., but its capacity has been increased from time to time until in 1909 it reached 200 sec.-ft. It has been difficult and expensive to maintain this canal owing to its location near the top of a steep hillside flanking the Weber River on the south. In July, 1893, a series of current meter measurements made to determine the seepage losses throughout its length showed a discharge at the headgate in Weber Canyon of 105.5 sec.-ft. which in 9½ miles seepage had reduced to 78½ sec.-ft., representing a loss of 26 per cent of the total diversion from the river. This seepage water found its way into the steep hillside and during 25 years of its operation as an unlined canal produced an endless variety of slides throughout a length of 7 miles. In fact, the whole hillside for this distance seemed to have been subjected to a severe earthquake shock. Tracts, several acres in extent, traversed by the canal have been known to drop through a vertical height of 7 ft. as a result of the action of seepage waters on the underlying materials, and buildings located more than 600 ft. from the center line of the canal have been removed from the path of the slides.

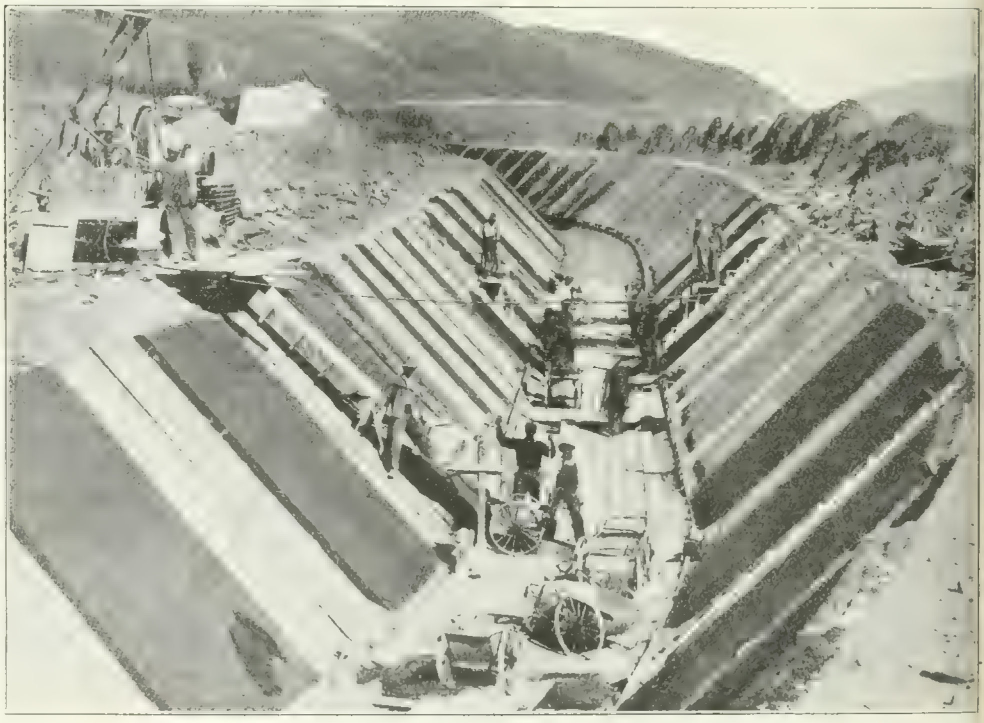


Fig. 15. Methods Used in Construction of Concrete Lining for Open Channel, Los Angeles Aqueduct.

In the fall of 1909 the company undertook to enlarge and concrete line this canal and to provide for a miximum carrying capacity of 725 sec.-ft. and at the same time retain the old location. This entailed the removal of a heavy growth of willows skirting the banks and a large amount of excavation. On account of the unstable character of the materials and the steep cross slope of the hill on which the canal is located the lining of so large a channel presented unusual difficulties. These have been met, however, and the canal successfully operated for the past two seasons.

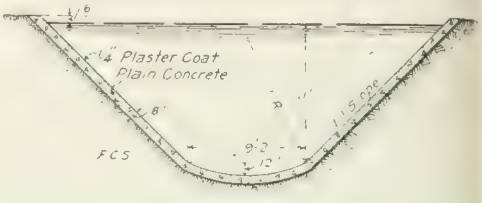


Fig. 14. Cross Section of Concrete-Lined Channel, Los Angeles Aqueduct, Los Angeles, Cal.

The canal was provided with drainage at various stretches along its length through the use of 6-in. drain tiling laid in longitudinal trenches 10 to 20 ins. deep. At intervals of about 800 ft. these drains were connected to cross drains of the same construction to convey the drainage waters to the outside of the outer canal bank.

It was at first proposed to use a 6-in. thickness of lining, but this was reduced to a 4-in. thickness for all but the worst portions. Figure 9, *a*, represents a cross section of 4-in. lining used for the greater portion of the channel. Where the canal bank was weak and where slides were liable to occur, a form as shown in Fig. 9, *b*, was adopted. In reducing the thickness from 6 to 4 ins. a somewhat richer mixture was used and more precautions were taken to secure good drainage. The specifications for concrete called for a 1:2:4

TABLE I.—SUMMARY OF DATA ON VARIOUS CANAL LININGS.

Name of canal or system and location.	Size of canal.			Length lined, miles	Thickness of lining, inches.	Mixture used.	Cost of cement per barrel delivered.	Cost of sand and gravel, per cu. yd.	Wages per day.	Total cost per sq. ft. of lining.	Remarks.
	Bottom width, feet.	Depth, feet.	Side slopes.								
Tucson Farms Co., Arizona.	2-4¾	3	1-1	2½	3	1:4:4 and 1¼:4.4	$3.24	....	$2.00	......	Reinforced concrete, $14.03 per cu. yd.
Belgo-Canadian Fruitlands Co., British Columbia	¾-5½	2¾	½-1	4½	2½-3	1:2:4	3.75	....	2.75 $3.00-4.00	$0.118 .130 .142	See p. 70; data are for laterals only.
Los Angeles Aqueduct, California	....	....	......	37	....	1:6 and 1:5	....		....	......	Concrete, about $5 per cu. yd. in place.
Modesto Irrigation District, California	34-44	7-5	2-1	0.43	2⅜-2½	....	....		....	.....	Lining in some of the fills reinforced with No. 6 wire fabric.
Patterson Land & Water Co., California	4½-7	......	1½-1	....	3¼	1:6 or 6½				......	3-in. concrete plus a ¼-in. 1:2 coat of mortar.
South San Joaquin Irrigation District, California	11.36	11	¼-1	7	bottom, 4 sides, 4-6	1:3:6	...			.....	Concrete, $11.50 per cu. yd. in place.
Turlock Irrigation District, California	40	....	⅕-1	....	walls, 4 floor, 6	1:3:5				.....	Length, 365 ft.; reinforced with No. 6 wire mesh and 2½-in. bars; concrete in place, $16 per cu. yd.
New York Canal, U. S. Reclamation Service, Idaho	40	8	1½-1	6½	4	1:3:6			2.50	.14	Surface painted with 1:2 mortar; cost of lining per lin. ft., $9.64.
North Side Twin Falls Land & Water Co., Idaho	40-60	.....	1¾-1 and vertical	1.59	earth, 4 rock, 6-8	1:3:6 and 1:6			.....	.	Concrete cost $16.50 per cu. yd.
Payette-Boise Project, Idaho	40	8¼	1½-1	1.82	4	1:3:6	...	..	*5.00	.....	Surface 1:2 mortar; laid in cold weather; some heating required; labor for mixing and placing concrete, $2.20 per cu. yd.; entire cost of lining, $9.64 per lin. ft.
Ridenbaugh Canal, Idaho	10	6½	1½-1	2	3½	....	.....	.....	....	......	In addition, a ½-in. coating of cement mortar.
Truckee-Carson Project, No. 1, Nevada	20	....	½-1	.95	6	1:3:5	2.55	....	....	.166	Does not include riprap backing.
Truckee-Carson Project, No. 2, Nevada	8.9	....	½-1	1.4	6	1:3:5	2.55	.....	....	.16	
Central Oregon Irrigation Co., Oregon	.....	....	....	....	....	1:4:5	.....	.....	....	......	
Umatilla Project, Canal M, Oregon	4	4	1¼-1	2.35	1½	mortar 1:4	2.40	$0.85	2.40	.062	A 4 by 3-in. curb at the top.
Umatilla Project, Canal L, Oregon	2	2½	1¼-1	.6	1½	mortar 1:4	2.00	2.75	2.40	.054	
Umatilla Project, Canal T, Oregon	3	3	1¼-1	1.0	1¾	mortar 1:4	2.25	1.20	2.40	.069	Do.
Umatilla Project, Canal A, Oregon	15	5	1¼-1	.6	2	mortar 1:4	2.30	1.25	2.40	.071	Side lined only.
Umatilla Project, other canals, Oregon	1-4	1½-3½	1¼-1	1.7	1½	mortar 1:4	2.85	1.25	2.40	.085	Scattered portions only.
Medina Valley Irrigation Co., Texas	.	....	3-1	.45	....	....	.....	.....	1.50-1.75	0.21	Cost includes back fill.
Davis & Weber Counties Canal Co., Utah	.	..	......	9.5	mostly 4 some 6	1:2:4 and 1:2½:5					6-in. drain tiling used below a portion of the lining.
Burbank Power & Water Co., Washington			....	.76	....	1:2½:4½	3.25	1.75	2.25	......	Cost of concrete in place, $12.50 per cu. yd. + 7 per cent for engineering.
Hanford Irrigation Co., Washington	8	.	1½-1	5.6	¾-1½	....	4.52	2.27	....	.051	Water per cu. yd. concrete, $0.39; not first-class construction.
Lower Yakima Irrigation Co., Washington	11.5	....	1½-1	5	1¾	1:3:4	3.10	.....	†2.50	.065	Contract for mixing and laying, $0.025 per sq. ft.
Northern Pacific Irrigation Co., Washington	3-3.5	2.2-1.5	½-1	4.3	2	1:3:4	3.00	1.75	2.50	.122	Work done in cold weather; heating required.
Yakima Project, U. S. Reclamation Service, Washington	...	....	....	....	....	....	.....	....	....	......	49,494 lin. ft. of canal lined, at $32.05 per cu. yd. of concrete in place, or $7.42 per lin. ft. of lining. Work in rough country.

*For 8 hours. †For 10 hours.

Portland cement, sand, and gravel mixture, on which the contract price per cubic yard for concrete in place was $6.80, while for a 1:2½:5 mixture, also used, $6.45 was paid. On all straight portions of canal the concrete was laid in sections 20 ft. wide. That placed on the bottom was first tamped into place and then carefully floated and smoothed. It was afterwards covered with sand kept moistened for a period of seven days by sprinkling. A 1:2 mortar of cement and sand was troweled over the surfaces of the slide slopes soon after the concrete had been tamped in and the forms removed. The slopes were then covered with burlap and kept moistened as described. The construction methods used on this canal are shown in Figs. 10 and 11. A tapering strip of wood, as shown in Fig. 2, *h* (E. & C., Jan. 27, 1915, p. 72), forms the expansion and contraction joint between each section of concrete. The specifications called for the removal of these strips and the filling of the spaces with hot asphalt, but this was not done.

Turlock Irrigation District, Turlock, Cal.—In 1910 this district made a hydraulic fill inclosing an old unsafe wooden flume on trestles across Peasley Gulch, and in the fall of that year, after the canal was emptied, the wooden flume box was removed and a concrete lining substituted. The lined section is 365 ft. long, with a bottom width of 40 ft. The side walls, 4 ins. thick and 9 ft. high, are reinforced with No. 6 wire fabric (6x6 ins.) and have a batter of 1/5 to 1. Buttresses with the same batter are built at 8-ft. intervals back of the lining and similarly reinforced. The floor, which is 6 ins. thick and of the same construction as the sides, is concaved, being 1 ft. lower at the middle than at the sides. Concrete floor ribs 12 ins. deep and 8 ins. wide are spaced equally with the buttresses and reinforced with two ½-in. steel bars. The lining is made of 1:3:5 concrete placed behind wooden forms and cost $16 per cubic yard. It has no joints and no cracks of importance have developed.

Modesto Irrigation District, Modesto, Cal.—Considerable concrete lining has been constructed to date in Modesto main canal, but all of it is for providing increased safety, and the small saving of seepage secured is merely incidental.

In the narrow canal sections near the headworks the velocities range from 5 to 8 feet per second. Where it has seemed necessary to provide considerable slab strength, the floor lining is from 4 to 6 ins. thick. The linings for hydraulic fills recently completed are 6 ins. thick and reinforced with No. 6 wire fabric 6x6 ins.

Linings of 2⅜ to 2½ ins. thickness have been used on four stretches of lined canal having lengths of 250, 250, 575 and 1,000 ft., respectively. The bottom width is 44 ft. and water depth of 5.5 for the first three and 34 ft. and 7 ft., respectively, for the fourth. All slopes are 2 to 1. In preparation for the linings the canal sections were carefully graded and aligned by chalk line and straightedge. Fills were made a little high, with loose sand where possible, and after saturating with water were graded. Fills as high as 10 ft. were graded and aligned within two or three days after the material was placed with a scraper, but they were made of clean sand thoroughly saturated with water. No settlement has been noticed. The lining was laid in cross strips 3 ft. long longitudinally, and these were imperfectly bonded to permit cracking at the joints. The latter, being numerous, permitted only narrow cracks, which are unimportant. It is said that in part of this lining the water reaches a velocity as high as 20 ft. per second at times and that no appreciable injury to the concrete has occurred after five or six years of use.

South San Joaquin Irrigation District, Manteca, Cal.—Concrete lining has been placed on 7 miles of the main canal, 3 miles of which is owned jointly with the Oakdale irrigation district. A typical lined channel has a bottom width of 11.36 ft., side slopes ¼ to 1, and is planned to carry a 9-ft. depth of water and allow 2 ft. additional for splash. This design, having a grade of 0.0775 per 100 ft., is intended to have a capacity of 850 sec.-ft. An excess grade for curves was computed from the following formula:

$$H_c = \frac{100\, v^2}{2 g r^2},$$

where *Hc* is the excess grade in feet per 100 ft.; *v* is the uniform velocity of water in feet per second; *r* is the radius of the curve in feet. The value of *n* for Kutter's formula was taken as 0.015. The lining thickness averages 4 ins. for the bottom and 4 to 6 ins. for the sides of the canal. A mixture of 1:3:6 concrete, placed behind forms and in alternate sections 12 to 16 ft. long, was used without allowing expansion joints. In many places where the channel is in rock cut no back forms were used, and in such case the alignment is irregular and follows the contour of the side walls. The cost of the concrete in the completed work was about $14.50 per cubic yard.

Burbank Power & Water Co., Burbank, Wash.—This company concrete-lined about 4,000 ft. of canal in 1910. The essential features of the design are shown in Fig. 12 and the construction is reported to be giving satisfactory results. The contract price of the concrete in place was $12.50 per cubic yard, and the engineering 7 per cent additional. The cement cost $2.75 per barrel at Burbank and $3.25 delivered at the work. Gravel and sand having within 5 per cent of the proportions used were found within a mile of the work and for which the contractor paid $1.75 per cubic yard delivered. The lining is made of a 1:2½:4½ mixture of concrete and is formed in cross strips 3 ft. long.

Medina Valley Irrigation Co., San Antonio, Tex.—Concrete lining has been placed in 2,390 ft. of the main supply canal having in this portion of its length a capacity of 850 sec.-ft. The canal, located on a sidehill slope of 3 to 1, is excavated in limestone having some pockets of rotten limestone and adobe. The ground surface is covered with a layer of broken stone and debris.

The work of excavation and placing of the lining was let to contract. In order to keep a low excavation cost the contractor blasted heavily and for this reason needed a large amount of rubble backfill. Figure 13 shows the main features of construction and the dimensions of the section used. Joints are spaced 16 ft. apart, and while cracks have appeared no harmful results are anticipated. Mexican labor, used on the work, cost $1.50 to $1.75 per day. The concrete was hand mixed, and except for the filling of local voids no plastering was done. The use of poor lumber for forms left an uneven concrete surface. The contract prices were $0.90 per cubic yard for rock excavation, $6 per cubic yard for concrete in place, and $1.50 per cubic yard for dry laid rubble. The company paid for one-half the rubble needed for back filling the overbreakage. For the entire 2,390 ft. of canal lined the costs per foot are:

	Approximate actual cost.	Cost to the company.
Excavation	$7.86	$10.56
Rubble	1.56	.86
Concrete	3.11	3.27
Cement	1.80	1.80
Total	$14.33	$16.49

Cement cost $2.40 per barrel delivered at a point on the railroad nearest the work. The cost of the concrete per square foot was 19 cts.

The Los Angeles Aqueduct, Los Angeles, Cal.—About 37 miles (196,402 ft.) of canal forming part of this aqueduct is concrete lined. The excavation was made with a steam shovel, and some of the excavation was in very rocky ground. The slopes and bottom of the channel left rough by the steam shovel were brought to a fairly even surface by trimming off the high places, and the low portions were shoveled full of moist earth which was tamped to place. The guideboards set to allow a slab length of 12 ft. were held to place by stakes driven into the earth. In placing the concrete for lining, a platform was built half way up the slope, and in order to reach the upper half of the slope the concrete was handled a second time from this platform. Alternate slabs were first laid and these were brought to surface by the use of a straight-edge supported on the guideboards. After this concrete had set and the forms were removed the intermediate slabs were concreted in and brought to a true surface, using the straightedge on the hardened slabs as guides. A 1¼-in. plaster coat of 1:2 mixture was finally applied. The bottom lining was afterwards laid continuous and with a curved bottom as shown in Fig. 14. The work of construction is shown in Fig. 15. This canal was designed to carry 923 sec.-ft. of water at a mean velocity of 4.05 ft. per second. The coefficient of friction *n* was taken at 0.014. No reinforcement was used, and on most of the work the lining is made of a concrete mixture having 1 part cement to 6 parts sand and gravel, but in some portions a 1:5 mixture was used. A blended mixture of one-half tufa and one-half hydraulic cement was used for all the lining. The total cost of the concrete per cubic yard in place was about $5, and the materials used in a cubic yard of concrete cost about as follows: Cement, $2.60; sand and gravel, $1; and mixing and placing, $1.

Ridenbaugh Canal, Boise, Idaho.—The 2-mile portion of this canal, which is concrete lined, is along a gravelly sidehill that had formerly caused large seepage losses and expensive maintenance. The lining has a 3½-in. base overlaid with a ½-in. top coating of cement mortar hand-troweled to a very smooth and even surface. The canal has a bottom width of 10 ft., 1½ to 1 side slopes, and a vertical depth of 6½ ft. At the top of the lining a 1-ft. berm extends back into the bank. When carrying a 6-ft. depth of water the canal has a capacity of 615 sec.-ft. The lined portion of this canal offers an example of unusual care in construction to obtain a smooth interior. Its curves have been spiraled throughout. The lining is made up of 16-ft. sections on tangents and 12-ft. sections on curves. The exact shape of the finished section was secured by the use of a template, Fig. 16, having the same area as the cross section of the finished canal. The concrete was laid continuously. Adjoining slabs were separated by one thickness of tar paper and connected by short lengths of ½-in. steel rods used as dowel pins. The entire surface of the lining was plastered and smoothed with a steel trowel as soon as the concrete had set sufficiently to permit it, and which doubtless accounts for the absence of surface scaling. No displacements due to pressure, settlement, or buckling are to be found in this lining. The only cracks which have appeared are those at the expansion joints. It has been noticed that in the summer these, found to be about 0.025 to 0.030 in. wide in the morning, are tightly closed by 1 or 2 o'clock in the afternoon.

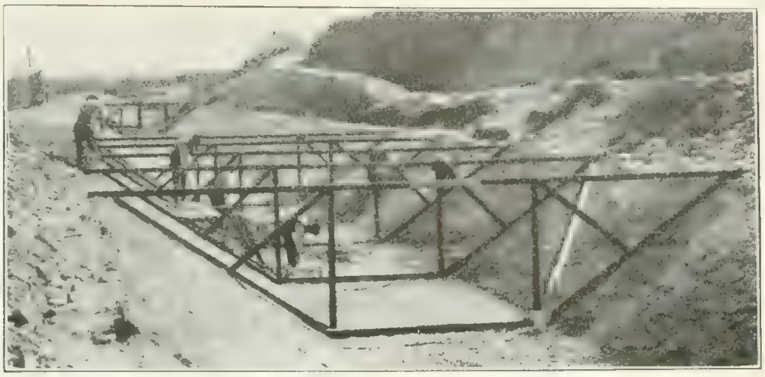


Fig. 16. Templates Used in Preparing Earth Section for Concrete Lining, Ridenbaugh Canal, Boise, Idaho.

WATER WORKS

Design Features of Cottonwood Conduit and New Concrete Settling Basin at San Diego, Calif.

(Staff Article.)

The present article relates to the design features of the works of the Cottonwood conduit, at San Diego, Calif. Section 1 of this conduit extends from the intake of the present concrete conduit, known as the Dulzura conduit, along Cottonwood creek easterly for a distance of about 16,700 ft., to what is known as Salazar's lower dam site. The Cottonwood conduit is seven miles long and conveys such water as is let out of the Morena reservoir over sandy wastes and swamp lands. It was found that in transit from Morena to the end of the present Dulzura conduit about 44 per cent of the water was lost in these sands and swamps. The first section of the new conduit, 16,700 ft. in length, was let by contract and is still under construction. The second section was built by the city under force account and was completed Dec. 6, 1914. The third and last section is at present being built by city employes. This article relates largely to Section 1 and to the new settling reservoir.

SECTION I.

For a part of its length, about 2,000 ft., Section 1 runs along the steep mountain side which is covered with heavy boulders. The right of way was cleared for at least 10 ft. on each side of the conduit for its entire length. This clearing and grubbing included trees, logs, underbrush, sage brush and other perishable matter, and also loose rocks or other material likely to fall into the conduit.

In excavating in earth the earth was in no case plowed or loosened by machinery or blasting nearer than 6 ins. to the finished subgrade or the sides against which the concrete was placed. The remainder was removed by pick and shovel just before the concrete was placed. When soft material was encountered in the sub-grade it was removed and replaced by concrete or with selected materials, such as a proper mixture of clay and gravel thoroughly compacted by ramming or otherwise. Solid rock was held to include all loose boulders containing 1 cu. yd. or more and all hard rock of compact strata of 6 ins. or more in thickness requiring blasting in loosening. Loose rock includes boulders containing from 2 cu. ft. to 1 cu. yd., and all materials requiring the use of pick and bar and which cannot be plowed with a strong 10-in. grading plow when well handled and drawn by a 6-horse team. All other materials were classed as earth.

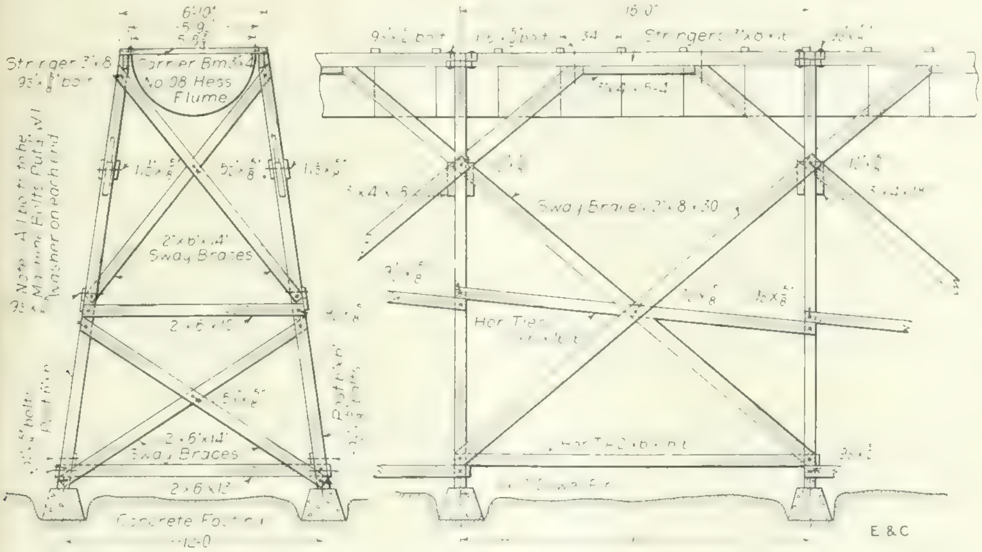


Fig. 1. Details of Trestle, of Height Exceeding 12 Ft., for Supporting Hess Metal Flume Portion of Cottonwood Conduit, San Diego, Calif.

Section 1 as a whole is subdivided into a steel flume section and a concrete conduit section. The latter is further subdivided into an arched form of covered conduit, a box type of concrete conduit and an open concrete conduit. The arched type of covered conduit may be described as of "pear-shape." At one point it has the following dimensions: the bottom is 4 ft. wide inside and is horizontal. The side walls, 4 ins. thick, are carried up vertically for a distance of 1½ ft. Above this level the wall consists of a circular arc of 3 ft. radius, the center of the circle being 1 ft. off the center line of the conduit section. This makes the section come to somewhat of a point at its top. The invert was built in sections not exceeding 15 ft. in length with keyed joints between adjacent sections. The placing of the key joint precedes the placing of the rest of the concrete by the time directed and proper care is taken to obtain a true, smooth top surface on the key block and it is coated with an approved nonadhesive substance. Pockets are left in the top of the concrete of such invert joints as may be necessary for the proper bonding of the expansion joints of the upper portion of the concrete to the invert. The upper portion of the conduit is built of some multiple of the length between the invert joints but in no case does this exceed 60 ft. Expansion joints are provided between the adjacent sections of the main body of the conduit. The covered box type is of variable area according to the grade and is designed to carry 70 cu. ft. of water per second. The open type of concrete conduit is of two classifications, "a" and "b." Class "a" has side slopes of 1:1 and is constructed without the aid of forms. Class "b" has side slopes varying from 1:1 to vertical walls. The open conduit is divided into 15-ft. sections by expansion joints. These joints are made by laying alternate sections of the conduit. The intermediate spaces which are left are filled in after the first sections have set for at least 24 hours. A proper form is placed in the end of each section, when laid, to make an offset joint. The first sections when laid are allowed to set 24 hours before the form, forming the offset in the end of the sections, is removed. After removing the form the joint in the end of the section is thoroughly cleaned of all crums and made smooth and perfect, then it is coated with an approved mixture of asphaltum and coal tar pitch and a layer of five-ply asbestos roofing felt is laid in the bottom and sides of the offset, after which the intermediate sections are laid completing the joint. Any air holes appearing on the inside surface of the conduit are cemented over after the forms are removed, and the entire inner surface is given a cement wash consisting of one part water and one part cement. After placing the concrete it is kept covered by very damp sand or is sprinkled with water to protect it from the heat of the sun until the concrete has set.

Metal Flume.—The design of the metal flume section is shown in Fig. 1. The metal of which this flume is composed is thoroughly galvanized with zinc spelter and the iron in it is at least 99.75 per cent pure. The method of supporting the flume at the adopted grade is clearly shown by the figure to which we refer. All joints in the metal flume are constructed to withstand leakage; the space between adjacent sections being filled with an approved mineral rubber or asphaltum cementing material which insures a smooth inner surface for the flume. The metal is No. 20 gage and the sectional area of the flume is either 10 or 12½ sq. ft. Figure 1 illustrates the detail of the trestle when 12 ft. high or over. The type of trestle and the footings for it are governed by the location of the flume. In some cases the concrete pedestals are dispensed with and the bent posts are anchored to rock in its natural bed. In general the side girders are 4x10 ins., the knee braces are 4x6 ins., the bent struts 6x6 ins., the wash boards 4x6 ins., the top struts 4x4 ins., and the bent posts are 6x6 ins. The bents are 12x16 ft. in plan. The contract price for placing concrete on Section 1 was $8.20 per cubic yard.

SECTION 2.

Section 2, which was built by the department's forces, consists of an open channel lined with concrete 4 ins. thick. The section is trapezoidal and is varied with the grade to give a carrying capacity of 70 cu. ft. per second. The actual cost of mixing and placing the concrete in this section, including overhead charges, amounted to $11.94 per cubic yard, as follows:

Item.	Cost per cu. yd. of concrete.
Cement	$4.75
Gravel	1.00
Sand	.50
Mixing and placing	1.25
Forms	3.50
Water	.15
Steel	.14
Equipment	.15
Overhead	.50
Total cost per cu. yd.	$11.94

CONCRETE SETTLING RESERVOIR.

The settling basin, shown in plan and sections in Fig. 2, is the outlet of the first section of the Cottonwood conduit and is the connecting link between that conduit and the old Dulzura conduit. The basin is 6 ft. deep and 100 ft. x 75 ft. in plan and has a baffle wall, as shown by section A-B, that deflects the current as the water passes in from the conduit. There is a weir section about 90 ft. long that stills the current and allows the flow to pass into a trough and thence into the old conduit section.

In the construction of the new basin 126 cu yds. of concrete were placed at a cost of $8 per yard, and 1,500 cu. yds. of sand were excavated at 15 cts. per yard. The slabs forming the bottom and sides of the reservoir are 4 ins. thick and consist of 1:2½:5 concrete laid on 6x8-in. concrete beams which act as expansion joints. The slabs are 10x11 ft. in plan and were laid in checkerboard fashion. After placing the concrete was allowed to set for seven days and was then covered with an approved asphaltum mixture which is guaranteed not to crack in the winter or to flow in the summer.

In section A-B is shown a driveway 10 ft. wide which provides access to the basin for the purpose of removing the settled-out sand,

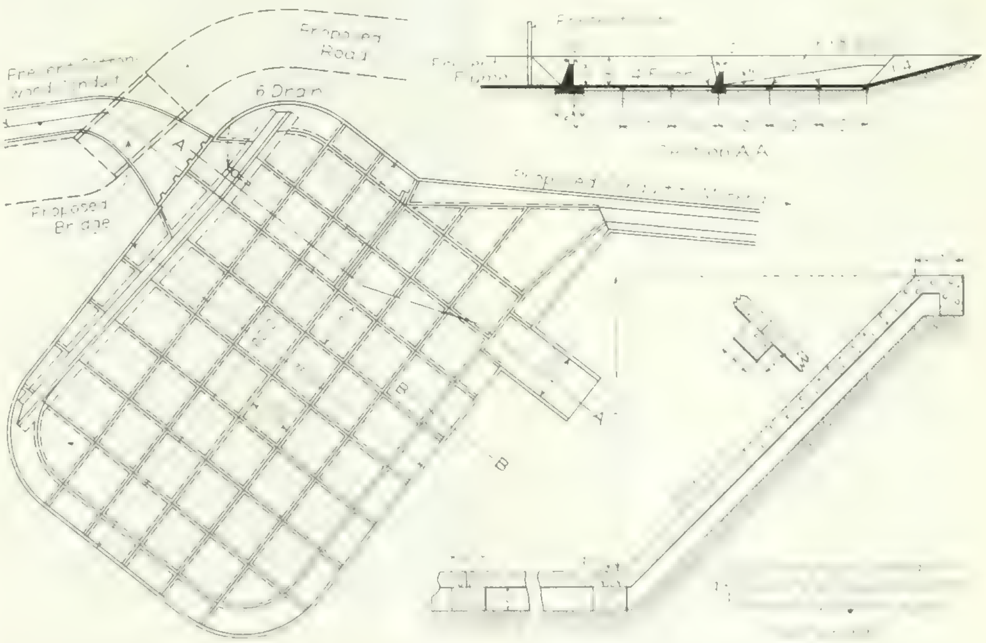


Fig. 2. Details of New Concrete Settling Basin, Cottonwood Conduit, San Diego, Calif.

either by shoveling to a wagon or by use of a slip scraper.

ACKNOWLEDGMENT.

Mr. D. L. Bissell was the contractor on this work. Mr. H. A. Whitney is hydraulic engineer of the Department of Water and Mr. H. R. Fay is Superintendent. We are indebted to Mr. Whitney for the information here given.

Placing Concrete in Wall and Dam of Water Supply Reservoir at Montreal by Compressed Air Method.

(STAFF ARTICLE.)

The accompanying sketch, Fig. 1, shows the arrangement of material handling plant employed in placing the concrete in the walls and dam of the new reservoir of the Montreal Water and Power Co. by the compressed air (Mac Michael) method. The cement used was unloaded from trolley cars on the track as shown. The sacks were unloaded by hand and were placed in the chute which carried them to the cement storage shed. A short siding on a trestle carried the aggregate past the cement shed. The crushed stone was dumped directly into the storage bin, over the mixer, as shown in Fig. 1, from side-dump cars. The capacity of this bin was 80 and of the cars 6 cu. yds., respectively. The sand was shoveled from box cars into an auxiliary bin, at one side of the pneumatic mixer, of a capacity of 500 cu. yds. The 80-cu. yd. working sand bin, over the mixer, was gravity fed from the auxiliary sand bin mentioned. The sliding gates, hand operated, regulated the discharge of stone and sand into the proper compartments of the measuring hopper shown. Cement was gravity fed from its storage shed into the stone compartment of the hopper. Water was applied to the contents of the hopper as they were discharged into the mixer.

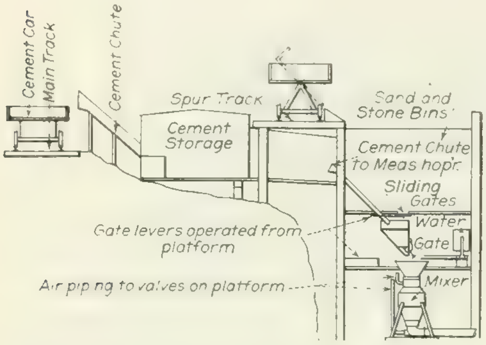


Fig. 1. Sectional Diagram Showing Arrangement of Material Handling Plant and Mixer for Placing Concrete Walls and Dam of New Reservoir at Montreal by Compressed Air Method.

The discharge pipe from the mixer extended to the forms and varied in length from time to time. This was an 8-in. steel pipe provided with flange joints of a special design to facilitate adding or removing sections. The mixed concrete was discharged directly into the forms from the end of the conveying pipe or from a boot at the end of the pipe as shown in Fig. 2. The latter figure is a view taken during the pouring of the dam where the lift was 37 ft. The conveyor pipe was being made ready for the concreting of the next section of the dam. At bends the pipe line was firmly secured to resist the side thrust produced by the inertia of the heavy moving mass of concrete. The sections were poured in three lifts of 15, 30 and 37 ft., respectively. The maximum length of discharge pipe was 600 ft., which included the 37-ft. lift. In this line the total curvature aggregated 400°. At this distance pauses were necessary between the discharge of successive batches to allow the air receiver to fill sufficiently. The wall was poured in alternate sections containing about 30 cu. yds. and this necessitated many shifts of forms and discharge piping thus delaying the work. Concrete was placed by the method described in zero weather without difficulty, the aggregate being heated.

Concreting Dam.—Table I gives a summary of the progress of the work in concreting the dam in the reservoir. Work was carried on in day and night shifts. In the work on the dam there were 54 shifts to place 8,122 cu. yds., or 150 cu. yds. per shift. The cost of labor on the day shift averaged $19 and on the night shift $27, or an average of $23 per shift. Thus the labor cost was 15½ cts. per cubic yard of concrete placed; the corresponding figure for power was 4.7 cts. per cubic yard. The average gang consisted of six men charging the mixer, including the operator, an extra cement wheeler, a foreman, and from two to eight men on the pipe and forms. The best day's run was 436 cu. yds. in 7½ hours. On this run the cost of labor per cubic yard was 6.1 cts. and the cost of power was 1.6 cts.

Concreting Wall.—The wall contained 2,600 cu. yds. and was poured in 26 shifts. The average daily cost for labor was $17.50 and for power $7. This gave a cost for labor and power of 24½ cts. per cubic yard. The average gang on the wall concreting consisted of two men handling cement, three handling aggregate, one mixer operator, one water man, one foreman and one to three men on forms and pipe line. The distance transported ranged from 100 to 600 ft. All wall concrete was lifted 40 ft. Pouring was actually in progress 50 per cent of the time.

Plant.—The compressor used was a W. B. 2 Sullivan, steam driven, 705 cu. ft. machine. There were 1,100 ft. of 6-in. air pipe between the compressor and the mixer. There were two air receivers, one of 150-cu. ft. capacity at the compressor and one of 50 cu. ft. capacity at the mixer. The compressor was run from the boilers of the stone crushing plant and the cost of steam was prorated to the different engines on the basis of the horsepower required. Under this arrangement the power cost for the compressor per shift was $7.

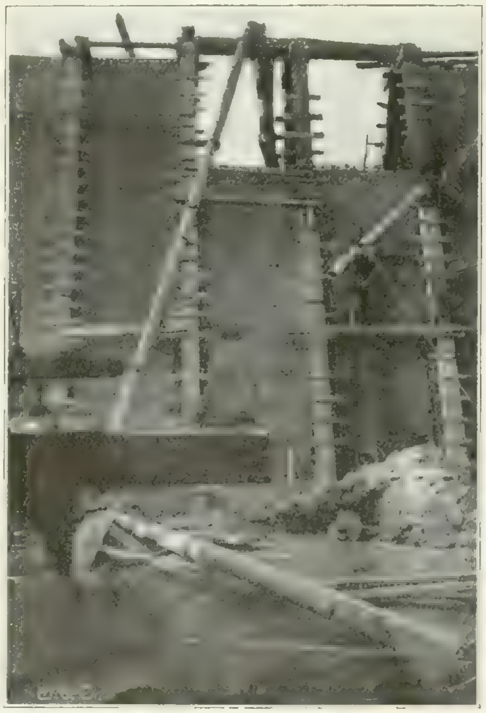


Fig. 2. View Showing Pouring of Concrete Dam in New Montreal Reservoir by Compressed Air Method.

ENGINEERS AND CONTRACTORS.

The mixer was furnished the general contractors, Laurin and Leitch, by the Pneumatic Concrete Mixing and Placing Co. of Montreal, the Canadian agents for the Mac Michael system of concreting. The Concrete Mixing and Placing Co., of 123 W. Madison St., Chicago, are the American agents. Mr. F. H. Pitcher, general manager and chief engineer of the water company, was in direct charge of the work.

TABLE I.—DATA ON PLACING CONCRETE IN DAM OF MONTREAL RESERVOIR BY COMPRESSED AIR METHOD.

No. of shifts.	Distances transported, in ft.	*No. hours pouring.	Cu. yds. poured.	Cu. yds. per hr.	Cu. yds. per shift.	Ratio hrs. pouring to ttl. hrs.	Avg. labor and power cost, cts.
32	180-300	227	4,181	18.5	130	70%	21
22	100-180	126	3,941	31.5	180	58%	17
54	100-300	353	8,122	23	150	65%	19

*Includes pipe repairs and minor changes.

Cost of Test Pitting.—The following are actual costs given in the "Engineering and Mining Journal" of test pitting in hard clay and hardpan with many large boulders, where the ground dulls the picks rapidly. Foreman's wages were $3; laborers, $2. Two-inch hardwood plank was used for cribbing when necessary. No superintendence or office expense charged.

Pit.	Depth, feet.	Hours labor.	Cost.	Per foot.
1	17	80	$18.00	$1.06
2	24	140	29.00	1.21
3	7	15	3.50	0.50
4	22	75	16.50	0.75
5	23	100	24.00	1.04
6	26	240	48.00	1.84½
7	41	270	56.00	1.366
8	46	335	72.50	1.58
9	38	255	64.00	1.70
10	33	240	54.00	1.67
11	10	60	12.00	1.20
12	9	100	22.00	2.444
13	9	20	4.00	0.444
14	17	60	12.00	0.706
15	12	55	12.50	1.00
Filling pits Nos. 1, 2, 3, 4			6.00	....
Filling pits Nos. 5, 6, 7, 8, 9, 10			35.00	....
Filling pits Nos. 11, 12, 13, 14			7.00	....

The contract price for sinking a test pit in sandy soil and doing all necessary cribbing, all supplies to be furnished and tools sharpened free of charge, to 20 ft. in depth is $1 per ft.; from 20 to 30 ft., $1.25 per foot.

International Engineering Congress.—The technical success of the International Engineering Congress to be held at San Francisco in 1915, is now well assured. Notwithstanding the difficulties arising as a result of the present European war, the Committee on Papers is able to count on from 200 to 250 papers and reports covering all phases of engineering work and contributed by authors representing some 18 different countries. The Congress will, therefore, be truly international in scope and character, although the representation from the countries involved in the European war will naturally be less than originally planned. The papers are now rapidly coming in and their character gives the fullest assurance that the proceedings will form a most important collection of engineering data and a broad and detailed review of the progress of engineering art during the past decade. The Committee on Management is now issuing to all important engineering societies, in this country and abroad, invitations to appoint official delegates to attend the sessions of the Congress, and the presence of a considerable body of such delegates is well assured. Membership in the Congress with the privilege of purchasing any or all of the volumes of the proceedings is open to all interested in engineering work. For full particulars, apply to W. A. Cattell, Secretary, 417 Foxcroft Building, San Francisco, Cal.

An analysis of water in East Grand Forks, Minn., made recently by the State Health Department, showed the number of bacteria to be 4,370 in the river water and 20 in the filtered water. There was no evidence of B. coli in the 10 cc. of the filtered water. These figures show that 99.5 per cent of the bacteria are being removed by the filtration process.

Engineering and Contracting

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CONCRETE: New Processes and Appliances.

The New Concrete Construction Processes and Appliances 113

Editorial calling attention to the Cement Show and briefly noting some of the newer features of concrete construction work. E. & C., Feb. 10, 1915; 2½ cols.

ROADS: Concrete, Handling Materials.

Recent Improvements in the Methods of Handling Materials in Concrete Road Construction 113

Discusses editorially the use of traction engines, motor trucks and industrial railways in the hauling of road materials, road finishing machines and concrete mixers, and recent improvements in methods of construction. E. & C., Feb. 10, 1915; 1 col.

DESIGN: Detailing; Importance of.

The Designing of Details................. 114

Editorial comment on the slight esteem in which structural detailing has been held. Emphasizes the importance of the subject and the need of a better knowledge of it. E. & C., Feb., 10, 1915; 1 col.

ROADS: Concrete, Kinks in Construction.

Practical Kinks in Concrete Road and Pavement Construction 114

Discusses practical kinks in concrete road and pavement construction: grading, water supply, mixing, placing finishing, integral curbs, tools, protection plates, and hauling materials. Gives in detail the design of a sack bundling rack for saving cement sacks. E. & C., Feb. 10, 1915; 12½ cols.

ROADS: Concrete; Illinois; Day Labor.

Methods and Cost of Concrete Road Construction by Day Labor Under the Supervision of the Illinois Highway Commission 118

Discusses details of concrete road construction and describes experiments with various types of joints. Data for several years are given concerning cost and other items. E. & C., Feb. 10, 1915; 6 cols.

BRIDGES: Columbia Highway, Oregon, Design of.

Design Features of the Various Types of Reinforced Concrete Bridges Along the Columbia Highway in Oregon.......... 122

Describes and illustrates the design features of some unusual reinforced concrete bridges along the Columbia Highway, Multnomah Co., Ore. These bridges offer some interesting studies in reinforced concrete highway bridge construction. E. & C., Feb. 10, 1915; 8½ cols.

BRIDGES: Estimating Curves for Highway Types.

Estimating Curves for Standard Bridges of the Illinois Highway Department.... 123

Gives data and a set of curves for estimating the quantities of materials in various types of highway bridges designed by the Illinois Highway Department. These curves cover the range of work designed and supervised by this department in Illinois. E. & C., Feb. 10, 1915; 8 cols.

STREAM IMPROVEMENT: Mansfield, O.; Enclosure in Reinforced Conduit.

Proposed Method of Enclosing a Stream in Reinforced Concrete Conduit Through Mansfield, O........................... 126

Describes local conditions calling for stream improvement and describes proposed engineering works. Conduit consists of adjacent two compartments, the larger for stream flood flow and the smaller, of varying cross-section, for intercepted surface and storm water along the route of the main conduit. Explains apportioning of cost on properties benefited. E. & C., Feb. 10, 1915; 3½ cols.

SEWERS: Storm Water, Design and Construction.

Design and Construction of the Market Street Flood Channel, Burlington, Ia.. 127

Illustrates design, describes construction difficulties, plant and methods; gives organization of construction forces and daily progress of gangs. E. & C., Feb. 10, 1915, 1½ cols.

CONCRETE: Depositing Under Water

Cost of Depositing Concrete in Bags Under Water 128

Describes methods and gives costs of depositing concrete in bags for an anchorage for submerged outfall. E. & C., Feb. 10, 1915; 1 col.

SEWER SIPHONS: Reinforced Concrete; in Connection with Subways.

Design and Construction Features of Reinforced Concrete Sewer Siphons Under New York Subways. 123

Describes design and construction methods. Discusses advantages and limitations of inverted siphons in sewers in connection with construction of subways. E. & C., Feb. 10, 1915; 3 cols.

SEWERS: Sanitary, Upper Alton, Ill.

Design, Construction and Cost of New Sanitary Sewerage System at Alton, Ill. 129

Describes design features, enumerates difficulties encountered and construction methods employed. Gives daily progress data for two types of trenching machines. Describes methods employed in driving a 1,000-ft. tunnel. E. & C., Feb. 10, 1915; 2½ cols.

IRRIGATION: Concrete Canal Linings:

Methods and Costs of Constructing Concrete Lining for Twenty Irrigation Canals 130

Describes and illustrates some twenty examples of design and structural features of concrete lining for irrigation canals. Gives methods and costs of construction and calls attention to both the good features and doubtful practices in the representative work chosen from various localities. Data obtained from report of the Chief of Irrigation Investigation. E. & C., Feb. 10, 1915; 18½ cols.

CONDUIT AND SETTLING BASIN: San Diego, Calif.; Design Features of.

Design Features of Cottonwood Conduits and New Concrete Settling Basin at San Diego, Calif............................. 136

Describes and illustrates design of settling basin and design of steel flume on wooden trestle. Also describes design of open and covered concrete sections of conduit and gives data on cost of concrete on one open section. E. & C., Feb. 10, 1915; 3 cols.

RESERVOIR: Montreal, Concrete, Construction by Compressed Air.

Placing Concrete in Wall and Dam of Water Supply Reservoir at Montreal by Compressed Air Method................ 138

Illustrates arrangement of plant for handling concreting materials by gravity flow to pneumatic mixer. Describes work done and gives cost and output data. E. & C., Feb. 10, 1915; 2 cols.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.! 76 Appraiser's Stores Bldg., San Francisco, Cal. ,and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Conveying Machinery.—Manager of abattoir in Russia wishes to correspond with American manufacturers and exporters of aerial railroad equipment for the transportation of meat. No. 15,500.

Iron and Steel.—A commission agent in France desires to represent American manufacturers of iron and steel products, wire, nails, screws, nuts, metal furniture, household articles, and agricultural implements. No. 15,501.

Steel Rails.—Railway company in Far East is in the market for 60-lb. steel rails, with fishplates, nuts, bolts, etc. It is proposed to construct about 20 miles of roadbed. Quotations should be made c. i. f. destination. No. 15,502.

Portable Sawmill.—Business man in South America desires to purchase a portable sawmill to be used in cutting timber running from 8 to 30 ins. in diameter. The machinery must be such that it may be transported by pack mules, etc. C. i. f. prices, and detailed information should be sent at once. Correspondence should be in Spanish, and all weights and measurements given in the metric system. No. 15,504.

Machinery.—Business men in the Far East are contemplating construction of flour mill of 100,000 lbs. daily capacity. No. 15,510.

Steam Turbines and Engines.—A merchant in Russia wishes to be placed in communication with manufacturers of steam turbines and steam engines. It is desired to purchase such engines, etc., as will permit the use of back steam, under pressure, to be used for drying and boiling purposes. Correspondence may be in English. No. 15,485.

Engines, Pumps, Motors, Etc.—A commercial traveler, with engineering experience, desires to obtain an exclusive agency for the sale of American goods in Spain. He is interested in gas, gasoline, kerosene and crude-oil engines; pumps and pumping machinery; electric motors; and miscellaneous machinery, tools and accessories. No. 15,475.

Machine Tools.—Business man in France desires to be put in communication with American manufacturers of machine tools of all kinds. Correspondence may be in English, and quotations should be given c. i. f. French ports. No. 15,476.

Locomotives.—The Chilean State Railway will receive tenders for the supply of 10 locomotives, of meter gage, to be delivered at the port of Coquimbo ready for service. Plans and specifications, etc., may be obtained from the Departmento de Materiales y Almacenes (Estacion Alameda), Ferrocarriles del Estado, Santiago, Chile, at which address tenders will be received until Feb. 27, 1915. No. 15,530.

Construction Material.—A representative of manufacturers of technical construction materials, rolling mill and foundry products, in one of the neutral European countries, has written an American consular office stating that he desires to establish commercial relations with American manufacturers of copper; nickel; tin; brass; tin plate; dynamo plate; steel sheeting; bronze in bars and sheets; seamless pipes and tubing; silver, platinum, and brass tubing; tool, cast, and hoop steel; steel wires; fibers; vulcanized rubber; asbestos; electrical instruments and apparati, etc. He desires to secure sole agencies. No. 15,546.

Contractors' Machinery.—A firm in Great Britain which deals in contractors' supplies, wishes to get into communication with American manufacturers of labor-saving machines, tools, and general supplies for contractors. No. 15,551.

Power Transmissions, Etc.—Firm in Switzerland, which has branch offices in Italy and Belgium, is desirous of communicating with American manufacturers of engineers' supplies and technical specialties, such as power transmissions; driving belts; lubricating apparati; oil filters; oils and greases; water, steam-pipe, and refrigerator insulations; and ventilators and fans. No. 15,515.

INDUSTRIAL NOTES

Mr. Edgar M. Hagar has resigned as president of the Universal Portland Cement Co., and will assume the presidency of a new company which he is forming to acquire a chain of Portland cement plants covering a large part of the United States. Mr. B. F. Affleck, heretofore general sales agent, has been elected president of the Universal Portland Cement Co.

Mr. Arthur C. Vicary, formerly of Lorain, O., has recently assumed the duties of sales manager of the steam shovel department of the Ball Engine Co., of Erie, Pa., which is now placing a line of revolving steam shovels on the market, under the name of the "Erie" steam shovels. Mr. Vicary has been engaged in the design and sale of steam shovels for years, and is widely known to steam shovel users—particularly in the eastern section of this country.

Among the contracts recently awarded the MacArthur Concrete Pile & Foundation Co., New York City, are the following: Concrete pile foundation of the bridge to be erected over the St. John River between Van Buren, Me., and St. Leonard, N. B.; Van Buren Bridge Co., owners; Cyr Brothers Co., General Contractors, Waterville, Me.; W. J. Wilgus, Consulting Engineer, New York. Concrete piles necessary in connection with the Perry Memorial, Put-in-Bay, O.; Stewart Engineering Corporation, General Contractors, New York; J. H. Friedlander and A. D. Seymour, Jr., Associate Architects; Boller, Hodge & Bayard, Consulting Engineers. Foundation for 5,000,000 cu. ft. gas holder for Lynn (Mass.) Gas & Electric Co., the work including about 1,400 pedestal concrete piles and a 12 in. concrete slab.

Among the recent contracts awarded the Raymond Concrete Pile Co. of New York and Chicago are the following: Concrete piles for the building for the Brett Lithograph Co., Long Island City, N. Y. Wm. Higginson, architect. American Concrete Steel Co., General Contractor. Concrete piles for the foundation of power plant for the City Hospital, Cleveland, O. J. H. Wells, General Contractor. Concrete piles for apartment building on Delaware Place and Seneca St., Chicago, Ill. Wm. Ernest Walker, Architect. McLennan Construction Co., General Contractors. Contract has been awarded by the H. J. Heinz Co., Pittsburgh, Pa., to the Raymond Concrete Pile Co. for standard Raymond Concrete Piles and reinforced concrete footings for the extension to their large warehouse at the Pittsburgh plant. Concrete piles for the foundation of the Nurses' Home of the Methodist Episcopal Hospital, Brooklyn, N. Y.

NEW CATALOGUES

Forms.—Paper, folder. The Whalen Form, Syracuse, N. Y.

Illustrates the Whalen collapsible steel culvert form, and a number of finished culverts. Shows New York State standard sections.

Wagon Loaders.—Paper, 6½x9 ins.; 4 pp. The George Haiss Mfg. Co., 139th St. and Rider Ave., New York City.

Bulletin No. 215 describing Haiss standard wagon loaders, with specifications and several views of loaders at work.

Column Molds.—Paper, 7¾x8¾ ins.; 12 pp. Deslauriers Column Mold Co., 311-15 Chestnut St., St. Paul, Minn.

Bulletin D, describing the company's method of construction with the use of round adjustable metal forms, pointing out the advantages of round columns, and of steel molds. Also describes corrugated steel decking and its advantages.

Turbines.—Paper, 6x9 ins.; 64 pp.; The Terry Steam Turbine Co., Hartford, Conn.

Bulletin No. 19, on centrifugal pumps, giving details and data on various turbo-pump applications. It is well illustrated and shows a number of interesting special installations.

Sewage Ejectors.—Paper, 6¼x9½ ins.; 32 pp. Pacific Flush-Tank Co., The Temple, Chicago.

Catalogue No. 17, describing "P F T." automatic sewage ejectors and appurtenances, with tables and illustrations showing various arrangements of ejectors, etc.

Gravel Washer.—Paper, 5½x7½ ins., 12 pp. Stocker Concrete Material Washer Co., Highland, Ill.

Catalogue No. E25 describing the Stocker gravel washer, showing views of the machines and their operation and giving testimonial letters.

Concrete Silos.—Paper, circulars. Reichert Manufacturing Co., 1436-1440 Booth St., Milwaukee, Wis.

Show the Reichert equipment and method of constructing concrete silos. The adjustable mold is the distinguishing feature of the method.

Iron Working Machinery.—Paper, circular. H. P. Richardson, 80 E. Jackson St., Chicago.

Describes and illustrates beam shears, coping machines and punches manufactured by the company.

Paints for Railway Cars.—Leatherette, 6¼x9¼ ins.; 44 pp. Lowe Brothers Co., Dayton, Ohio.

Handbook of paints and varnishes for railway cars and structures, showing samples of some of the colors, with notes as to application, special uses, etc.

Water Meters.—Paper, 8x10¾ ins.; 12 pp. Buffalo Meter Co., 290 Terrace, Buffalo, N. Y.

Bulletin on water meter rates and regulations, containing articles on the Elements of a Meter Rate; How to Establish a Meter Rate; Rates of 709 Water Works and Meter Regulations.

Ventilating.—Paper, 8½x11 ins.; 12 pp. American Blower Co., 141 Broadway, New York City.

Describes the "Sirocco" ventilating system installed in the Fletcher Savings and Trust Co. Building in Philadelphia, and illustrates with diagrams and half-tone. "Sirocco" fans are also shown.

Good Roads.—Paper, 7½x10½ ins.; 16 pp. American Rolling Mill Co., Middletown, O.

The February number of The Highway Magazine, containing interesting articles on highway construction and maintenance, and showing by photographs and description the advantages of culverts made of Armco-American Ingot Iron.

Hoisting Equipment.—9¼x12¼ ins.; 68 pp. The John F. Byers Machine Co., Ravenna, Ohio.

Catalogue No. 21 showing steam hoisting engines, portable excavators, derricks, derrick cars and irons, hand-power hoists, builders' material, elevators, wire rope blocks and sheaves and other hoisting equipment for contractors and builders.

Crushers.—Paper, 7x9 ins., 3 bulletins. Chalmers & Williams, Inc., 72 W. Adams St., Chicago.

Catalogue L., 48 pp., the Bronze Ball Gyratory Crusher; Section A., 12 pp. Jaw Rock Breakers; Section R., 18 pp., Symons Disc Crusher. All illustrated and containing descriptive matter, data as to sizes, capacities, etc., and diagrams showing special features and general design of the machines.

CURRENT NEWS

The Doings of the Week.

Trade and industry as a whole showed a gradual advance during the past week. Many developments of importance have taken place in the past few days. One of the most encouraging of them was the heavy over-subscription of the $49,000,000 bond issue of the Pennsylvania. This offering was on the market for only one hour and was then withdrawn as the issue had been largely over-subscribed in that time. This is a good indication of the excellent investment demand that now prevails. Another favorable development was the export figures for January. According to telegraphic reports from the 13 principal custom ports, the exports for the month were in excess of imports by over $131,000,000. Baltimore, Md., disposed of an $8,500,000 municipal bond issue, and New York banking interests took up a $5,000,000 loan for the Province of Manitoba. Cleveland, O., announced that on March 8 it would sell $4,000,000 of bonds for water works, lighting and street improvements. The railroads continued their activity in placing orders for rails and equipment. During the week orders for steel rails totaling 81,000 tons were placed and contracts for 285,000 tons more are still pending In the construction field, judging from the volume of new work reaching the call for bids stage, only a fair showing was made. Some good-sized undertakings were placed under contract, and a few fair-sized jobs came up for advertising. Several large private building contracts were placed during the past week. One of them provides for a $1,000,000 hotel at Columbus, O. In the iron and steel trade a continued improvement has been shown during the past week. The Carnegie Steel Co.'s Ohio works began operating last Monday on 100 per cent capacity. Lackawanna Steel and Pennsylvania Steel Co.'s placed additional men at work, and the rail mill at Gary reopened this week with orders on its books that will keep it busy at full capacity for three months. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Feb. 3 were as follows:

Finished Iron and Steel.	Feb. 3.	Jan. 27.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.20	1.20
Iron bars, Pittsburgh........	1.10	1.10
Iron bars, Chicago............	1.00	1.00
Steel bars, Pittsburgh........	1.10	1.10
Steel bars, New York.......	1.26	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York......	1.26	1.26
Beams, etc., Pittsburgh......	1.10	1.10
Beams, etc., New York......	1.26	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh...	1.15	1.15
Steel hoops, Pittsburgh......	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.80
Galv. sheets, No. 28, P'gh...	3.00	2.90
Wire nails, Pittsburgh......	1.55	1.55
Cut nails, Pittsburgh.........	1.50	1.50
Fence wire, base, P'gh.......	1.35	1.35
Barb wire, galv., P'gh........	1.95	1.95

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railroads.—The outstanding development of the past week in this field was the excellent investment demand for railway securities. This was shown by the five-fold subscription to the $49,000,000 Pennsylvania R. R. bond issue. As a result many of the carriers will at once take steps for securing the necessary finances for their equipment and construction needs. In the last few days the Illinois Central R. R. has sold $10,000,000 bonds, and the Lackawanna $5,000,000. The Erie R. R. shortly will sell $13,400,000 and the Chicago, Milwaukee & St. Paul, $30,000,000. The New York Central Lines propose a $100,000,000 issue. As regards construction work there have been no developments of importance. There is good reason to believe, however, that in the next two or three weeks a number of important undertakings will be ready for bidders. Steps are now being taken to organize a syndicate to finance the $65,000,000 union terminal at Chicago, and it is likely that definite announcement will be made soon regarding the commencement of the work.

Roads and Streets.—No particularly large undertakings in the state highway field came up for bids last week. Maryland is asking proposals for 5 contracts aggregating 12.52 miles, but aside from this none of the other states appear to be calling for bids on any work. A number of municipal paving jobs are ready for bidders. Wilkes-Barre, Pa., is calling for proposals on 40,000 sq. yds. of sheet asphalt and 46,000 sq. yds. of vitrified brick; Pueblo, Colo., opens bids Feb. 15 on a $180,000 contract; Clearwater, Fla., opens bids Feb. 17 on paving work to cost $45,000. Whitlock & Gorrill, San Francisco, Cal., at $70,000 were low bidders on section C of the State Highway in Butte County, California; Consolidated Engineering Co., Baltimore, Md., was low bidder on the second section of the Key highway in Maryland; County Commissioners at San Antonio, Tex., awarded a 56-mile sand-clay contract; about $275,000 worth of road was placed under contract by various counties in Indiana.

Bridges.—The largest piece of bridge work coming up for bids the past week appears to be the construction of the approaches to the high wagon bridge at Winona, Minn. This will be about 1,700 ft. long and will cost about $100,000. Bids will be opened at Winona on March 1. The city of Concord, N. H., has awarded bridge contracts amounting to about $52,000. The Concrete Construction Co., Kansas City, Mo., was awarded the contract at $28,500 for the reinforced concrete bridge at Salina, Kan.

Drainage and Irrigation.—Several fair-sized contracts in both the irrigation and drainage fields are being advertised. The U. S. Reclamation Service is calling for bids on 640,000 cu. yds of excavation in the vicinity of Grand Junction and Fruita, Colo. The Kaw Valley Drainage District, Kansas City, Kan., opens proposals Feb. 27 on 1,000,000 cu. yds. of hydraulic dredge work; Murray County, Minnesota, is asking bids on a Judicial ditch estimated to cost $73,000. O'Connor & Hilton Co., Great Falls, Mont., at $43,691, was low bidder for the Greenfields distribution system for the U. S. Reclamation Service. The Commissioners of the West Matanzos Drainage and Levee District, Lewistown, Ill., awarded a 566,000 cu. yd. levee job to O'Meara & Son.

Sewerage.—The Commissioner of the District of Columbia, Washington, D. C., are calling for bids on 3,500 ft. of 6½ by 7 ft. trunk sewer; Lodi, O., opens proposals Feb. 6 on a sewer system and sewage disposal plant; Sisseton, S. D., is asking bids on 6 miles of sewers and sewage treatment works; Baltimore, Md., is calling for proposals on sewerage work to cost about $250,000. Low bidders—Section 18 of the Passaic Valley trunk sewer, New Jersey, were New York & New Jersey Construction Co., Newark, N. J., at $191,894, on the river bank route, and Charles A. Haskin, Somerville, Mass., at $187,392 on the tunnel route.

Positions With Illinois Utilities Commission.

Engineers and persons in some other lines of work in public utilities corporations will be interested in the recent announcement of the State Civil Service Commission regarding positions under the Illinois Public Utilities Commission which are to be filled at an early date by examination. The following is a list of the positions, together with a statement of the salary limits for each place:

Accounting Service:	Per month.
Transportation rate expert, Rank III.	$300@375
Transportation rate expert, Rank II .	175@250
Accountant, Rank II.................	200@250
Utilities statistician, Rank II	175@250
Tariff clerk (examination March 6).	100@[illegible]
Accountant, Rank I...............	125@175
Utilities rate expert.................	125@175
Utilities statistician, Rank I.........	100@150
Engineering Service:	
Assistant chief utilities engineer	300@[illegible]
Gas engineer	250@[illegible]
Railroad engineer	250@[illegible]
Electrical engineer ..	200@300
Telephone engineer .	200@300
Mechanical engineer	150@250
Service engineer	200@300
Assistant railroad engineer..........	150@200
Case man	125@150
Assistant utilities engineer..	90@125
Service inspector	90@125
Utilities investigator	100@150
Draftsman (examination March 6)..	75@100

In most of the above positions vacancies now exist and will be filled by examinations at early dates. It has not yet been determined definitely just what positions will be open to non-residents of Illinois, but it is possible that applications will be received by the State Civil Service Commission, Springfield, Ill., for engineers in many cases regardless of residence.

IF.

(By Robert Isham Randolph, with Apologies to Rudyard Kipling.)

If you can swing an axe, or wield a brush-hook,
Or drive a stake, or drag a chain all day.
If you can scribble "figgers" in a note book,
Or shoot a range pole half a mile away.
If you can sight a transit or a level,
Or move a target up and down a rod.
If you fear neither man, nor devil,
And know yourself and trust the living God.

If you can wade a swamp, or swim a river,
Nor fear the deeps, nor yet the dizzy heights.
If you can stand the cold without a shiver,
And take the Higgin's ink to bed o' nights.
If you can turn a thumb screw with your fingers,
When every digit's like a frozen thumb.
If you can work as long as daylight lingers,
And not complain, nor think you're going some.

If you can sight through tropic heat's refraction,
Or toil all day beneath a blistering sun.
If you can find a sort of satisfaction
In knowing that you've got a job well done.
If you can be an esquimo and nigger,
And try to be a gentleman, to boot.
If you can use a "guessin' stick" to figger
And know a coefficient from a root.

If your calculus and descriptive are forgotten,
And your algebra just serves you fairly well.
If your drafting and your lettering are rotten,
And your Trautwine's always handy by to tell.
If you can close a traverse without fudgin',
Or check a line of levels by a foot.
If you can set a slope stake, just by judgin',
And never kicked a tripod with your foot.

If you can run a line where you are told,
And make it stay somewhere upon the map.
If you can read your notes when they get cold,
And know that contours mustn't ever lap.
If you can line a truss or tap a rivet,
Or make a surly foreman come across.
If you can take an order, well as give it,
And not have secret pity for the boss.

If you can climb a stool and not feel lowly,
Nor have your head turned by a swivel chair.
If you can reach your judgments slowly
And make your rulings always just and fair.
If you can give yourself and all that's in you
And make the others give their own best, too.
If you can handle men of brawn and sinew,
And like the men and make 'em like you too.

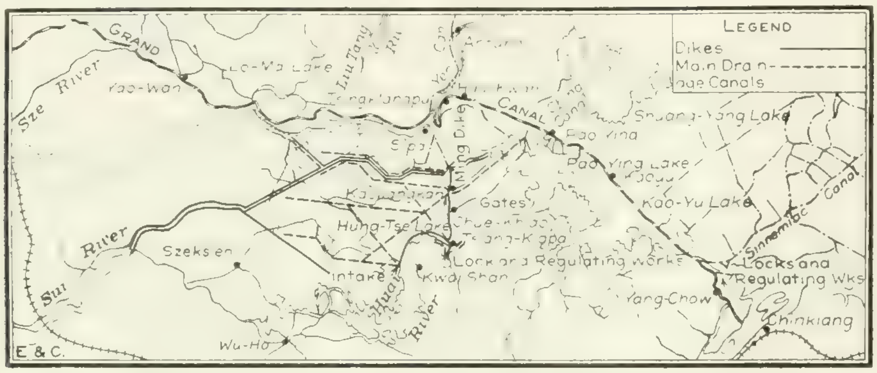
If you can't boast a college education,
Or, if you've got a sheep-skin, can forget.
If you get a living wage for compensation,
And give a little more than what you get.
If you can meet with triumph and disaster
And treat them without favor, nor with fear,
You'll be a man and your own master,
But—what is more—you'll be an ENGINEER.

HUAI VALLEY CONSERVANCY PROJECT, CHINA.

Regulation and Reclamation Works for Flood Prevention.

Involves Expenditure of $30,000,000 and Requires 362,000,000 Cu. Yds. of Excavation.

Regulation and reclamation works requiring an estimated expenditure of $30,000,000 are recommended in the recently issued report of the Board of Engineers appointed last spring by the American National Red Cross to make investigations connected with the Huai River conservancy project, China. The conservancy area comprises the drainage areas of the Huai River, the Inner Grand Canal, the Yi River, the Sze River, and the Shu River, situated in Honan, Anhwei and Kiangsu Provinces, China. The object of the work is to improve these water courses, especially as to the physical conditions that affect flooding of arable lands, continual submergence of lands, or submergence to such an extent as to create swamps. The physical conditions and probable constructional features of the project were outlined in our issue of Feb. 11, 1914. The engineering board, consisting of Wm. L. Sibert, Daniel W. Mead and Arthur P. Davis, were appointed in May in accordance with an arrangement by the Red Cross with the Republic of China. The board, among other things, was instructed to make a further survey and investigations of the project. The various reclamation schemes heretofore suggested were carefully considered. None of them, however, were favored, the board recommending a new plan.



Location of Works for Huai Valley Conservancy Project.

The project recommended by the Board of Engineers provides that the waters of the Huai should go into the Yangtse River near Chinkiang, and that such waters be diverted into Paoying and Kaoyu Lakes in such a way as to make entirely feasible the reclamation of the bed of Hungtse Lake. The reclamation of the lake bed would make it practicable to construct a channel across the bed with high dikes, through which could pass to Paoying Lake the waters of the Sui and the drainage water from a large part of the territory annually flooded, bounded by Hungtse Lake, the old Yellow River bed, the Tientsin-Pukow Ry. and the Huai River below Pengpu.

The diversion of the Huai River to Paoying Lake would be accomplished by means of a dike extending from the left bank of the mouth of the river opposite Kweishan to the village of Tsiangkiapa. This would run roughly parallel to the shore of the Laotzeshan Peninsula. This would form the shore line of a channel for the diversion of the Huai River from Hungste Lake, which after the proposed excavation would be capable of carrying about 200,000 cu. ft. of water per second at lake stage of 13 meters and disposing of ordinary floods of 100,000 cu. ft. per second without permitting the water at Kweishan to rise more than 12 meters above sea level. It is proposed to build regulating works at the Tsiangkiapa outlet, with a capacity of 200,000 cu. ft. per second, with water surface just above the works 12 meters above sea level; to provide a channel below Tsiangkiapa with a discharge capacity of 200,000 cu. ft. per second to Paoying Lake, with the latter at a stage of 8 meters above sea level; and channels from that lake to the Yangtse having the same capacity, with the river at 19 ft. on the Chinkiang gage.

It is proposed to provide this unwatered bed of Hungtse Lake with an extensive network of canals and laterals, with beds about 3 meters below the surface of the ground. The outlets of the principal drains would be provided with controlling works, so that the channels would serve for drainage when left open; by closing them the canals would be filled from the Huai River and used for irrigation by means of moderate lifts varying from 1 ft. to 6 or 7 ft., according to the distance from the source of supply. This system, also, would be available for navigation, and would connect with the Grand Canal and thus make available the waters of the Huai River for navigation in that canal and for irrigation east of it when needed.

The enlarged channel capacity to be provided between the Kaoyu Lake and the Yangtse would in dry weather empty that lake, and unless prevented, so deplete the waters of the Grand Canal as to destroy navigation and deprive the lands east of it of irrigation water. To prevent this and to improve navigation it is proposed to build a lift lock in the Grand Canal near the town of Shaopo, with a total lift under extreme conditions of about 4 meters, and a channel with lock and regulating works connecting the Grand Canal above this lock with the channel leading to Sinnemiao. It also is proposed to dredge the Grand Canal from its lock southward to a bottom elevation of minus 4 ft. on the Chinkiang gage.

Just above Tsingkiangpu it is proposed to build a lift lock of 4 meters lift capacity, so located as to eliminate from the main canal all the sluice locks above that town and also the great curves that occur in the canal in that vicinity. It is proposed to provide a regulated flood channel from the canal above this lock to Paoying Lake to care for the same proportion of the flood waters from the upper Grand Canal as have formerly passed down the Grand Canal and into the Hungtse Lake. It is proposed also to connect the valley of the Sui with Paoying Lake by a large drainage channel with a normal capacity of 50,000 cu. ft. per second. This channel would cross the reclaimed lands of Hungtse Lake and would be separated from them by high dikes. Branch dikes from these connecting with high ground to the north and south would be provided to protect the reclaimed lands of Hungtse Lake from overflow. Various branches and laterals connecting with the main drain would be necessary to properly drain the lands.

The region that would be chiefly benefited under the project recommended by the Board of Engineers is the area bounded on the north by the old bed of the Yellow River; on the east by the old bed and the Ming Dike; and on the south by the southern margin of Hungtse Lake and the Huai River; and on the west by the Tientsin-Pukow Ry. The upper Huai River and its tributary valleys would be but slightly affected by the proposed works. Substantial benefits also would accrue to the agricultural land east of the Grand Canal, which is frequently innundated by the excess waters from the canal, and is as often short of irrigation water.

The lands to be directly benefited by this project may be divided into five districts, as follows: District No. 1, comprises lands that will be reclaimed and irrigated. This includes the greater portion of the bed of Hungtse Lake, and comprises an area of about 350,000 acres, valued at least $75 per acre. District No. 2 comprises lands that will be reclaimed but not irrigated. This includes the northeastern portion of Hungtse Lake, an area of about 36,000 acres, having a valuation of at least $50 per acre. District No. 3 takes in lands around Hungtse Lake that have been mostly cultivated but subject to frequent inundations, and which will be protected from overflow and provided with drainage channels. The estimated area is 300,000 acres; this would be benefited at least to the extent of $15 per acre. District No. 4 comprises lands heretofore cultivated which will be provided with main drainage channels for the escape of all flood waters. This class includes the area bounded on the north by the old bed of the Yellow River, Hungtse Lake and District No. 3; on the south by the Huai River, and on the west by the Tientsin-Pukow Ry. The benefited area is estimated at 1,700,000 acres. This would be improved at least to the extent of $4 per acre. District No. 5 includes lands benefited by the regulation of the Grand Canal, preventing both overflow therefrom and water shortage therein for irrigation. This includes a large portion of the lands east of the Grand Canal and south of the old bed of the Yellow River. The amount is estimated roughly at 5,000,000 acres, and the entire area would be benefited to the extent of at least $10,000,000. In addition to the direct benefits, there will be various indirect benefits, of which the most important is the improvement of navigation in the Grand Canal, in consideration of which it is proposed to collect equitable charges for the use of the locks to be provided. The following is a summary of the estimated returns:

Value of reclaimed lands in Districts 1 and 2	$27,050,000
Value of benefits in District No. 3	4,500,000
Value of benefits in District No. 4	6,800,000
Value of benefits in District No. 5	10,000,000
Total	$48,350,000

In addition it is estimated that there should be received annually at the end of the six-year period of construction the sum of $2,361,000, made up of $225,000 from revenues of the Grand Canal and other canals in the area, and $2,136,000 from taxes on land.

The Board of Engineers estimate the cost of the recommended work at about $30,000,000 and states that it can be economically completed within about six years after beginning construction, provided funds are available as needed, and the work is vigorously prosecuted. It is stated that if the bonds issued bear 5 per cent interest, and are sold at 90 cts. on the dollar, and if 3 per cent can be obtained on unexpended balances, the total issue to cover discount and interest during a six-year construction period will amount to $45,000,000. The Board expresses the opinion that on the basis of the estimated benefits and the returns from canal tolls and the taxes suggested, a satisfactory method for financing the project can be devised. A summary of the estimated costs is as follows:

	Cu. yds.	
Main outfall channel to Yangtse	62,650,750[1]	$ 6,265,075
Excavation in San Ho Channel	30,000,000[2]	2,400,000
Main diversion dike around Lao Tsesan	15,173,730[3]	1,365,635
Excavation parallel to same, not used in dike	41,920,000[3]	3,772,800
Dike parallel to Ming Dike	2,169,360[4]	151,855
Dike across Pao Ying Lake	191,260[4]	13,388
Rock riprap	700,000[5]	350,000
Canal from Pao Ying Lake to Grand Canal	2,567,600[6]	154,056
Flood channel from Grand Canal to Pao Ying Lake	8,162,610[4]	571,383
Sui River Channel through lake to Ming Dike	39,300,000[1]	3,930,000
Sui River Channel from Ming Dike to Pao Ying Lake	9,400,560[2]	752,045
Sui River Channel feeder		

and guide dikes above Hungtse Lake	21,509,500[6]	1,390,569
Drainage for lake bed northeast of Sui Channel	7,708,040[6]	462,482
Main drain of north system on irrigated land..	10,218,000[4]	715,260
North branch of south system	8,449,500[4]	591,465
South branch of south system	18,706,800[4]	1,309,476
Main trunk of south system above Kaoliang Kan	13,534,920[2]	1,082,793
Main trunk of south system below Kaoliang Kan	4,258,810[4]	298,116
Irrigation system:		
Eastern irrigation canal..	1,730,510[6]	103,830
Central irrigation canal...	1,228,780[6]	73,722
Western irrigation canal.	655,000[6]	39,300
Lateral system, 1,547 kilometers	35,370,000[7]	1,591,650
Sub-laterals, 2,400 kilometers	26,200,000[8]	1,048,000
Dredging in Grand Canal.	665,400[1]	66,540
Sinnemiao Channel	926,000[6]	55,560
Control works and lock at Tsangkiapa	....	752,000
Irrigation headworks near Chuchwang	...	30,000
Control works at Kaoliang Kan.	....	200,000
Lock and control works near Tsingkiangpu	....	240,000
Lock and control works near Shaopo	....	250,000
Total		$30,000,000

[1]At 10 cts. per cu. yd. [2]At 8 cts. per cu. yd. [3]At 9 cts. per cu. yd. [4]At 7 cts. per cu. yd. [5]At 50 cts. per sq. yd. [6]At 6 cts. per cu. yd. [7]At 4½ cts. per cu. yd. [8]At 4 cts. per cu. yd.

A 1,700-FT. BRIDGE NEAR WINONA, MINN.

Bids Asked for Wisconsin Approach to Mississippi River Structure.

Bids are now being asked on a good-sized bridge undertaking near Winona, Minn. The work calls for the construction of an approach from the Wisconsin side to the high wagon bridge over the Mississippi River at Winona. The new structure will commence at the pier on the north shore of the main channel at the end of the present steel bridge and will extend across the island and the Wisconsin channel to the highway on the north bank of the Wisconsin channel just above the present bridge. Alternate bids will be taken for a reinforced concrete structure and for a steel structure. If the latter is built, the approach will have a total length of 1,700 ft. 11 ins.; the deck spans will have a clear width between railing of 23 ft., 18 ft. of this width being for the roadway and curb and 5 ft. for a walk on the westerly side of the roadway; the through spans will have a roadway 18 ft. wide between trusses and a 5-ft. walk. If the concrete structure is built it will have a total length of 1,736 ft. and a clear width between railings of 23 ft. It will consist of the following spans:

A suspended I-beam span, constructed on a curve, having a length of 22½ ft., measured along the chord of the center line. The southerly end of this span will be supported on a new steel bent erected on the north shore of the existing steel bridge. Next will come an 86-ft. reinforced concrete cantilever span consisting of two reinforced concrete cantilever girders spaced 17 ft. 4 in. c. to c. and supported upon two pair of reinforced concrete columns and pedestals spaced 50 ft. c. to c. longitudinally. The south cantilever arms of the girders will extend 16 ft. beyond the center of the columns and the north arms will extend 20 ft.

The adjoining section of the structure will consist of three 90-ft. reinforced concrete cantilever spans, each span composed of two reinforced concrete cantilever girders spaced 17 ft. 4 ins. c. to c. and supported upon two pairs of reinforced concrete columns and pedestal spans 50 ft. c. to c. longitudinally. The cantilever arms of the girders will extend 20 ft. beyond the centers of the columns at each end of the span. Next will come seven reinforced concrete cantilever girder spans, each consisting of two reinforced concrete cantilever girders spaced 17 ft. 6 ins. c. to c. and supported upon two pair of reinforced concrete columns and pedestals spaced 36 ft. c. to c. The cantilever arms will extend 14 ft.

The structure will be carried over the Wisconsin channel by 12 reinforced concrete arch rib spans, supported upon an abutment at each end and upon 11 intermediate piers. Each of the spans will consist of two arch ribs spaced 17 ft. 6 ins. c. to c. and having a clear span at the springing line of 64½ ft. The approach at the north end of the bridge will consist of two parallel reinforced concrete walls about 23 ft. long, supported at one end upon the north abutment and at the other end upon the concrete piers.

The specifications for the steel structure call for the following: A suspended I-beam span 22 ft. 6 ins. long; three 136 ft. 4 13/16 in. cantilever deck spans, each cantilever span consisting of two trusses spaced 16 ft. c. to c. and supported upon two pairs of pedestals spaced 97 ft. 5 3/16 in. c. to c. longitudinally; one 111 ft. 11 in. cantilever deck span with a 26 ft. 5¾ in. suspended I-beam span at each end, the cantilever span consisting of two trusses spaced 16 ft. c. to c. and supported upon two pairs of pedestals spaced 79 ft. 11¼ ins. c. to c.; four plate girder spans, each consisting of two plate girders 48 ft. 7⅜ ins. over all and spaced 16 ft. c. to c., the spans supported upon four pairs of concrete pedestals and pier No. 1 on the south side of the Wisconsin channel; the Wisconsin channel will be crossed by six through spans, each consisting of two trusses spaced 20 ft. 4 ins. c. to c. and 140 ft. in length, supported upon six concrete piers and one abutment at the north end. All pedestals and piers with the exception of the four pairs of pedestals under the plate girder spans will be supported upon round piling, and the six piers in the Wisconsin channel and the north abutment will be protected by riprap. The floor system for the steel structure will consist of a reinforced concrete slab upon steel joists; the roadway portion will be paved with brick and the sidewalk and curbs will be concrete. For the concrete bridge the floor system will consist of a reinforced concrete slab 24½ ft. in width over all and 6½ ins. thick, supported upon the girders or upon the spandrel walls of the arches as the case may be and upon transverse floor beams and a center longitudinal girder. The roadway will be paved with brick, and the sidewalk and curb will be concrete.

Bids for the construction of the Wisconsin approach will be received by the City Council of Winona, Minn., until 8 p. m., March 1. L. P. Wolff, St. Paul, Minn., is Consulting Engineer. H. B. Walling is City Engineer.

Street Improvements at Oshkosh, Wis., for 1915.

A considerable amount for paving work is contemplated by Oshkosh, Wis., for the present season. The date for the letting has not been decided upon but it is likely that bids will be received about the last week in this month. The following is an outline of the contemplated work:

High St.—From northwesterly line of Wisconsin Ave. to W. Algoma St., brick sheet, asphalt, sarcolithic, asphaltic concrete, cement No. 2: 7,240 cu. yds. of earth work, 17,620 sq. yds. of pavement, 11,100 ft. of cement curb and gutter. Street railway portion: 3,475 sq. yds. of pavement, 1,623 cu. yds. of earth work.

W. Algoma St.—From westerly line of Sawyer Ave. to westerly line of Punhoqua St., cement No. 1, cement No. 2, asphaltic concrete: 1,832 cu. yds. of earth work, 29,118 sq. yds. of pavement, 1,526 ft. of cement curb and gutter. Street railway portion: 460 sq. yds. of pavement, 182 cu. yds. of earth work.

W. Algoma St.—From westerly line of Sawyer Ave. to Paine Lbr. Co. office, except bridge; brick, cement No. 2, cedar block: 809 cu. yds. of earth work, 3,266 sq. yds. of pavement, 1,896 ft. of cement curb and gutter. Street railway portion: 1,025 sq. yds. of pavement, 350 cu. yds. of earth work.

Evaline St.—From southerly line of Ceape St. to northerly line of Lake Drive (River St.); cement No. 1, tar macadam, bituminous concrete No. 1: 1,340 cu. yds. of earth work, 150 cu. yds. in terrace and sidewalk, 3,780 sq. yds. of pavement, 2,875 ft. of cement curb and gutter.

Lake Drive.—(River St.). From westerly line of Frankfort St. to westerly line of Lake St.; cement No. 1, tar macadam, bituminous concrete No. 1: 1,039 cu. yds. of earth work, 15 cu. yds. of earth work in terrace and sidewalk, 3,572 sq. yds. of pavement, 2,400 ft. of cement curb and gutter.

Vine St.—From High St. to Algoma St.; cement No. 1, tar macadam, bituminous concrete o. 1: 186 cu. yds. of earth work, 528 sq. yds. of pavement, 634 ft. of cement curb and gutter.

E. Lincoln Ave.—From Main St. to C. & N. W. Ry.; cement No. 1, tar macadam, bituminous concrete, No. 1: 1,833 cu. yds. of earth work, 58 cu. yds. of earth work fill, 4,640 sq. yds. of pavement, 3,038 ft. of cement curb and gutter.

Harrison St.—From Main St. to Murdock St.; cement No. 1, cement No. 2, sarcolithic; 4,232 cu. yds. of earth work, 4,540 sq. yds. of pavement.

Alley.—(Opera House) from Market St. to Bond St. (between High and Algoma Sts.); cement No. 1, asphaltic concrete, creosote block: 530 cu. yds. of earth work, 547 sq. yds. of paving, 492 ft. of curbing.

Twelfth St.—(Boulevard). From Minnesota St. to Ohio St.; cement No. 1, tar macadam, bituminous concrete No. 1: 1,643 cu. yds. of earth work, 5,625 sq. yds. of paving, 3,646 ft. of cement curb and gutter, 750 cu. yds. of filling in Boulevard space and in sidewalk sub-grade.

In the above approximate quantities, the terraces are not calculated as to filling. G. H. Randall is city engineer.

Three Dredging Contracts in New Jersey.

Three small dredging contracts are now being advertised for bids by the U. S. Engineer at New York City. The work calls for dredging in Woodbridge Creek, Raritan Bay and Shrewsbury River, New Jersey.

Woodbridge Creek is a small crooked tidal stream about 5 miles long, running through flat marshes for most of its length and emptying into the west side of Arthur Kill or Staten Island Sound, 2 miles north of Perth Amboy, N. J. The improvement provides for dredging between the mouth and Salamander Dock, a distance of 1⅞ miles. The present depths are 3 ft. to 8 ft. The depth to be made is 8 ft. and the width to be dredged is 50 ft. The material is believed to be mud, sand and gravel. About $5,000 is available.

Raritan Bay lies between the southern end of Staten Island and New Jersey, and lower New York Bay on the east. The work to be done consists in dredging for maintenance. The depth to be made is 21 ft., and the width will not exceed 300 ft. The material is believed to be mud and sand. About $18,000 is available.

Shrewsbury River is a large tidal basin in the eastern part of New Jersey, and consists of two branches: the north branch, or Navesink River, and the south branch. A channel called the main stem unites the two branches at the eastern ends and extends northwardly to the outlet in Sandy Hook. The work to be done consists in dredging for maintenance, through the bars in the main stem, near Highlands bridge, in Reeves Channel, at the upper and lower crossover, and in the vicinity of the Seabright bridge. The depth to be made is 6 ft. at mean low water with an allowance of 2 ft. per overdepth. The width will not exceed 300 ft. in the main stem and 150 ft. in the branches. The material is believed to be sand. About $8,000 is available.

Bids for the above work will be received until noon, Feb. 19, by Col. Frederic V. Abbott, U. S. Engineer, 39 Whitehall St., New York City.

The Iowa State Drainage Association will meet in Webster City, Iowa, February 25 and 26. Mr. M. F. P. Costelloe of Ames, Iowa, is secretary of the association.

STATE AID HIGHWAY CONSTRUCTION IN WISCONSIN.

Details of Work to Be Done This Year in 32 Counties.

Earth Roads—Gravel—Macadam—Concrete.

A state aid fund of $1,206,221 is available for highway construction in Wisconsin in 1915. The distribution of this sum among the various counties was given in our issue of Feb. 3. As the state pays one-third of the cost of the roads, the total expenditure contemplated in this state for the coming season will be in the neighborhood of $3,720,000. In the article in our last issue it was stated that the probable highway improvements would include 50 miles of concrete road, 350 miles of stone macadam, 200 miles of gravel macadam, 100 miles of shale and other inferior surfacings and 550 miles of grading. Table I gives a summary of the work to be done in several of the counties. This information has been compiled from reports of the County Highway Commissioner, who will have charge of the work under the direction of the State Highway Commission.

Further details as to the appropriations available and work proposed by these counties are given below:

Ashland County will have $30,000 available for highway improvements, and will construct 15 miles of earth road and a like amount of gravel and sand covering on clay. Part of the work will be done by contract. No date has been set for awarding the jobs. W. E. Dillon, Butternut, Wis., is County Highway Commissioner.

Barron County will have about $38,000 available for its construction work. It will expend $4,800 for concrete pavement in the city limits of Barron. The work for Barron will be done by contract. Contracts also will be let during this winter for an 80-ft. span bridge. The date for awarding these contracts has not been decided upon. Simon S. Berg, Rice Lake, Wis., is County Highway Commissioner.

Buffalo County's construction program for this year calls for 6¾ miles of earth road, 1½ miles of macadam and one mile of concrete. Part of the work, at least, will be done by contract. The sum of $24,000 is available for construction purposes. J. Reinhardt, Nelson, Wis., is County Highway Commissioner.

Burnett County will do its highway work by day labor. It proposes the building of 15 miles of earth road, and will have $15,000 available for construction purposes. Hugh Jeffries, Danbury, Wis., is County Highway Commissioner.

Crawford County will have $21,000 available for construction purposes, but will do the work by day labor. J. N. Campbell, Bell Center, Wis., is County Highway Commissioner.

Dane County has an extensive construction program in view, including 40 miles of earth road, 6 miles of gravel, 28 miles of macadam and 2 miles of concrete. The last mentioned will be done by contract; date for the letting has not been decided upon. The sum of $195,000 is available for construction purposes. W. H. Sommers, Madison, Wis., is County Highway Commissioner.

Dodge County will have $100,000 available for construction purposes this season. It proposes the building of 5 miles of earth road, 15 miles of gravel road, 20 miles of macadam and 1 mile of concrete. No contract will be let. E. F. Klug, Ruseville, Wis., is County Highway Commissioner.

Douglas County proposes to construct 40 miles of earth road, 2 miles of gravel and 2 miles of macadam. The work will be done by contract, the first letting probably being in June. About $100,000 is available for construction purposes. C. J. Morisset, Superior (East End), Wis., is County Highway Commissioner.

Dunn County will have $30,000 available for its work this year. It proposes to improve about 6 miles of earth road by grading and to grade and gravel about 7 miles additional. Several concrete bridges will be constructed. Most of the work will be done by contract, which will be let in early spring. Wm. E. Raven, Colfax, Wis., is County Highway Commissioner.

Grant County's program for the present season includes 8 miles of earth road, 6 miles of gravel and 10 miles of macadam. Part of the work will be done by contracts, which will be let this spring. The sum of $100,000 is available for construction purposes. Henry Mink, Lancaster, Wis., is County Highway Commissioner.

Green County will have $91,270 available for construction purposes this year. It proposes to build 5 miles of gravel road and 10 miles of macadam and possibly ½ mile of concrete. Some of the work may be done by contract. E. L. Edwards, Monroe, Wis., is County Highway Commissioner.

Green Lake County may construct about ¾ mile of gravel road and 6 miles of macadam. About 50 per cent of the latter will be 18 ft. wide. It is probable the work will be done by day labor. About $24,000 is available. T. J. Paull, Princeton, Wis., is County Highway Commissioner.

Iron County will have $42,000 available for construction purposes, and will expend this sum monthly for earth roads. Wm. Weber, Saxon, Wis., is County Highway Commissioner.

Jefferson County proposes to construct 3 miles of macadam and 2 miles of concrete. Part of the work will be done by contract. The sum of $29,000 is available for construction. R. D. Royce, Fort Atkinson, Wis., is County Highway Commissioner.

Juneau County will have $58,794 available for its work this year. It proposes to construct 5 miles of earth road and 5 miles of macadam. A. V. Robinson, New Lisbon, Wis., is County Highway Commissioner.

Kewanee County's work for the present year provides for the construction of 8 or 9 miles of gravel macadam and several bridges. About ½ mile of concrete road will be laid in the city of Algoma. This will be done by contract; date of letting has not been decided. Moses Shaw, Algoma, Wis., is County Highway Commissioner.

La Crosse County proposes the construction of 8 miles of earth road and 30 miles of macadam. The work will be done by day labor. John Hintgen, La Crosse, Wis., is County Highway Commissioner.

Milwaukee County will have about $700,000 available for construction work this year. It proposes to construct 5 miles of gravel road, 37 miles of concrete and 3 miles of asphalt. The work will be done by contract, the lettings being held at various times from January to April. H. J. Kuelling, Milwaukee, Wis., is County Highway Engineer.

Oconto County proposes to construct during the present season 16 miles of earth road, 14 miles of gravel and 8 miles of macadam. It has $20,000 available for construction. Part of the work will be done by contracts, which may be let in the spring. James Deveraux, Oconto, Wis., is County Highway Commissioner.

Oneida County proposes the construction of 35 miles of road, of which 33 miles will be of the earth type and 2 miles gravel. The work will be done by contract and day labor and will start about April 1. The sum of $57,865 is available. Frank E. Parker, Rhinelander, Wis., is County Highway Commissioner.

Price County will have $36,000 available for construction this season, and proposes to build 40 miles of earth road. Some of the work may be done by contract, but more of it will be carried out by day labor. C. G. Nelson, Ogema, Wis., is County Highway Commissioner.

Richland County will have $47,045 available for construction purposes. Of this sum $15,000 is to be expended in city of Richland Center. The type of pavement for the city has not been determined. The work will be done by contract and the letting probably will be held some time this month. In addition the county will construct about 10 miles of macadam. G. H. Mainwaring, Richland Center, Wis., is County Highway Commissioner.

Rock County's construction program for the present year includes 20 miles of gravel, 20 miles of macadam and ½ mile of concrete. The work will be done by contract. An appropriation of $105,000 is available. Chas. E. Moore, Janesville, Wis., is County Highway Commissioner.

Sauk County proposes to construct 4 miles of gravel, 20 miles of macadam and 1 mile of concrete. If satisfactory bids are received the work will be done by contract. An appropriation of $60,000 is available for construction purposes. G. F. Post, Baraboo, Wis., is County Highway Commissioner.

Sawyer County will have $19,000 available for its work and proposes the construction of 20 miles of earth road. If satisfactory bids are received the work may be done by contract, which would be let about April. E. J. Collett, Hayward, Wis., is County Highway Commissioner.

Shawano County's construction program includes 8 miles of earth road, 3½ miles of gravel and 3½ miles of macadam. About one-third of the improvements will be carried out by contracts. The lettings will be held in the spring and summer. About $35,000 is available. O. C. Rollman, Shawano, Wis., is County Highway Commissioner.

TABLE I.—ROAD WORK FOR 1915 IN 32 WISCONSIN COUNTIES.

County.	Type of road—Earth, miles.	Gravel, miles.	Mac., miles.	Conc., miles.
Ashland	15	15	..	..
Barron	22	..	..	..[1]
Buffalo	6¾	..	1½	1
Burnett	15	..	..	..
Crawford	?	?	?	?
Dane	40	6	28	2
Dodge	5	15	20	1
Douglas	40	2	2	..
Dunn	6[2]	7	..	..
Grant	8	6	10	..
Green	5	10	..	½
Green Lake	..	¾	6	..
Iron	?	..	..	..
Jefferson	..	..	3	2
Juneau	5	..	10	..
Kewaunee	..	8[3]	..	[4]½
La Crosse	8	..	30	..
Milwaukee[5]	..	5	..	37
Oconto	16	14	8	..
Oneida	33	2	..	..
Price	40	..	..	..
Richland	..	..	10	..
Rock	..	20	20	½
Sauk	..	4	20	1
Sawyer	20	..	..	..
Shawano	8	3½	3½	..
Taylor	20	2	..	..
Vernon	12[6]	..	3	..
Walworth[7]	..	5¾	6½	1½
Washington	..	8	2	1
Waupaca	20	8	12	..
Winnebago	..	8	5	..

[1] $4,800 for concrete paving in city of Barron. [2] Grading only. [3] Gravel macadam. [4] In city of Algona. [5] Also 3 miles of asphalt. [6] 12 to 15 miles. [7] Also ½ mile brick pavement.

Taylor County proposes to construct 20 miles of earth road and 2 miles of gravel road. Part of the work will be done by contract; lettings to be held in May and June. The sum of $25,000 is available for construction purposes. H. C. Peterson, Medford, Wis., is County Highway Commissioner.

Vernon County will have $60,000 available for carrying out its highway improvement plans the coming season. It proposes to construct 12 to 15 miles of earth road and 3 miles of macadam. The work will be done by force account. Alex Ristow, Genoa, Wis., is County Highway Commissioner.

Walworth County proposes to construct 5¾ miles of gravel road, 6½ miles of macadam, ½ mile of brick and 1½ miles of concrete. The brick and concrete paving will be done by contract; no data for the letting has been decided upon as yet. The remainder of the work will be carried out by force account. The sum of $70,000 is available for construction purposes. H. J. Peters, Elkhorn, Wis., is County Highway Commissioner.

Washington County will have about $42,000 available for construction purposes this year. It proposes to build 8 miles of gravel road, 2 miles of macadam and 1 mile of concrete. Some of the work will be done by contract; no date has been set for the letting. Chas.

Johnson, Barton, Wis., is County Highway Commissioner.

Waupaca County proposes to construct 20 miles of earth road, 8 miles of gravel and 12 miles of macadam. No contracts will be let. The sum of $55,000 is available for construction purposes. Charles J. Knudson, Scandinavia, Wis., is County Highway Commissioner.

Winnebago County will have $49,674 available for its highway work this year. It proposes to construct 8 miles of gravel road and 5 miles of macadam. The work probably will be done by day labor. James Binning, Oshkosh, Wis., is County Highway Commissioner.

PERSONALS

Mr. A. G. Wulff, civil engineer, announces that he has opened an office at 309 Provident Bank Building, Cincinnati, Ohio, and is prepared to handle surveys, plans, specifications and superintendence, particularly of sewerage and other municipal work.

Mr. Clarence D. Pollock, formerly chief engineer of highways at San Antonio, Texas, and prior to that principal assistant engineer in charge of paving for the Bureau of Highways of Brooklyn, and acting engineer for the Borough of Manhattan, has been appointed consulting engineer of the Granite Paving Block Manufacturers' Association of the United States. A brief account of Mr. Pollock's professional experience, which has been extensive, appeared in our issue of Aug. 5, 1914.

Edward M. Hagar, Who Resigns as President of the Universal Portland Cement Co.

Mr. R. V. Orbison, civil engineer of Pasadena, Calif., and for the past year deputy city engineer at that place, has been made city engineer. He has been connected with the city engineer's office since 1912, and prior to that he was field engineer for the Jannis Investment Co. of Los Angeles, having charge of field work on tracts ranging from 200 to 3,700 acres, including subdivisions, water systems and road building. Mr. Orbison was field engineer for the Utah Sugar Co. from 1902 to 1905, and for the following year was transitman on the Yosemite Valley Short Line Railway, locating nearly one-half of that line. For one year he was chief engineer to S. W. Ferguson of San Francisco, and from 1907 to 1910 was traveling engineer for Stone & Webster in Texas, where he was engaged on street railway, power house and car barn construction.

New President for Cement Company.

Mr. Edward M. Hagar has resigned as president of the Universal Portland Cement Co., one of the subsidiaries of the United States Steel Corporation. Mr. Hagar has been the head of this cement business for fifteen years and manufactured the first barrel in May, 1910. The company has been conspicuously successful as shown by the growth of its business from 32,000 bbls. produced in 1900, to its present capacity of approximately 12,000,000 bbls. per year. For several years the Universal Portland Cement Co. has been the largest shipper of Portland cement in the world.

Mr. Hagar was for two years president of the Association of American Portland Cement Manufacturers and has been an important factor in the promotion and development of the use of cement in building construction of all kinds. He also founded the Cement Products Exhibition Co. in 1907. This company conducts the annual cement shows, which are recognized as among the most important industrial exhibitions held annually in the United States.

Mr. Hagar was graduated from the Massachusetts Institute of Technology in 1893 and received a post-graduate degree from Cornell University in 1894. Prior to his connection with the cement industry, Mr. Hagar organized and conducted the business of Edward M. Hagar & Co., located in Chicago and acting as sales representatives for machinery manufacturers.

Mr. Hagar retires to assume the presidency of a new company which he is forming to acquire a chain of Portland cement plants covering a large part of the United States. The headquarters of the new company will be in Chicago.

Mr. B. F. Affleck has been elected president of the company to succeed Mr. Hagar. Mr. Affleck entered the service of the Illinois Steel Co. in 1896 and from 1901 to 1903 represented the cement department of the company in the St. Louis territory. When the Universal Portland Cement Co. was incorporated in 1906 to take over the cement business of the Illinois Steel Co. he became general sales agent. He is vice president of the Cement Products Exhibition Co. Mr. Affleck is recognized as a pioneer in promoting the use of concrete as a paving material.

Mr. John N. Carlisle, appointed by Governor Sulzer in May, 1913, as New York State Highway Commissioner, has resigned.

Mr. E. P. Roberts announces the re-opening of his office as consulting engineer at 2053 E. 96th St., Cleveland. Mr. Roberts has been engineer for or reported upon more than 200 public utility properties and more than 300 manufacturing and other private properties. During the past two years he has been commissioner of smoke abatement for the city of Cleveland. Mr. Roberts is a member of the American Society of Mechanical Engineering; the American Institute of Electrical Engineering and the Cleveland Engineering Society, and an associate member of the American Electric Railway Association. In his new office Mr. Roberts is prepared to undertake examination, reports and valuation of public service and industrial properties, etc.

Mr. C. S. Coe, formerly division engineer on the Key West extension of the Florida East Coast Railroad, has been appointed engineer of maintenance of way for that railroad, with headquarters at St. Augustine, Fla. Mr. Coe graduated in civil engineering from the University of Minnesota in 1889. For the following year he was assistant resident engineer for the Northern Pacific Railway, and in 1891-92 was assistant engineer for the Great Northern. After a brief service with the Chicago, Milwaukee & St. Paul he entered private practice until 1899, when he became resident engineer for the Northwestern. From 1902 to 1905 he was resident engineer on the Chicago, Milwaukee & St. Paul, except for a brief term as assistant and locating engineer on the Des Moines Inter-Urban Railway in 1904. Mr. Coe has been with the Florida East Coast Railway since December, 1905, first as resident engineer on the Key West Extension, having charge of viaduct construction. During that time he constructed viaducts totaling nearly 12 miles, all over open water. He had entire charge of engineering and inspection, labor forces and floating equipment. Since 1910 he has ranked as division engineer.

Mr. Henry D. Alexander has been appointed deputy superintendent of public works of New York State. Mr. Alexander is a graduate of Cornell University, in civil engineering, class of 1893. For three years after graduation he held various minor engineering positions, entering the New York State Engineers' Department in 1896 as a leveler. He has been in that department ever since, with the exception of one and one-half years on railroad and Government work. He passed through the various grades of the Department until he reached the position of special resident engineer, which he held at the time of his present appointment. In that office he had general charge of barge canal work at Albany and of preparation of plans for work on the Western Division of the canals.

Mr. Cecil N. Haggart has been appointed bridge and structural engineer of the Lake Erie and Ohio River Canal Board with headquarters in the Farmers' Bank Building, Pittsburgh, Pa. He will have charge of the work of getting up plans and estimates for all new bridges, changes to bridges, movable dams, lock gates and all other steel work, for the Board which is preparing an estimate of cost of the proposed canal. Mr. Haggart has been in practice as a consulting and designing engineer since 1912. Prior to that he was for four years assistant chief bridge designer on the New York State Barge Canal. His first experience was that of structural draftsman and engineer with the American Bridge Co. and later with the McClintic-Marshall Construction Co.

B. F. Affleck, the New President of the Universal Portland Cement Co.

Mr. H. Bortin, formerly engineer in charge of the valuation department of the Union Pacific Railroad for four years, and a member of its valuation committee, and later assistant to the general secretary of the president's conference committee on Federal valuation of railroads announces his entry into private practice as consulting valuation engineer, with office at 149 Broadway, New York City. Mr. Bortin will undertake investigations, reports, estimates and appraisals in compliance with Government valuation orders, will make complete valuations for "short line" railroads, and will prepare information for hearing before commissions and courts. Mr. Bortin is an associate member of the American Society of Civil Engineers.

Mr. Arthur H. Diamant has been elected president and managing engineer of the Excavation and Foundation Co., 3 Dover St., New York City. Mr. Diamant has been engineer of construction for the Clark Co. of New York, for the past year on steel pile and reinforced concrete foundations. Prior to that for two years he was engineer of construction for the Canavan Brothers Co., in charge of earth and rock work, heavy foundations, and underpining of tall buildings. Mr. Diamant began his engineering work in 1897 as transitman for the Metropolitan Street Railway Co. of New York. From 1899 to 1902 he was assistant engineer for the Board of Public Improvements, New York City. He was awarded a bronze medal and diploma by the Paris Exposition of 1900 for engineering work. From 1903 to 1909 Mr. Diamant was division engineer for the New York City Aqueduct Commission, in charge of design and construction of dams, reservoirs, pipe lines, tunnels, aqueducts, etc. In 1910 he became engineer for the Blaw Steel Construction Co. on sales, design and installation of steel forms. He resigned in 1911 to accept the position with the Canavan Brothers Co.

CONTRACTORS.

The Hanscom Construction Co., 70 Kilby St., Boston, Mass., has been awarded a contract for an intercepting drain at Fall River, Mass., requiring about 2 miles of concrete lined trench, about 12,000 barrels of cement and one-half million pounds of reinforcing material. The contract price is $173,834.

The Hanscom Company has made a specialty of constructing water supply systems, including the supply and installation of engines and pumps. Mr. L. L. Wadsworth is president of the company, and Mr. H. A. Hanscom, treasurer.

The Roach-Manigan Paving Co. of Memphis, Tenn., has recently been awarded a number of important street paving and road contracts in various parts of Texas, including the 100,000 sq. yds. of asphaltic concrete pavement at $225,000, noted in our Contract News Section. Other contracts now in hand are street paving in San Antonio, $150,000; in Dallas, $56,000; in Houston, $50,000; a filter plant at Waco, $76,000; road work in Hunt County, Texas, $400,000; Hill County road work, $300,000; road work at Corsicana, Texas, $250,000. The company is a large and growing concern, with the main office at Memphis, and branch offices in Dallas, Ft. Worth, San Antonio, Waco, Houston and New Orleans. During the past three years contracts amounting to about $2,000,000 in Texas road and street work have been carried out, and about $1,000,000 of work in Arkansas, Tennessee and Louisiana. The officers and directors are all men of wide experience in contracting and construction work. Both Mr. W. Broadnox, president and Mr. C. D. Smith, vice-president, have been in the business for about 20 years. Of the directors, Mr. M. J. Roach, one of the founders and former president of the firm, has had 25 years of active construction work experience; Mr. E. J. Scott has been in that line of work for 15 years past; Mr. E. P. White was a contractor in New Orleans for 15 years; Mr. L. T. Kavanaugh was in business as a dealer in building materials for 15 years, and Mr. W. P. McCadden has had about 10 years of experience in the field.

OBITUARIES

Felix Barbeau, noted railway contractor of Minneapolis, died in that city Jan. 31, aged 64. Mr. Barbeau had lived in Minneapolis for 46 years, and was the contractor who built the Soo line from Duluth to the Twin Cities. He was founder of the railroad contracting business known today under the name of Barbeau & Werring, and built practically all of the railroads running west from Minneapolis into Dakota and Montana.

Mr. John Ross, a railway contractor of Montreal, died in that city recently. Mr. Ross was a native of Scotland and went to Canada at an early age. He entered the contracting business and was formerly a partner of the late Duncan McDermott, a widely known railway builder, who died recently. This firm built the Canadian Pacific through the Rocky Mountains, and afterward did considerable work throughout the northwest for the different railways in the early days of the beginning of what today has developed into the greatest transcontinental system on the North American continent. Ten years ago Mr. Ross became affiliated with the Ross, Harris, McRae Contracting Co., which constructed the Toronto-Sudbury branch of the Canadian Pacific. They also handled large contracts for work on the old Welland Canal, and built several sections of railway through the province of Quebec.

CIVIL SERVICE NEWS

The United States Civil Service Commission announces examinations as follows:

Designing Engineer; Reclamation Service; $2,000 to $3,000 per annum. Five years of irrigation engineering experience required. Apply to the Commission for Form 1312. Examination Mar. 2.

Consulting Mining Engineer; Bureau of Mines; $10 per day or $3,000 to $6,000 per annum when permanent. Apply for Forms 304 and 2095. Examination Mar. 2.

The following-named examinations will be held on March 10, 1915:

- Aid, Bureau of Standards.
- Aid, Coast and Geodetic Survey.
- Assistant inspector of boilers.
- Assistant inspector of hulls.
- Computer, Coast and Geodetic Survey (men only).
- Draftsman:
  - Copyist topographic, Departmental Service.
  - Junior engineer, Engineer Department at large.
  - Topographic, Departmental Service.
- Forest Assistant, Forest Service.
- Junior chemist, Departmental Service.
- Superintendent of construction, Supervising Architect's Office.
- Surveyor, Philippine Service.

The following-named examinations will be held on April 14, 1915:

- Cadet engineer, Lighthouse Service.
- Civil engineer and draftsman.
- Computer, Nautical Almanac Office and Naval Observatory (men only).
- Draftsman:
  - Copyist, ship, Navy Department.
  - Mechanical, Panama Canal Service (men only).
  - Ship, Navy Department.
  - Topographic, Panama Canal Service (men only).
- Engineer, Indian Service.
- Junior engineer (mining), Bureau of Mines.

Application forms may be obtained from the commission and will be accompanied by full information.

The New York State Civil Service Commission announces the following examinations for February 27:

Junior Assistant, Engineering Departments, $901 to $1,200. Non-residents of state may apply.

Chainman; $2.50 to $3.00. Some practical experience required. Must be resident of state.

Inspector of Construction, Green county; $3.50 to $4.50 per day. Experience in construction of roads, or other public works. Residence in county required.

Iowa Engineering Society.—The Twenty-seventh Annual Meeting of the society will be held at the Iowa State University in Iowa City, February 17-19. There will be a manufacturers' exhibit of clay products and of engineering and surveying instruments. A number of interesting papers are named in the program, including the following: "Vertical Fiber Brick Paving," J. S. Tucker, University of Oklahoma; "Testing and Grading of Concrete Aggregates," R. W. Crum; "City Planning," Nelson P. Lewis and R. F. Weirick; Report of Committee on Sanitary Engineering; "Degree of Purification Desirable and Practicable in Sewage Treatment Plants in Iowa," Lafayette Higgins; "Choosing the Curvature of a Concrete Arch," B. J. Lambert; "The Air Lift for Deep Well Pumping," A. H. Ford, and "Engineering, a Profession," W. H. Kimball.

January Footage Progress on Rogers Pass Tunnel.

An excellent record was established last month by the contractors in driving the west end pioneer heading of the Canadian Pacific Ry. Co.'s Roger Pass tunnel. The footage for this heading in January amounted to 932 ft. This figure is 122 ft. over the American record established by the Mount Royal Canadian Northern Ry. tunnel heading. The material encountered in the west end tunnel was slate. The footage for the other headings for January in the Rogers Pass Tunnel were as follows:

	Ft.
East end center heading	443
East end pioneer heading	594
West end center heading	701

The material encountered in the two east end headings was schist and quartzite; the west end center heading was driven through slate and quartzite. Foley, Welch & Stewart are the contractors, their superintendent for the work being A. C. Dennis, Glacier, B. C. Joseph Murphy is assistant superintendent on East and Joseph Fowler is assistant superintendent on West end, with W. Fowler and J. Young as walkers and A. Adams, J. Stewart and D. Hamer as shift foremen on Pioneer heading.

A $350,000 Waterway Development Near Tacoma, Wash.

An extensive waterway development is projected for Pierce County, Washington. The work will be undertaken by the Commercial Waterway District No. 1, a local improvement district, with offices at Tacoma. The district was formed for the purpose of dredging Hylebos Creek waterway and organization was effected about the first of the year. The proposed improvement will cost about $350,000 and will entail the dredging of about 4,000,000 cu. yds. of material.

The channel will be 2½ miles long, with a width of 400 ft. for the lower mile of its length, and a 300-ft. width for the upper 1½ miles. The purchase of necessary right of way, condemnation proceedings, surveys and preparation of estimates will probably consume 6 months' time and the work should be ready for contractors next summer. L. A. Nicholson, 207 National Bank of Tacoma Bldg., Tacoma, Wash., is the engineer.

A $50,000 Bridge at North Platte, Neb.

Contracts will be let about April 1 for a $50,000 state aid bridge to be constructed near North Platte, Neb. Designs have been prepared for a concrete structure and for a riveted truss bridge. The latter will consist of five 135 ft. skew trusses. The substructure will consist of four piers composed of two 60-in. tubes 25 ft. long. There will be 40 ft. piles in each tube. The abutment will be 20 ft. by 24 ft. or 29 ft. in size. The roadway width will be 16 ft. and the flooring will be concrete.

The design for the concrete bridge calls for 520 cu. yds. of concrete in the substructure, which will be composed of nine piers, 4½ ft. to 6 ft. in width and 29 ft. or 24 ft. long, and 16½ ft. by 24 ft. or 29 ft. abutments. The substructure will be on sand and gravel foundation on 30-ft. wood piles. The estimated cost of the substructure is $12,000. The superstructure will consist of 10 spans skewed 50° and will require 1,180 cu. yds. of concrete. The roadway width will be 16 ft. and 20 ft. There will be a sand fill in arches and a 12 in. clay surface. Donald D. Price, Lincoln, Neb., is State engineer.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

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The Road Mixer at the 1915 Cement Show.

The exhibit at the 1915 Cement Show which "stood out" visually beyond all others was the special concrete mixer for road construction. We made no count of the number of these special machines on the exhibition floor but there were perhaps half a score. In size they surpassed all but a few of the other devices exhibited. In expression of the idea of unity of design and construction for a special task they were inferior to no device on exhibition. The road mixer of 1915 is an exceedingly perfect concrete working appliance.

In our last issue a brief enumeration was presented of the features of concrete mixer design and construction as exemplified in present day practice. They were: mobility, mechanical unity, soundness of construction, independence of manual aid, and variety in size and price. As exemplifying all these features in the superlative degree the road mixer ranks perhaps first. The modern road mixer has the mobility of the most improved traction engine. Its running gear, even to the use in cases of caterpillar traction, steel framing and steering wheels, follows the best traction engine practice. The half dozen leading makes of road mixers present complete mechanical unity in design and construction; they are not special machines pieced together of parts of standard machinery but machines specially designed in all parts to perform a definite service. In independence of manual aid the road mixer is exceptional. One operator in most cases directs and actuates, charging, mixing, discharging, conveying, placing and movement along the work.

It will not be supposed that all road mixers had all these features to an equal extent or in the same degree of perfection. There were perceptible differences in solidity of construction and in weight, materials and workmanship. There were differences in size and price. In principle, excluding the mixing motion, the mixers exhibited differed only in respect to the conveying method employed. They were divided into mixers with chute conveyors and mixers with boom and bucket conveyors.

A Model Factory Building Possessing Co-operative Features.

Small manufacturing companies are often seriously handicapped by their inability to secure plants possessing adequate facilities to meet their needs. Many companies either are unable or are unwilling to finance the construction of a new plant, yet are unable to rent suitable quarters. Most of the rentable buildings have poorly arranged factory space and improper heating, lighting and ventilating facilities, which result in excessive overhead charges. Moreover, few rentable buildings furnish the space required for the present needs of the company and at the same time permit its future growth. Many cities have found it extremely difficult to attract new manufacturing concerns or even to retain those which they have induced to operate. In this issue we are publishing an article which gives details of how the Commerce Club of Toledo, Ohio, has solved, in a practical manner, the problem of attracting and retaining small industries. The venture which has been tried out by this organization not only has given satisfaction to those industries affected but it has yielded a fair return on the original investment.

In order to encourage small manufacturing companies to operate in Toledo a model factory building, four stories in height and providing approximately 160,000 sq. ft. of rentable floor space, was constructed. The project was financed by a $100,000 bond issue and by selling $194,000 of common stock, this stock being taken up by the members of the Commerce Club. The building is so constructed as to permit of future extensions as conditions warrant an increase in floor space. At the present time the building is used largely by metal working industries, and about 94 per cent of the available floor space is rented.

The success of the venture is due mainly to the fact that those in charge of it have had a true conception of the requirements of light manufacturing companies and of the advantages of co-operative facilities. No attempt was made to save money by building a cheap structure, but it was considered essential that every modern facility be provided. The heating, lighting and ventilating facilities are excellent. The structure is subdivided to meet the requirements of its tenants by tile partitions, the subdivisions being in units ranging from 1,000 to 40,000 sq. ft. The removal or erection of partitions to meet the changing needs of tenants can thus be done at small expense. As the management purchases the power, light and water, and then apportions them to the various tenants, the smaller companies thus obtain much lower rates than they would otherwise be able to secure. Other co-operative features are a general stock room, where supplies may be purchased practically at cost, a restaurant, and an emergency hospital. The management also is able to secure lower trucking rates than would be available were each tenant to act independently.

This solution of the small factory problem seems to be almost an ideal one—it certainly possesses many advantages over the old bonus system, which encourages industries simply by appearing to offer "something for nothing." Of the companies now occupying the Toledo building about 85 per cent are new companies which have been organized in Toledo or have moved there from other cities, which shows that the main purpose of such a venture, viz., the attracting of new companies, has been accomplished.

Methods of Determining the Comparative Cost of Hauling in Road Construction.

In road construction the problem of determining the comparative economy of hauling materials by various methods is frequently encountered. As a rule, the selection lies between team, traction engine, motor truck and industrial railway hauling. The output, or amount of material transported from one point to another point, is dependent upon three factors: (1) capacity or load hauled, (2) speed of operation, and (3) total cost of operation per mile traveled, including all items of daily expense, maintenance and depreciation. These three main variables apply to each of the four methods of hauling mentioned. Their evaluation is no simple matter but in their proper evaluation for the conditions existing on each separate hauling project lies a means of obtaining a comparison between the relative economy of various methods of hauling as applied to the project in question, and, also, a means of quickly determining one of the factors involved in the selection of hauling equipment.

Any attempt to generalize upon the comparative costs of hauling by various methods is a snare and a delusion unless applied to a particular problem. It is quite possible to place undue emphasis upon the costs shown in the charts on another page of this journal. The costs given are of no value in themselves because under no conceivable conditions in road construction would costs of hauling by four different methods be as stated in the article. But the graphic method of comparison as applied to each particular hauling project is interesting and of value.

Theoretically the cost of hauling over different distances varies as a straight line, in practice it has been found that on long hauls the ton-mile costs are usually materially less than on short hauls, due to an increased average speed of travel. Straight line formulas are based upon the same speed of travel over all distances and are therefore misleading in that respect.

Bearing in mind the many variables that enter into the selection of hauling equipment on each separate project other than the mere cost of hauling, it is unnecessary to point out the importance of exercising judgment based on a firmer foundation than charts which may be a guide and aid to the judgment but in themselves prove nothing.

Again an Erie Canal Enlargement Greatly Exceeds the Estimated Cost.

From earliest days the estimates of cost relating to the Erie Canal have been greatly exceeded by the actual cost. The "hundred million dollar barge canal," now nearing completion, will prove to be almost a two hundred million dollar barge canal. The "nine million dollar deepening," begun in 1895, was abandoned when the appropriation was exhausted for it was then evident that the final cost would be double the estimate. The following table from Gillette's "Earthwork and Its Cost" gives most of the previous history of estimates and actual costs relating to this celebrated waterway:

Structure.	Cost Engineer's estimate.	Actual.
Erie Canal (first)	$ 4,926,738	$ 7,143,789
Erie Canal (first enlargement)	23,402,863	32,008,851
Erie Canal (second enlargement	12,000,000	....
Black River Canal	1,068,437	3,157,296
Hoosac Tunnel	1,948,557	10,000,000
Manchester Ship Canal...	26,000,000	67,351,105

The reasons for excess of cost over estimates on these different canal projects are numerous. In the main they may be said to have been:

1. Final construction different from initial plans and specifications.

2. Inadequate surveys borings, etc., preliminary to the estimates.

3. Rise of prices during the construction period, the rise being partly due to the increased demand for men and materials consequent upon the canal work itself.

4. Careless omission of cost items, such as interest during construction, general expense items, etc.

5. Underestimates of prices, particularly of land secured by condemnation.

6. Graft and incompetency in administration, often arising from changes of administration.

In consequence of these and similar causes, Erie Canal improvements have averaged a cost about double the original estimates. The Panama Canal, as we now know, has shown a similar history, for similar reasons, excepting reason (6)—graft and incompetency.

The commanding officer of an army force may offer most excellent reasons why he suffered defeat, but neither his superiors nor the public is apt to be much interested in his excuses. Engineers are the commanders of engineering projects, insofar as economics is involved, and it boots them little to excuse underestimates of cost. The public will continue to blame them for their errors, regardless of every excuse.

One of the commonest engineering excuses for underestimates of cost is this: I supposed that I, as an engineer, was called upon to estimate only the direct costs of the engineering structure. As for damages to land, interest during construction, executive and general expense, rise of prices due to changes in supply and demand—all those I regarded as beyond my domain, so I omitted them from consideration.

There may have been a time, in fact there was a time, when an engineer was supposed to have little personal knowledge of cost factors such as those just enumerated, but no engineer in charge of a large project has any right to plead ignorance of the great economic factors. He, above all other men, is the economist to whom the public or the proprietor has a right to look for a full answer to the cost problems. He should have before him the actual detail costs of many other similar projects. He should be perfectly familiar with supply and demand conditions, not only of the present but of the past, curves of prices and their trends should be at his hand. He should know the general expense and all other "overhead costs" of many works He should be familiar with the results of legal actions relating to land condemnations and the like. His, in a word, is the task of weighing not part but all the dollars and cents variables that enter the complete equation of cost. How otherwise, indeed, can he correctly solve that equation for a minimum total cost?

Let us have an end of reports by engineers excusing high costs because of this, that or the other circumstance. It is well for engineers to discuss among themselves the reasons for such errors, in order that similar errors may be reduced in the future. But if engineers will make up their minds to take full responsibility for the estimates of the entire cost of their works, there will be less likelihood of their trying to offer excuses after a blunder has become evident, also they will be far less likely to blunder.

In this connection let us again call attention to certain defects in the New York State laws relating to the office of the State Engineer. To begin with a grave defect exists in the fact that this position is elective. Incidentally, we may add, the State Engineer is "the tail of the ticket." It needs no argument to convince engineers that the best man for the place of state engineer can seldom be secured by election. Who of us, be he ever so competent, cares to submit either to a political convention or to a direct primary, the evidence of his fitness for an engineering position?

Second, the state law prohibits the state engineer from succeeding himself in office after he has served four years. Under this law no state engineer can hope to finish a large project started under his administration. What more need be said of it?

Third, the salary of the state engineer is $5,000 a year. It should be nearer $50,000 a year, considering the magnitude of the work and the class of engineer entitled to hold a position of such responsibility.

The engineers of New York state have only themselves to blame if they permit the state engineership to remain the football of politics and the highball of the public economic inebriacy. Concerted action on the part of engineers will secure changes in the laws, and proper changes should result in better engineering and the entire elimination of excuses for costs in excess of estimates, as well as for such wastes of public funds as the two hundred million dollar barge canal now promises to be. At half that cost it was a questionable investment. What is it when land damages, interest on bonds, etc., etc., have swelled the one to a two?

Ready Bond Sales Are "Harbingers of Industrial Summer."

The ready sale of Philadelphia's large municipal bond issue has been followed by oversubscription of the $49,000,000 4.5 per cent bonds offered by the Pennsylvania Railroad. The bonds sold above par, and are already being quoted at prices that net the investor only 4.25 per cent.

Abundance of capital is seeking safe investment. It was said only a few months ago that there would be scarcity of investment capital in 1915 because of very large refunding issues of bonds. This was poor reasoning, for, when bonds mature, the capital paid back to the bondholders seeks immediate reinvestment, usually in the very same sort of bonds that it was formerly invested in.

For extensive improvements it is usually necessary for companies to sell stock as well as bonds; but for moderate additions to property it generally suffices to issue bonds. Hence it is likely that far-sighted companies will begin to take advantage of low interest rates and low costs of material. As stated in a previous editorial, there is not a valid excuse for further hesitation about raising funds for public works. In a recent New York speech, Ex-President Roosevelt urged a large increase in construction of municipal, state and federal government plant. Along this line there is now in progress a campaign for an underground rapid transit system in Philadelphia, the construction of which would involve an expenditure of some $40,000,000. It is not unlikely that construction work will be authorized this spring.

Engineers can be very influential in creating public opinion favorable to extensions of public works this year. A good money market and very low prices for construction of all kinds are economic factors so favorable that there should be no hesitancy in advocating investments in needed public structures.

A Millionaire Road Foreman.

Western millionaires are by reputation red-blooded, two-fisted men. During the past year one of the foremen of road construction camps, or roadmaster as he is called, in Multnomah county, Washington, was John B. Yohn, several times a millionaire. Work began at 4 a. m. and ended late at night and Mr. Yohn was always on the job. He worked without pay and devoted the energy and ability that had amassed a fortune for him to forwarding road construction in his county.

The gift of time and proven ability to the public is in many respects more valuable than a gift of money. The incentive and inspiration toward public service to men less fortunate in some respects and not so much in the public eye has a value that a gift of money cannot approach. The strength of a democratic form of government is largely dependent upon the leadership of influential citizens in affairs of public moment and their personal and active participation in them with no desire for reward other than a duty performed and the building up of the community and nation. The example of Mr. Yohn is worthy of emulation.

A Judge for County Surveyor.

Governor Major of Missouri has appointed a well known lawyer to the position of County Surveyor of Jackson county. Jackson county is the county in which lies the considerable municipality of Kansas City and according to the newspapers the engineers of that city are "surprised" at the selection. Naturally. Surprise, an unexpected turn of thought, is one of the elements that differentiates American humor and Governor Major is merely an unsuspected Missouri humorist. We have only to turn to his own words to know this. He says:

> I wanted a man of executive ability upon whose honesty I could implicitly rely to administer the affairs of the office. He will have the overseeing of the expenditure of more than a million dollars in the next two years and I wanted a man familiar with road work in Jackson County who could administer the office efficiently and see that a dollar's worth of work is put on the roads for every dollar spent, and that every contractor lived up to the letter of his contract. I have that man in Judge Southern.

This utterance does not mean that honest engineers cannot be found in Kansas City or in the state of Missouri—it simply avers that an honest lawyer is among their citizens. Governor Major is himself a lawyer and, feeling privileged in his own family, he is merely lighting up the gubernatorial routine, so drab to one used to the flame and murk of trust "busting," with a touch of irony. But road building is an *engineering work!* Yes truly, and here is the unexpected turn of thought that makes the real exquisiteness of the joke, the Governor classifies it as a *legal process.* What conception could be more unexpected! The engineers of Missouri should not take Governor Major's appointment too seriously as reflecting on their good repute. Perhaps he is planning to "surprise" the Bar of Missouri by appointing a civil engineer as Attorney General.

Examples of Very Good and Very Poor Public Works Reports.

The importance of including specific information of general interest in public works reports has frequently been emphasized in Engineering and Contracting. We have held this to be necessary, first to make the report of greatest interest to the home reader, and, second, to make it of any considerable interest at all to the engineers and public works officials of other cities and to engineers in general practice.

Within the past few days the editors have received copies of two reports which serve well to illustrate how valuable such publications can be made and how valueless they too frequently are made. The very good report is the Annual Report of the Water Board of the City of Baltimore for 1913. The very poor report, from the criterion mentioned in our first paragraph, is the single volume containing the Annual Reports for 1910, 1911, 1912 and 1913 of the Department of Engineering of the City of Rochester. Let it be plain that in this statement there is no comparison of the quality of the engineering work of the cities named. Also, it is only justice to point out that the Rochester report is in line with prevailing practice in making city reports, while the Baltimore report is exceptional. We are simply using these two reports impersonally as examples, in one case of a practice which we think should be criticised, and in the other case of a practice which should be commended.

The Baltimore report is one of the very best ever published; a brief review of its contents will indicate that we do not speak extravagantly when we so class it. In addition to the financial statement the report consists essentially of the following matter: Capacity and duty test data for a new vertical triple expansion pumping engine; an account of the overhauling of a similar pump after long service; a description of the application of hypochlorite and alum to the supply; full description and plans of new filtration plant, including low lift pumping station, aerators, filtration plant proper, including chemical house, coagulating basins and filters, and the filtered water reservoirs; description of works for new Gunpowder River supply, including the new Loch Raven dam, two roads, two bridges, a steel pipe conduit, distribution mains and various appurtenances; tabulated bids covering the last named improvements; full statistics on water consumption; tabulations showing extensions of water mains and connections, and other statistical matter; a description of the construction and operation of an experimental water filter; a full copy of the report by George W. Fuller on the "Most Practicable Method for Filtering Baltimore's Water Supply"; a report of the tests on the experimental filter; a full copy of the report by John H. Gregory on the failure of groined arches at the new filtration plant; a report from the biological laboratories; a description of the plan for the reforestation of the Loch Raven watersheds; and an illustrated report describing the procedure and giving the results of the pitometer survey for the curtailment of water waste. The entire report, aside from the inserted folding plates, occupies 220 6x9-in. pages.

The Rochester report mentioned contains 476 6x9-in. pages. As stated, it covers a period of four years and relates to the entire engineering department. It consists almost wholly of tabulations of statistical matter. There is a worth while summary of water works statistics in the form proposed by the New England Water Works Association; this is valuable for purposes of comparison. There is given also a copy of the five-year contract for street lighting, and of the specifications for arc lamps. One page is devoted to sewage disposal. There is also a table showing the discharges of the Rush water works conduit, as computed from gagings, which gives values for the coefficient in the Chezy formula. There are slightly over 300 pages devoted to statistical tables relating to the water works distributing system. This comprehensive record can not fairly be called of even local interest since it is extremely doubtful if many persons in Rochester aside from the water department employees have any interest in the exact locations of valves, hydrants, etc., the length and location of water pipe extensions, and similar matter. Similarly, about 120 pages are devoted to tabulations of statistics pertaining to sewer, street and sidewalk work.

The two reports are so entirely dissimilar in their scope that a difference of opinion between their compilers as to what constitutes matter suitable for inclusion in public works reports is evident. We may profitably consider which form of report possesses the greater value. Again let it be borne in mind that criticism of engineering work in Rochester is farthest from our purpose. Our criticism, offered wholly in a constructive and friendly spirit, has to do merely with the futile but expensive manner in which the Rochester Engineering Department records for public distribution the results of its labors.

It is true that 1913 was a year of exceptional activity in the Baltimore Water Department. Special attention is called, however, to the fact that the compilers of the report for that year made good use of their opportunity to record many matters of permanent value to all water supply engineers. The report is well worth filing in every water works man's library. On the other hand most engineers know something of the good and extensive work done in Rochester in connection with sewage collection and disposal, yet the four-year report mentioned gives but a single page to these matters. That page mentions construction work on the intercepting and outlet sewers, and on the outlet pipe in Lake Ontario. The regulating chambers are also very briefly mentioned. While the plans for the disposal plant were still in something of a fluid state when the report was completed many important points must have been decided upon and many interesting details must have been designed. Would it not have been well to devote at least 25 pages of the report to a consideration of these matters? We think so. The statistical matter given is all worthy of record, but why publish it? Why not file such matter when it is put in shape for publication and let it go at that? We can see no good reason for publishing it and no adequate return for the money so spent.

We hope there will be many more reports like the Baltimore water report for 1913.

BUILDINGS

End Framing for Armory at University of Illinois and Some General Features of This Structure.

(Staff Article.)

In our issue of Aug. 6, 1913, we described and illustrated the design, and gave cost data on the erection, of the 206-ft. span, three-hinged arches of the University of Illinois Armory. At the time of the erection of these arches the end bays of the structure were not included in the construction program, owing to lack of appropriations. The end bays and end framing have recently been completed, and the structure is entirely enclosed, although the galleries and the ornamental towers at the corners have not yet been constructed. The clear length of the armory is 400 ft., its width is 212 ft., and its height, from the end pins of the arches to the pin at the apex, is 94 ft. 3 ins. The following data apply to the end bays and end framing, and to the architectural features and equipment of the structure.

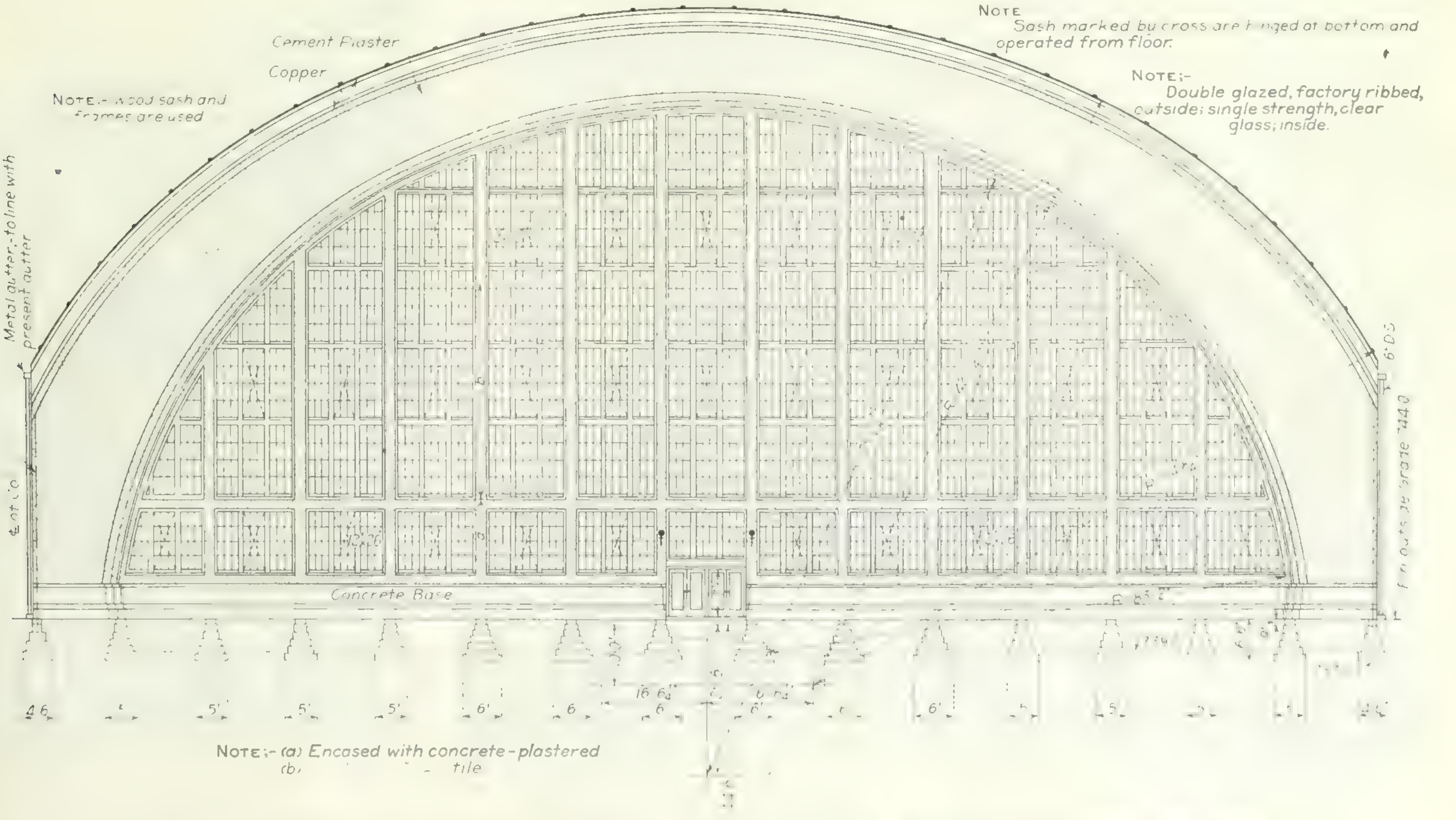
Cement Plaster
Copper
Note:- Wood sash and frames are used
Metal gutter-to line with present gutter
Note
Sash marked by cross are hinged at bottom and operated from floor.
Note;-
Double glazed, factory ribbed, outside; single strength, clear glass; inside.
Concrete Base
Note;-(a) Encased with concrete-plastered
(b) tile
4 6
5'
5'
5'
6'
6
6
16 6
6'
6'
5

Fig. 1. Elevation of East End of University of Illinois Armory Showing Architectural Features.

GENERAL ARCHITECTURAL FEATURES.

The extraordinary span and height of the three-hinged arches required special care in the design and construction of the end framing. This framing consists principally of wide latticed columns, spaced 14 ft. 3⅛ ins. on centers, longitudinal girts, and a rigidly braced segmental cornice. The three-hinged arches are omitted in the ends of the structure, and the built-up purlins are riveted to the end framing. The deep end rings, or cornices, have a cement-gun finish, and are continued from ground line to ground line. Stairways are placed in these rings, which give access to the top of the structure. Above the concrete belt course, which extends 7 ft. 2 ins. above the column footings, the latticed columns at the end of the structure are encased with fireproof tile to form the window mullions. With the exception of the end rings, practically the entire ends of the structure are fitted with windows, arranged in six horizontal tiers, the sash in alternate tiers being movable. To prevent condensation, double-glass windows are used. The glass in the outside panes is double-strength, factory ribbed, and that in the inside panes is clear, single-strength. Figure 1 is an end elevation of the armory showing the architectural features. The windows indicated by a cross are movable; all others are fixed. Figure 2 (a) is a foundation plan of the two end panel in the end of the armory, and Fig. 2 (b) is a horizontal section through the lower tier of windows.

The side walls are constructed of 8-in. terra cotta tiles, the concrete finish of the exterior being applied with the cement gun. The roof construction, with the exception of that over the end rings, consists of 4 x 8-in. wooden rafters of Southern pine, 1⅛ x 6-in. matched and dressed sheathing of No. 1 common pine, and the National Roofing Co.'s "Security" wide-weld asphalt roofing. A copper roofing is used for the end rings. Figure 3 is a view of the armory showing the general architectural features.

HEATING SYSTEM.

The armory is heated partly by a direct radiation system and partly by a recirculating system, which draws the air from the ends, near the top, and redistributes it from points about 20 ft. above the floor. These heating systems furnish an equivalent of 73,000 sq. ft. of direct radiation, made up of 23,000 sq. ft. of direct radiation and 9,500 sq. ft. of fan coils, each square foot of the latter being equivalent to 5.5 sq. ft. of direct radiation. The fans and coils are located in diagonally opposite corners of the structure.

The radiators are placed in two rows along the sides and ends of the building. The upper row at each side is suspended from the rafters, the top of these radiators being about on a level with the top of the side walls; while the lower row is suspended from the arches, the bottom of the radiators in this row being about 4 ft. above the floor. The lower row of radiators at each end rests on the floor; while the bottom of the radiators in each upper row is about on a level with the sills of the second tier of windows, these radiators being fitted against the columns so as not to obstruct the windows.

To test the distributing system, temperature readings were taken at various points throughout the structure, at a uniform distance of 5 ft. above the floor. These readings showed a maximum variation of only 3° F.

LIGHTING SYSTEM.

The lighting system consists of forty-two 500-watt tungsten lights (three on each arch), suspended from "Thompson" cut-out sockets. These lights can be lowered to the floor, as required. The lights on each arch can be operated as a separate unit from a central switchboard located in one corner of the building.

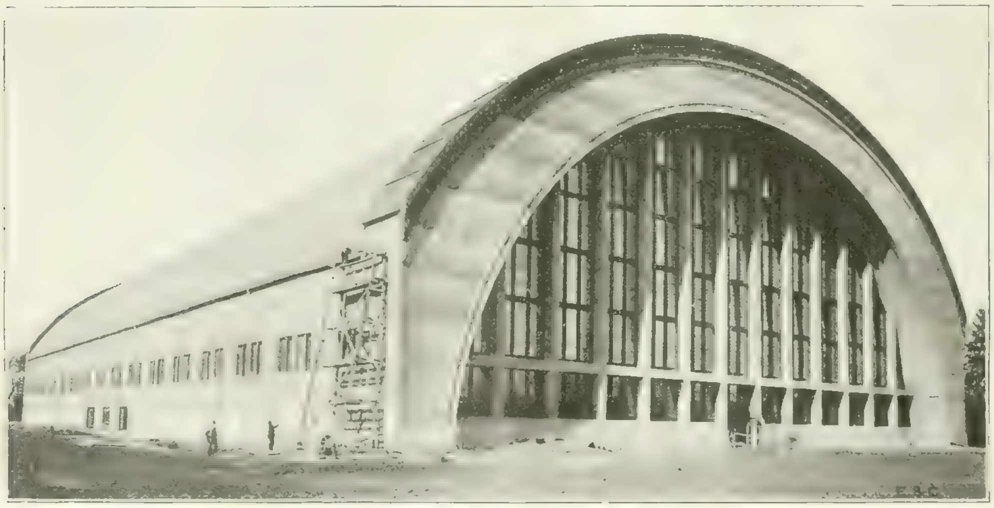

Fig. 3. View of University of Illinois Armory Showing End Construction.

FLOOR CONSTRUCTION.

Two types of floor were laid. In the center of the structure, covering an oval area 140 ft. wide by 340 ft. long, there is a dirt floor; the remaining area has a concrete floor.

In an effort to obtain a dirt floor which would not become too compact, and at the same time would not become dusty, considerable experimenting was done. It was finally decided to lay the dirt floor as follows: First a base, consisting of a 4-in. layer of cinders, was laid, the cinders being sprinkled and tamped. A 2½-in. layer of powdered yellow clay was then placed on the cinders, and upon this there was placed a 2½-in. layer of building sand. The clay and sand were then thoroughly mixed with a disk plow, then dragged, sprinkled, and rolled. This 5-in. wearing surface of 1:1 sand and clay is expected to meet both athletic and military requirements. The inner boundary line of the concrete floor forms the outside curb of a seven-lap-to-the-mile running track.

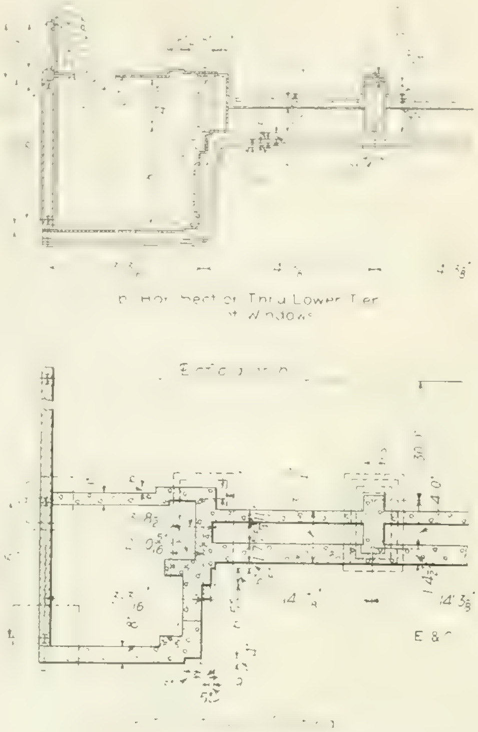

Fig. 2. Foundation Plan of Two Side Panels of End Framing and Horizontal Section Through Lower Tier of Windows.

MATERIALS

All concrete, except that used for walls and for other surfaces which are not plastered and have finish surfaces, was mixed in the proportions of 1 part cement, 3 parts sand, and 5 parts crushed stone having a maximum size of 1½ in. The concrete for walls and surfaces which are not plastered and have finish surfaces consists of 1 part cement, 2 parts sand, and 4 parts crushed stone.

The tiles, which encase the end columns, are bedded in mortar consisting of 1 part Portland cement, 3 parts sand, and 2 parts lime. These tiles are anchored to the columns at every course with galvanized wire hooks.

The sash is made of straight-grained white pine 2¼ ins. thick, all fixed sash being screwed to the frames. Each movable sash is hinged at the bottom, and is operated from the floor level. The window frames are made of "B" grade cypress.

The specifications for the outside surface of the end rings call for 2 ins. of concrete applied on No. 24 gage expanded metal. The inner surface of these rings consists of a 1-in. layer of concrete applied on expanded metal. These surfaces were applied with the cement-gun, heavy building paper first being attached to the expanded metal to retain the concrete. It was specified that the expanded metal should be in the center of the 2-in. concrete furring; as actually constructed, however, the inner surface of the metal is barely covered, as the building paper was held closely against the metal.

The side walls, which consist of 8-in. terra cotta tiles laid in cement mortar have a rough concrete finish applied with the cement gun. Figure 4 shows the equipment and scaffolds used in applying the concrete finish:

SASH OPERATING DEVICE.

On account of the size and number of sash to be operated, special care was given to the design and construction of the sash operating device by the architect to insure ease and certainty of operation. As the device contains some unusual features it will be described somewhat in detail.

The operator is of the rack and pinion type with two racks to each sash, attached about 8 ft. from the bottom of the sash and operated by pinions connected to a horizontal shaft, this shaft being operated by a worm gear. There are three lines of shafting at each end of the armory. The two upper lines are continuous, while the lower line is operated in two parts, the shafting being omitted in the center panel of the structure. The first, third and fifth tiers of sash are movable. The shafting is supported at a distance of 15 ins. from the face of the columns on brackets attached to

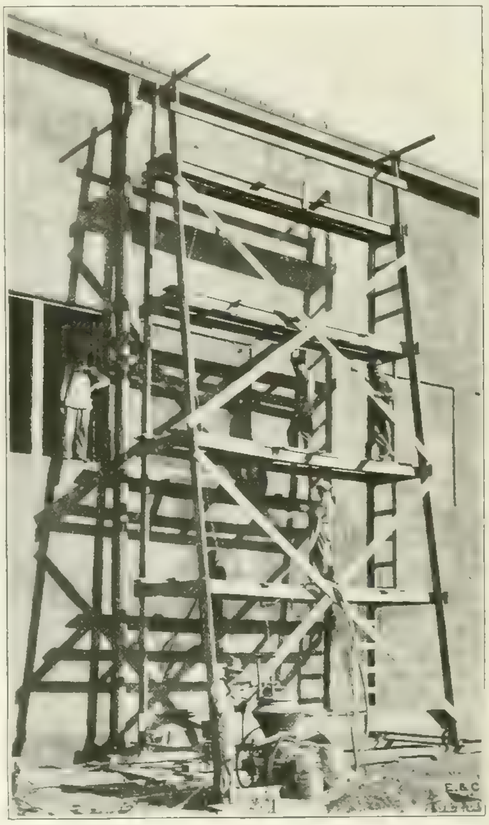

Fig. 4. View Showing Manner of Applying Concrete Finish to Terra Cotta Tile Walls.

each column, the shaft bearings being fitted with bronze bushings and with compression grease cups holding 6 ozs. each. The shaft gears are cast iron, 12 ins. in diameter and with machined teeth, the gears being fitted with square shafts and special sleeve couplings for connecting them to the main shafting.

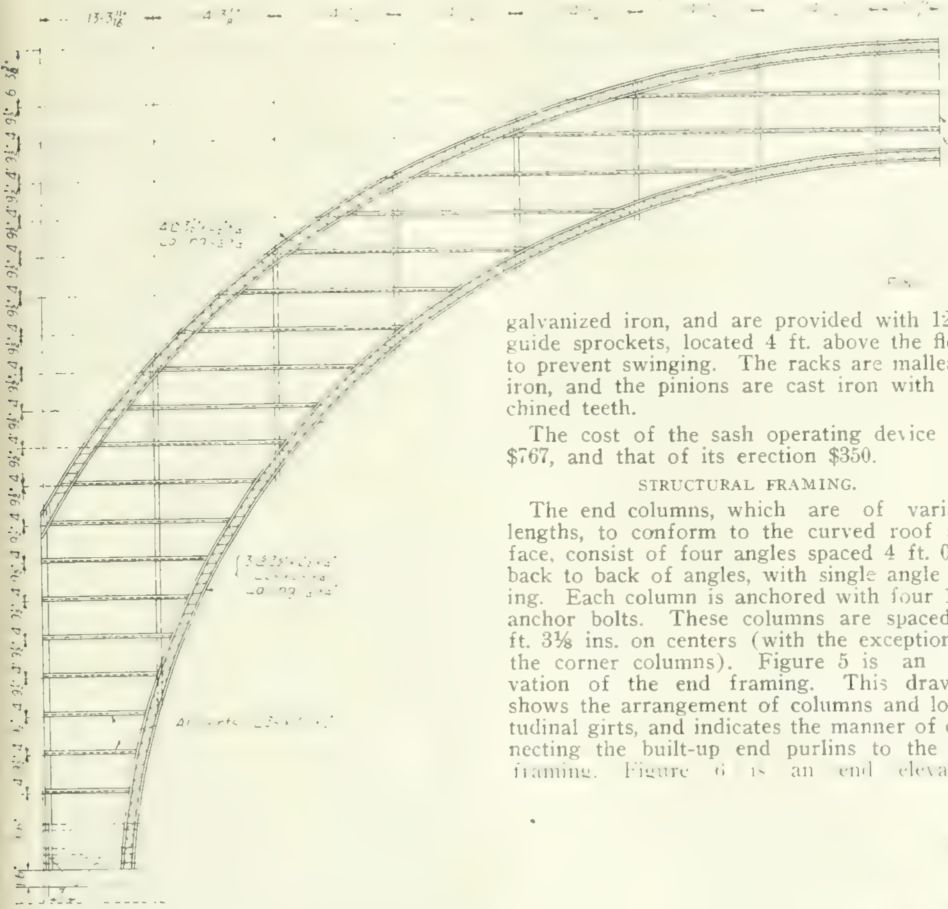

Fig. 6. Structural Framing for End Rings of University of Illinois Armory.

The lower line of shafting is turned by a worm gear, which is operated by a 12-in. hand wheel attached to a ¾-in. vertical steel rod, the hand wheel being 5 ft. above the floor. The two upper lines are operated by chains and sprocket wheels. The worms are machined from solid forgings, and are equipped with ball thrust bearings which are accurately fitted to worm wheels to secure smooth operation. The bearing brackets are designed to prevent spreading or inaccurate alignment. The sprocket wheels are 12 ins. in diameter and are equipped with "keepers." The chains are galvanized iron, and are provided with 12-in. guide sprockets, located 4 ft. above the floor, to prevent swinging. The racks are malleable iron, and the pinions are cast iron with machined teeth.

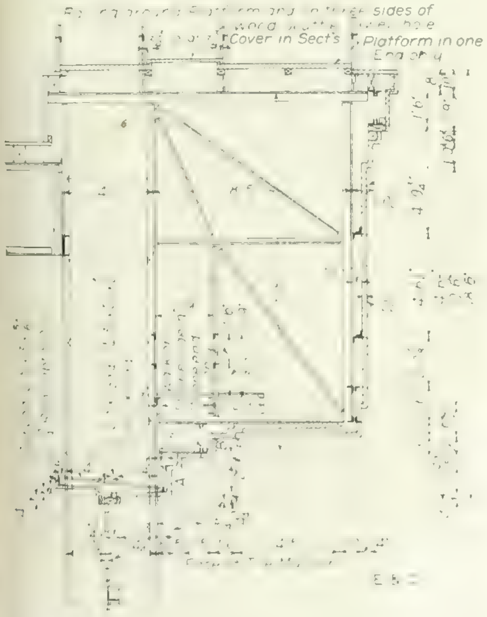

Fig. 7. Cross Section of Cornice at Center—University of Illinois Armory.

The cost of the sash operating device was $767, and that of its erection $350.

STRUCTURAL FRAMING.

The end columns, which are of variable lengths, to conform to the curved roof surface, consist of four angles spaced 4 ft. 0 in. back to back of angles, with single angle lacing. Each column is anchored with four 1-in. anchor bolts. These columns are spaced 14 ft. 3⅛ ins. on centers (with the exception of the corner columns). Figure 5 is an elevation of the end framing. This drawing shows the arrangement of columns and longitudinal girts, and indicates the manner of connecting the built-up end purlins to the end framing. Figure 6 is an end elevation of the cornice, or end ring. This drawing shows the arrangement of the framing in the outer face of the cornice. Figure 7 is a cross section of the cornice at its center, and shows the structural steel framing and the concrete finish. The latticed members represented in Fig. 7 by "A" and "B" are curved to follow the outline of the cornice.

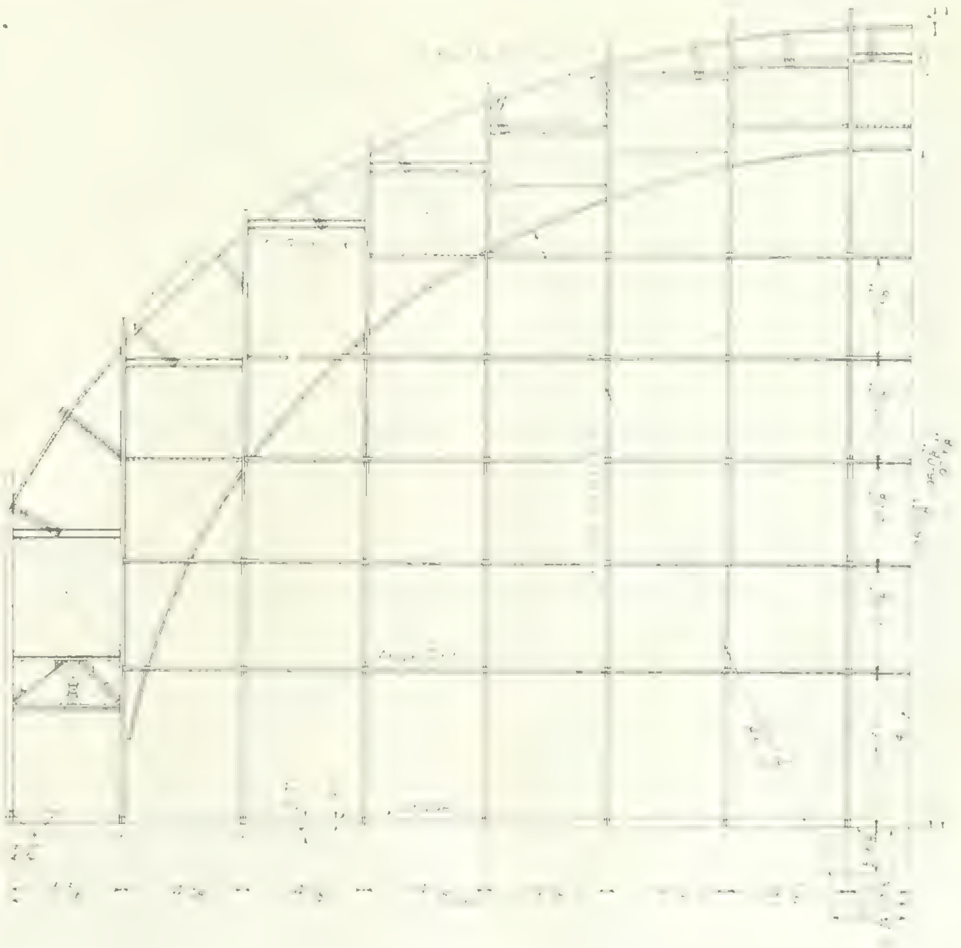

Fig. 5. Structural Framing for Ends of University of Illinois Armory.

The built-up purlins and bracing in the plane of the roof, for the end bays, are similar to those described and illustrated in our Aug. 6, 1913, issue.

COST DATA.

The following contract costs apply to the construction of the two end bays and the end framing

General contract for enclosure, exclusive of steelwork and footings	$34,049.90
Steel contract	33,303.00
Footings	1,381.91
Sash operator, installed	1,117.00

Other cost items, which apply to the entire structure, are:

Heating contract	$18,770.46
Lighting contract	5,800.00
Concrete and dirt floor approximate cost	5,500.00

PERSONNEL.

The plans for the completion of the armory were prepared by James M. White, supervising architect, University of Illinois, from sketches made by W. Carbys Zimmerman, formerly state architect. The construction work was in general charge of the supervising architect of the University of Illinois.

The general contract for enclosure was executed by N. H. Shields, Danville, Ill., and that for furnishing and erecting the steelwork by the Morava Construction Co., Chicago, Ill.

Granite Quarried from Boulders.—An interesting feature of the production of granite in California is the quantity of stone quarried from large residual boulders. These boulders, according to the United States Geological Survey, represent the remnants left from prolonged disintegration of large granite masses, but after a thin weathered coating is removed they yield sound stone. Good granite should stand a crushing strain of at least 20,000 lbs. to the square inch; some granites will stand 40,000 lbs. This may be compared to common red brick, which will crush at about 3,000 lbs. to the square inch.

A Model Factory Building for Small Plants in Toledo, Ohio.

Small light-manufacturing plants located in rented quarters are often seriously handicapped by being compelled to occupy old, out-of-date buildings possessing few modern conveniences. With poorly arranged factory space, and with improper lighting, heating and ventilating systems, their overhead charges are high and consequently the cost of production is excessive. Some plants require such a small space that the erection of a separate building is not practical, while the owners of other industries do not care to tie up their capital in factory buildings. The following article describing how the city of Toledo, Ohio, solved the problem of providing adequate factory facilities for small industries is based on information appearing in a recent issue of the *Iron Age*. The movement to erect the factory building originated with the Toledo Commerce Club which, after investigating conditions, found that the lack of accommodations interfered with the establishment of new industries in Toledo. The Commerce Club, as an organization, was unable to undertake the erection of a factory building, but a company known as the Toledo Factories Company was organized within the membership of the club, practically all of the members being stockholders.

FINANCING THE PROJECT.

To finance the model factory building a $100,000 bond issue, drawing 5 per cent interest, was authorized. The bonds were taken by some of the local banks, and $194,000 in common stock was sold. While the primary object was to aid the city the details of the project were carried out with the idea of making it a safe financial investment with a fair turn to the stockholders. Earnings have been sufficient to warrant the directors to authorize recently the payment of dividends at the rate of 4 per cent per annum on the stock.

THE SITE.

The site selected was a 3½-acre tract occupying a block on a car line convenient to the railroad depots, docks and downtown section of the city. In view of the fact that none of the tenants would receive his raw material or ship his products in car lots, the advantages of the site selected, including the purchase of a large tract of land at a comparatively low cost, were regarded as overbalancing those of a site adjoining a railroad siding.

DETAILS OF BUILDING

The building is a four-story, reinforced concrete structure built in two main sections or units, each 200x90 ft. in plan and connected by an intermediate section 66x66 ft. This is taken up for the most part with the elevators, stairways and office space, and on the ground floor with the main entrance and loading platforms. There is an extension to the second unit, similar in dimensions to the one that connects the present two units, and to this will be connected two additional units, which the company plans to build when the demand for space warrants the doubling of the present floor space. The power plant is located in the basement of this section. No basement space is provided in other parts of the plant. The present units provide approximately 160,000 sq. ft. of rentable floor space.

Figure 1 is a typical floor plan of the structure indicating the possibilities of subdividing the floor space to suit the needs of the tenants. The reinforced concrete columns are spaced 22 ft. on centers, each way. With the exception of the space taken by the pilasters, the entire side wall space from the floor to the ceiling, which is 12 ft. high, is fitted with 12x18-in. plain glass set in "Fenestra" steel sash. There are 29,000 panes of glass in the building. The large amount of glass surface provides the maximum amount of outside lighting and, as the interior space is so divided that every tenant has outside window surface, every occupant has an abundance of light. The floors are of the slab construction and are designed for a floor load of 200 lbs. per square foot. The type of building permits the use of heavy and high speed machinery with no perceptible vibration, and the building is equally adapted for metal working shops, or for other lines of light manufacturing where machinery is required.

The building is subdivided in space to suit the requirements of tenants by means of 4-in. Egyptian tile partitions erected between the columns. The removal or erection of partitions to suit the requirements of tenants involves little expense. The subdivisions are made in units ranging from 1,000 to 40,000 sq. ft. Most of the tenants use 3,000 sq. ft. of space. A number started with 1,000 sq. ft. and as their business has grown have increased their space to 3,000 sq. ft.

The building is served by two "Haughton" electric elevators, one a three-ton freight elevator and the other a passenger elevator. The loading platforms on the ground floor directly adjoin the freight elevator.

RENTAL RATES.

The rental rates range from 19 to 24 cts. per square foot per year, depending on the size of space taken, the average being about 20 cts. This price includes heat and ventilation, the installation of an automatic sprinkler system and the ordinary water supply, an extra charge for water not being made unless a considerable amount is used for manufacturing purposes. With the fireproof construction of the building, automatic sprinklers and other safeguards against fire, the insurance rate is much lower than in old types of buildings having little or no protection against fire. The maximum insurance rate for tenants is 15 cts. per $100 per year.

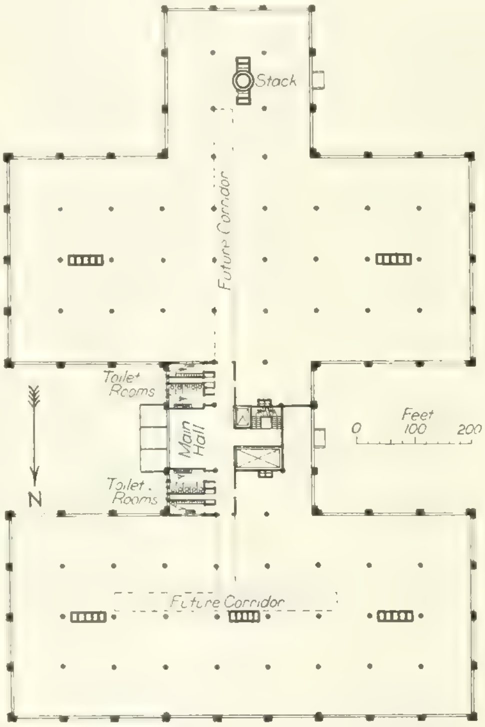

Fig. 1. Typical Floor Plan of Model Factory Building in Toledo, O. Indicating Possibilities of Subdividing Floor Space.

HEATING AND VENTILATING SYSTEM.

The heating and ventilating systems of the building are unusual for a structure used for manufacturing purposes. Owing to the fact that the building is occupied by a number of tenants there are frequent changes in partitions due to the changes in occupancy and to the desire of some tenants to increase their floor space. These conditions necessitated a flexible arrangement of the heating and ventilating system. Owing to the large amount of window surface very little wall space was available for radiation, and ceiling radiation was impracticable because some of the tenants desire attractive looking rooms. For these reasons the all indirect system was determined upon. The principal advantage in heating the building with direct radiation lies in the fact that the rooms may be warmed without mechanical intervention. The plant was designed to accomplish this result without radiators by placing the heating surface at the bases of large vertical air ducts. This, it is claimed, has worked out with excellent results. All of the factory rooms are supplied with fresh air without the necessity of opening any of the outside windows.

There are five main indirect heating chambers connected with a fan by large concrete air ducts arranged for easy inspection and cleaning and provided with electric lights so that one may walk freely to all parts of the distribution system. To minimize the operating cost the fan and tempering coils are placed adjacent to the boiler room, and the fan is driven by a steam engine, the exhaust steam from which is utilized for heating. Steam is circulated at a vacuum, thermostatic traps and a vacuum pump being used in connection with the system. The air delivery throughout the building provides a change for about every 15 minutes. Space is left for the future installation of an air washer, but owing to favorable surroundings, this is not required at present.

The fresh air supply is taken from the outside into an air shaft and through a "Sirocco" fan with a capacity of 138,000 cu. ft. per minute when operated at 125 r.p.m. and driven by a 50-HP. steam engine. The air is drawn through tempering coils, a temperature of 68° being automatically maintained by means of the thermostat that controls a by-pass damper under the tempering coils. As it passes through the tempering coil the air is humidified by steam jets from three horizontal pipes located on the warm side of the coils. These jets are controlled by a diaphragm valve regulated by a humidostat.

The tempered air passes into a main 7x8-ft. air duct of concrete, which extends the length of the building under the corridor and from which branches lead to five plenum chambers provided with four sections of "Vento" cast-iron radiators. These heating stacks take low-pressure steam. Automatic temperature control and dampers are provided throughout the building, each room having a thermostat which controls the temperature without changing the volume of the air. The thermostats, in order that they may not be unduly interfered with by an unauthorized person, are placed in the vent flues where they are subjected to a constant fair sample of the air coming from the rooms which they control. They are set to operate at a temperature a little lower than they would be set for were they located in the ordinary manner in the rooms.

The flues are arranged in banks of five, four of these being heat flues, one of which supplies a floor in that section of the building and the fifth being a vent flue for the first floor. A heat flue that supplies warm air for the first floor becomes a vent flue for the second floor and so on, so that only five flues are required to serve the four floors. Some of the separate heat flues are 30x30 ins. and others are 24x30 ins. When small subdivisions of the rooms are required horizontal supply and vent ducts are provided at the ceiling. The fresh air is taken into the rooms near the ceilings through adjustable diffusers. In many of the rooms there are ventilation openings at both floor and ceiling, the lower opening being used in winter. The upper openings are for additional ventilation in the summer, or when fumes arise from manufacturing processes. The various groups of vent flues terminate in heavy ventilators on the roof.

For heating and ventilating the office rooms in the section between the two main wings there are two double flues, one on each side of the elevator shaft, and the tempered air as it comes from the flues is blown through the coils of radiators located before the outlets. The corridors are heated by tempered air that comes from the main air duct through the elevator shaft, this air supply being regulated by pneumatically controlled dampers. Direct radiation is provided for the toilet rooms.

A re-circulating system is provided for use during the night when the building is not occupied and fresh air is not essential. The outdoor supply of fresh air is shut off, and the air in the building is re-circulated, it being drawn to the fan through the corridors and elevator shafts. To prevent the drawing in of outside air through the ventilators, dampers are provided at the top of the vent flues that are pneumatically closed by a switch in the basement. Steam for the heating system and for power is furnished by two 250-HP. water-tube boilers, equipped with hand-fired smoke-consuming furnaces.

The accomplishment of results without direct radiators is said to have been most satisfactory as there are no obstructions, no local overheating and no radiators to interfere with in the moving of partitions. The fuel cost for heating for the season 1913-1914 was $3,009. This is $1.22 per 1,000 cu. ft. of contents for the season, or $16.80 per 1,000 sq. ft. of floor surface. It is stated that the temperature of the building has been 70° at 7 o'clock in the morning during the coldest weather of the heating season, when the outside temperature has been as low as 3 and 4° below zero. A test was made during the severest cold weather, and when the temperature was 70° in the center of the room it was 69° at a distance of 1 ft. from the glass surface in the most exposed room in the building.

SANITARY FEATURES.

Another unusual feature for a manufacturing plant is the sanitary arrangements. There are four toilet rooms in each floor, one each for the office and shop men and one each for the office and shop women, the two for the men being adjoining on one side of the corridor and the two for the women being on the opposite side. Each toilet room is provided with four washstands and two closets. Each bowl is vented, the air being taken through a porcelain duct which is connected with a pipe that leads back of the fixtures into a narrow chamber separating the two adjoining toilet rooms. Through these chambers an air shaft extends up to the penthouse, where the air is exhausted by a fan. The closets are connected with flush valves, all parts of which, except the push button, are located in the chamber back of the toilet rooms. All pipes connected with the toilet rooms are located in this chamber, where they cannot be tampered with.

OTHER FACILITIES.

Tenants are supplied with electric current, natural and artificial gas, compressed air, steam for manufacturing purposes outside of power (the latter being furnished on a metered basis), and hot and cold water by separate lines running to each user from the central source of supply. Electricity for power and light is purchased from a commercial company, being stepped down from 4,300 volts to 220 and 110-volt, 3-phase, 60-cycle current. As the building company buys the electric current direct, and apportions the cost among the tenants according to the amount which each uses, a lower rate is secured. While the largest consumer can buy his current outside at the same rate which he is now paying, other tenants are saving as much as 20 per cent on the power purchased. Steam for manufacturing purposes is distributed through a main riser, with a header on each floor and with supply lines from the header.

Besides the reduction of the power bills there are other interesting co-operative features in connection with this plant. The building maintains a general stock room where such general supplies as waste, oils, electric lamps and fuses are furnished as a matter of convenience at practically cost. The management has secured lower trucking rates than would be available were each tenant acting independently. An emergency hospital room is maintained by the management at a central point, where first aid is rendered in case of sickness and accident. A restaurant is conducted in the building, under the supervision of the management to insure satisfactory service. Here a regular noon-day meal is served to shop employees for 15 cts., and office employees who desire can have their lunches sent to their offices.

At the present time about 94 per cent of the floor space is occupied, and the tenants appear to be well satisfied. About one-half of the tenants are new companies which have been organized in Toledo and about one-third are companies which have moved from other places; the remainder are industries which formerly occupied other quarters in Toledo. Although the building is adapted for various lines of manufacture, a large part of the space is taken by companies engaged in metal working industries.

Preliminary Report of Committee on Edison Fire.

The preliminary report of the "Committee on Edison Fire," appointed by the American Concrete Institute, has recently been submitted. The findings of this committee, which consists of Cass Gilbert (chairman), Walter Cook, W. H. Ham, Richard L. Humphrey, Rudolph P. Miller, C. L. Norton, J. Knox Taylor, and E. J. Moore (secretary), are as follows:

On Wednesday, Dec. 9, 1914, at about 5:25 P. M., a fire occurred in the film inspecting building of the factory of Thomas A. Edison, Inc., West Orange, N. J., and rapidly spread to adjacent buildings of the plant, destroying six one, two and three-story wood and brick buildings, and burned out the contents of seven structures constituting three groups of reinforced concrete buildings.

Your Committee appointed to report on the Edison fire, after a careful investigation of the character of the buildings and their contents, the origin and intensity of the fire, and the behavior of the various materials of construction in the fire, has reached the following preliminary findings:

1. No building or any portion thereof can be considered absolutely fireproof. The resistance of buildings and building materials to fire is only relative; no material can resist a fire if it be of sufficient great intensity or duration.

2. The information obtained confirms the general principles already well established concerning protection against the origin and spread of fire.

3. The buildings of this plant were not in accord with present well established practice in that they deviated from this practice in the following particulars:

(a) Large undivided floor areas. (Lack of fire walls and stops.)
(b) Unprotected exterior openings. (Wooden sash with plain glass, etc.)
(c) Absence of proper fire walls, partitions and fire doors.
(d) Failure to inclose properly vertical openings, stairway and elevator shafts.
(e) Absence of adequate sprinkler equipment.
(f) Absence of adequate water supply and fire fighting apparatus.
(g) Failure to either isolate non-fireproof buildings or to protect against them.
(h) Failure to isolate hazardous processes of manufacture either by placing such processes in separate buildings or surrounding them by proper fire walls.

4. The fire fully demonstrated the advantages of monolithic structures. The fact that at five different places several of the wall columns were rendered useless, and yet the upper portions of the building stood intact, is evidence of the superior merits of concrete in monolithic construction.

5. Considering the extraordinary conditions surrounding this fire, the behavior of the concrete buildings was highly satisfactory and constitutes an excellent demonstration of the merits of concrete as a fire-resisting building material. It is not so surprising that the concrete buildings were damaged as that any material should have so satisfactorily withstood these unusual conditions.

6. This fire brought out the following important problems which are considered worthy of further investigation:

(a) The strength of the structure after the fire; to be determined by floor load tests.
(b) The extent to which the floor system has been strengthened by the method of reconstruction.
(c) The strength of the columns after the fire; the strength of the restored columns.
(d) The effect of expansion, from temperature changes, on large units.
(e) Such other effects of this fire on the structures and structural materials as the conditions may permit.

7. Your Committee is of the opinion:

(a) That the best type of construction is one which eliminates corners and presents flat or rounded surfaces to the action of the fire. That interior columns of circular or octagonal section offer greater resistance to fire and are less liable to damage than columns of square section, and that the elimination of sharp corners in the floor construction is desirable.
(b) That good construction requires a sufficient number of lateral ties or hooping in the columns, and that such construction would offer greater resistance to fire.
(c) That in the beam-and-girder type of construction in order to develop fully T action the slab should be cast at the same time that the beams and girders are poured, and there should be adequate ties between the reinforcement of the beams and girders and that of the slab.

The detailed information upon which the foregoing statements are based is submitted. (This information is here omitted.—Editors.)

A series of investigations and tests are being arranged to develop additional data which, it is expected, will require some time and which will be presented in a final report as soon as the data can be obtained and collated.

Your Committee wishes to express its admiration for the commendable energy displayed by Thomas A. Edison and his associates in the rehabilitation of this plant. Two of the buildings are already occupied, a number of the other structures replaced with temporary buildings, and work is actively in progress for the restoration of the remaining portions of the plant.

Your Committee desires to acknowledge its obligations and hereby extends its thanks for the courtesies extended to it and the assistance rendered in its investigations by the officials of Thomas A. Edison, Inc., The Moyer Engineering and Construction Company, and T. L. Condron and Company, Engineers.

Waterproofing Materials in Egypt.—There is a considerable amount of waterproofing and dampproofing material used in Egypt. Most of the houses have flat roofs, asphalt being generally employed by local contractors for roofing purposes. Of late asphalted felt and bituminous sheeting protected by plaster have come into use and are giving satisfaction, as they afford ample protection from the violent sun and occasional but torrential rains.

The use of paints on the outside of stucco and concrete for dampproofing purposes is not customary. It has been found, however, that where local bricks have been used in the construction of houses they have not proved durable, and occasionally a coating of English manufacture, called "Szerelmy," has been applied with some success.

American firms have attempted on several occasions to introduce their damp and waterproofings in Egypt and some sales have resulted. There are two concerns, both in Cairo, controlled by British capital, that have a practical monopoly on all the damp and waterproofing sold in Egypt.

WATER WORKS

The Use, Design, Construction, Cost and Durability of Wooden Stave Pipe.

IV.

The Cost of Wooden Stave Pipe.

Contributed by Andrew Swickard, Hydraulic Engineer, Palo Alto, Calif.

There are a number of variable elements that enter into the cost of wooden pipe. This applies particularly to the "continuous" type. The cost of "machine banded" at any one factory should vary but little; the changes in prices of material being the cause of any considerable variation.

The different kinds of material entering into the construction of a pipe may be, and generally are, manufactured at points widely separated. For "continuous" pipe the shipments of staves, rods, shoes and paint are made from these respective points of manufacture direct to the railway point of delivery most convenient to the place where the pipe is to be built. For "machine banded" pipe the staves, wire, and material entering into the coating, are assembled at the factory where the finished pipe is turned out, and the finished sections of pipe are then shipped to the most convenient point of delivery in the vicinity of the pipe line location.

From the foregoing it is apparent that the freight costs might be large or small depending on the length of haul and other considerations that determine freight charges. Likewise the cost of hauling material from the railway point of delivery and distributing it along the pipe line can vary largely for different projects.

The cost of assembling the pipe in place is subject to variations, in proportion to wages and effectiveness of labor; both of these vary with localities.

The actual cost to the manufacturer of "machine banded" pipe will vary with the facilities for obtaining material, and for banding the pipe; these vary with different factories. The purchaser is not concerned with the costs but with the price asked at the factory and the freight charges to destination. These can be obtained from manufacturers for their standard pipe or for pipe made in accordance with submitted specifications. The cost of hauling the pipe will vary between wide limits. The length of haul, condition of roads, accessibility of the pipe location, are potent factors of cost that can be estimated only for actual projects. Once the pipe is delivered in or alongside the trench, or location, the cost of joining the sections would vary approximately from ½ ct. per foot for small sizes to 7 or 8 cts. per foot for larger sizes.

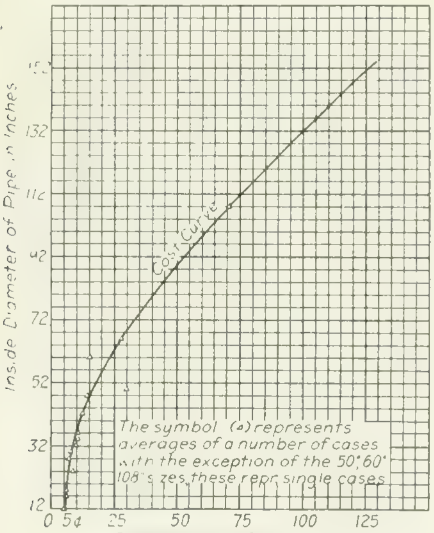

Fig. 1. Labor Cost Curve for Continuous Wooden Stave Pipe.

Curve gives labor cost of assembling the staves, inserting the metal tongues, putting on 5 or 6 bands per 10 ft., driving the staves endwise, and sorting and distributing the staves from piles about 200 ft. apart.

SPECIMEN ESTIMATE OF COST OF MACHINE BANDED PIPE.

It will not be amiss to make an approximate estimate of the cost per lineal foot to manufacture, for example, redwood pipe 8 ins. in diameter, banded with No. 6 galvanized steel wire; the banding spaced for the pressure due to a 100 ft. head of water. The estimate follows:

Staves manufactured from 1½x4-in. rough, having a finished thickness of 1 in.; 9 staves to complete the ring. Wire spaced 1 3/16 ins. c. to c.; 0.264 lb. per wrap.

Staves, 4½ ft. B. M. at $35	$0.157
Wire, 2.2 lbs. at 2 cts.	.041
Bandling, labor, say	.035
Coating, ⅜ in. thick, say	.030
Overhead charges, say	.020
Cost per lineal foot of pipe	$0.286

The staves are the largest single item entering into the cost. This can be materially reduced by using staves made from lumber costing less, or by using thinner staves. If fir staves costing, say, $25 per M were used the reduction of cost in the example given would amount to 4½ cts. per foot of pipe. Also the cost could be reduced by using thinner staves; staves 11/16 in. thick run from 1x3 in. rough lumber, would reduce the quantity of lumber used per foot of pipe from 4½ to 2¾ ft., board measure. In the case of redwood the reduction in cost from that due to using staves 1 in. thick would be 6.1 cts. per foot of pipe, and in the case of fir staves, the reduction from the cost of using staves 1 in. thick would be 4.3 cts. per foot of pipe. The thinner staves admit of the use of a little less wire, amounting to 0.6 ct. per foot of pipe less. The cost of manufacturing 8-in. pipe, banded for a head of water 100 ft. high, under the different specifications mentioned are approximately as follows:

	Cost per ft. of pipe in cts.
Redwood staves 1 in. thick	28.6
Redwood staves 11/16 in. thick	21.9
Fir staves 1 in. thick	24.1
Fir staves 11/16 in. thick	19.2

It isn't probable that the use of the thin staves would be economical, except under special conditions.

TOTAL COST OF CONTINUOUS STAVE PIPE.

The total cost of a "continuous stave pipe" is made up of numerous items, and is about as follows:

Staves—
  Cost of rough lumber:
    Yarding.
    Handling to mill.
    Milling.
    Interest and insurance.
  Transportation:
    Railway or boat.
    Wagon or auto truck to convenient points.
    Distribution along the line.
Construction:
  Assembling the staves, including tongues, with only enough bands on to hold them together.
Bands—
  Factory cost of rods:
    Freight charges.
    Wagon haul.
    Distribution along pipe line.
    Bending to proper form.
    Painting.
  Factory cost of shoes:
    Freight.
    Haul.
    Distribution.
    Painting.
    Assembling on pipe, spacing and back-cinching.
Tongues—
  Factory cost of band iron:
    Freight.
    Hauling.
    Cutting into proper lengths.
    Painting and distribution.

It is not an easy matter to secure proper stave material. Firms that are regularly engaged in the manufacture and construction of wooden pipe have formed connections with lumber manufacturers, usually with the smaller and inland mills, by which they take all their lumber that is suitable for pipe construction. The large mills that sell in cargo lots, the run of the mill, will not look at pipe stave business, because the magnitude of their output compared to the demand for stave material would make the stave business fragmentary, and besides the picking out of choice material would lower the grade of the remaining lot. The best chances are with large lumber yards carrying dry stock that have the facilities for milling the staves.

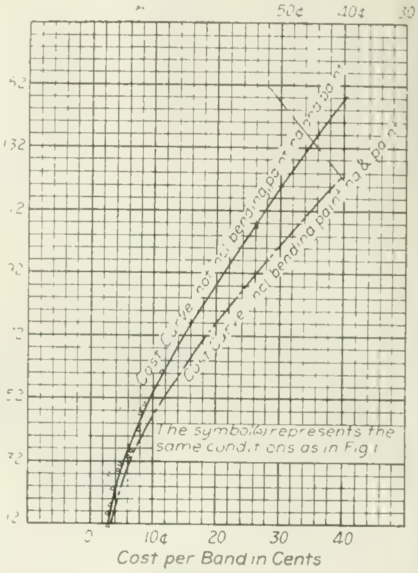

Fig. 2. Labor Cost Curves for Putting Bands on Continuous Wooden Stave Pipe.

The solid line represents the cost of distributing, putting on, spacing and cinching. The dotted line includes bending, painting and paint in addition to the other items.

Staves are necessarily made from selected stock. Picking the best pieces from a commercial grade of lumber that has a given market value lowers the value of what remains and dealers will add the estimated decrease in value to the selected stock. The price of air dried selected redwood staves would be made up somewhat after this manner.

	Per M.
Cargo price, say	$27.00
Yarding and handling to mill, say	1.50
Decrease in value of grade, say	4.00
Milling, say	1.50
Interest, insurance, etc., say	.50
Profit to yard and mill, say	3.50
Price f. o. b. cars at mill	$38.00

Heretofore the large redwood region has depended entirely on water transportation in order to get lumber to market, but a railroad tapping this region has recently been put in operation. This road connects with the overland systems, and will probably encourage the equipment of inland mills, that will be independent and thus aid in getting selected material at better prices than were obtainable heretofore.

The railroads in the northwest or fir region made possible the inland mills, which furnish most of the stave material. These mills are likely to be independent of the dominant influences that control the lumber business in general.

It isn't often that advantage can be taken of water transportation; it is confined to seacoast ports which are only occasionally advantageous points of delivery for pipe material. When staves are shipped by water it is necessary to crate them, because the methods of handling freight aboard vessels would injure the staves to an extent that would render much of the stock useless. Crating would add materially to the cost of the staves.

The cost of transportation is incidental to the distance and other physical conditions attending any given project. The same applies to the distribution of the material along the pipe line. If the topography is such that wagons can be drawn along in the immediate vicinity of the pipe line, the task is easy but if the line is along the side of a steep canyon and the material must be hoisted from below or let down from above by means of an aerial tramway, or other similar means, the cost becomes comparatively high.

After the staves have been distributed along the line at convenient points, in piles averaging about 300 ft. apart and each pile containing enough staves to fill in the intervening gaps, the material must be sorted and laid ahead of the construction party in piles containing the number of staves necessary to complete the ring of the pipe. This phase of the distribution is a part of the cost of assembling the staves in the pipe. The cost of assembling the staves with only enough bands put on to hold them together varies with local conditions. The cost curve shown in Fig. 1 is an average of actual costs for sizes of pipe below 9 ft. in diameter; above 9 ft. the curve is merely extended. This curve is based on 9 hours labor at $2.50 per day, one foreman at $3 per day, and part of a general foreman's time, say ¼ of $6 or $1.50 per day.

The cost of assembling the staves of a 66-in. pipe as represented in Fig. 1 is 28 cts. In an actual case where the average length of pipe set up per day was 64 lin. ft. the detailed cost was as follows:

		Per day.
Part of superintendent's time		$ 3.00
Foreman		3.00
Four assistant builders		10.00
One distributor of material		2.50
Water boy		.50
	64	$19.00
		29.7*

*Cts per foot of pipe.

The crew putting on and spacing the bands would follow the assembling gang, and following these would be the back-cinchers. When the spacing of the bands averages about 3 ins., two men ordinarily can put on and space the bands as fast as the pipe can be assembled. The size of the pipe and whether the band is in one or two parts will influence the progress made. Because of the same influence the number in the back-cinching crew will vary from 4 to 8 men in order to keep up with the assembling of the pipe. Figure 2 represents the cost per band in place on the pipe, painted and back-cinched or finally tightened.

A band passes through a number of stages of preparation before it is finally disposed of on the pipe; it must be bent to the proper form, dipped in paint, distributed, assembled and spaced on the pipe, hammered to a proper seating on the wood, and finally cinched. The dotted line in Fig. 2 represents the cost of putting a band through this process, and Figs. 3 and 4 represent the cost of each of the separate steps.

The bending and the painting of the rods is usually done immediately along the pipe line, it being more convenient to deliver the bands straight than bent. Also it is desirable to keep the handling of the bands, after they are painted, at a minimum.

The bending or shaping of the bands requires one man at a bending table. The table is a substantial structure as high as a man's waist, with a raised circle or half circle on the top, around which the band is bent. A full circle is used when the rod is in one piece and the half circle when the rod is in two pieces.

The quantity and the character of the paint used will affect the cost of the painting; the quality only as far as the price is concerned, but the character will influence the thickness of the coat and waste. The use of a paint that dries rapidly and thickens quickly in the dipping vat, and therefore requires frequent additions of a thinner, will result in considerable waste, especially on the dripping board; the paint that drips from the bands will become too thick to run back into the vat.

The distribution of the bands after being painted should have considerable attention in order to keep the cost at a minimum. They are best placed when left in bundles alongside the line, out of the way of the stave assembling crew but so that the band assemblers have merely to reach for them. The number of bands distributed over, say, every 50 ft. should be determined by the band spacing over the given distance.

The cost of back-cinching, which consists of hammering the bands to a proper bearing on the staves and cinching them down tight, is the most variable of any item of cost connected with the actual construction of the pipe. It is a thoughtless sort of job and men, good, bad, and indifferent, are usually put at this task; the resulting cost in a way corresponds with the men.

The accompanying cost diagrams give average costs for building "continuous stave" pipe. The cost will be affected by: the quantity of pipe to be installed, the character of the season as affected by the locality, the physical character of the country over which the pipe is located, and the kind of labor that is available. A pipe built on a bench cut into a rugged mountain side, where nearly every section of pipe set up will have to be curved, would run up in cost. The assembling of the staves under such condition might exceed the cost given by the curve by 50 per cent. The cost of the items connected with the banding of the pipe would not vary nearly as much as the stave work under such conditions.

EXAMPLE OF USE OF UNIT COSTS.

As an example of the use of the cost of the various items, we will aplpy them to an assumed case, as follows:

The pipe to be 60 ins. inside diameter; staves 2½ ins. thick, milled from 3x6-in. stock, 36 staves to complete the ring, requiring 54 ft. B. M. of rough lumber per foot of pipe, the actual material in the finished staves being 75.7 per cent of that in the rough material or 40.9 ft. B. M.

The total length of the pipe being, say, 30,000 lin. ft., requiring a total of 90,000 bands, or an average of 3 bands per foot; the rods to be made from ⅝-in. round and in two parts, the two parts together weighing 19.5 lbs.; the two shoes for each band weighing 3.5 lbs., or 1.75 lbs. each.

The metal tongues for the stave joints will be approximately 2½ in number per foot of pipe, weighing 1 lb. if cut from No. 10 iron, 1½ ins. wide.

Assume that the freight on the staves is 20 cts. per 100 lbs. and that the cost of the haul from the railway point of delivery is $1.25 per ton; that the freight on the rods, shoes, and band iron is 75 cts. per 100 lbs. and the hauling $1.25 per ton.

Assume that the staves cost f. o. b. cars $38 per 1,000 ft. B. M. of rough lumber; that the rods cost $1.95 per 100 lbs., f. o. b. cars; the shoes $3.50 per 100 lbs., and the band iron $2 per 100 lbs., f. o. b. cars.

Lbs.

Assume weight of staves [illegible] lbs. per 1,000 ft. B. M., then the weight

$$\frac{[illegible]}{1000}$$

per foot of pipe [illegible] 110.43

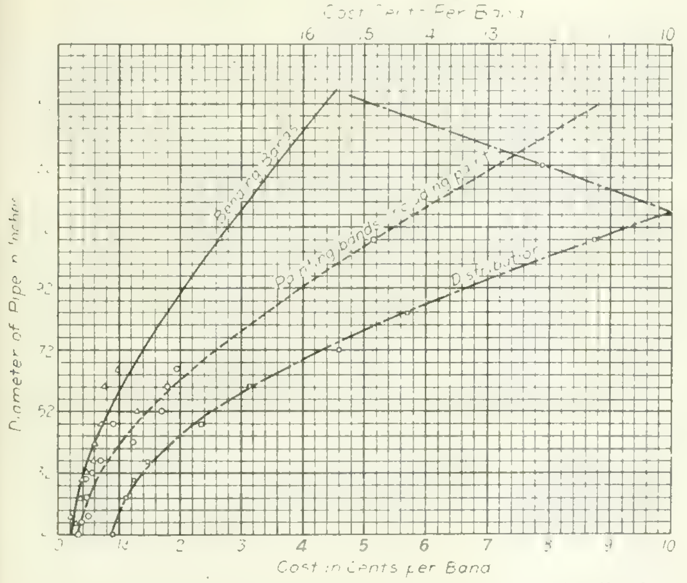

Fig. 3. Labor Cost of Bending, Painting and Distributing Bands for Wooden Stave Pipe.

Cost of painting includes paint. Distributing cost covers carrying bands from dipping tank, located at about 300 ft. intervals along the pipe line. The symbols along the bending and painting curves are average costs, those along the distribution curve are the result of computations from relative information. The painting cost includes that of the rods, shoes and tongues.

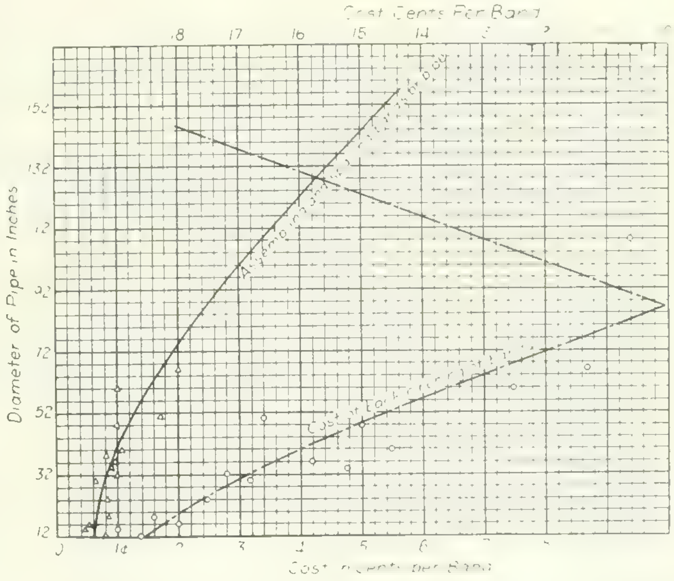

Fig. 4. Labor Cost of Assembling and Spacing Bands on Pipe and Back-Cinching on Wooden Stave Pipe.

Back-cinching consists of tightening and hammering bands to a proper bearing in the wood. The symbols represent average costs; the variation in the cost of back-cinching is much greater than for any other item of cost because all classes of labor are employed on this part of the work.

Bands, weight per foot of pipe [illegible]		69.00
Tongues =		1.00
Total weight =		180.43*

*Lbs. per foot

ESTIMATED COST PER FOOT OF PIPE

Staves—			
Material,	[illegible] / 1000	$2.0[illegible]	
Waste, [illegible]		0.040	
Freight,	[illegible] 10 9 [illegible] $0.20 / 1000×100	0.[illegible]21	
Haul,	2500 [illegible] $1.25 / 1000×2000	0.00[illegible]	
Assembling (from Fig. 1)		0.230	$2.58[illegible]
Tongues—			
Material, 1 lb. × $0.0[illegible]		0.020	
Waste, 1½%		0.01[illegible]	
Freight,	1 lb. × $0.75 / 100	0.008	
Haul,	1 lb. × $1.25 / 2000	0.001	
Cutting into clips		0.00[illegible]	0.0[illegible]
Bands—			
Rods,	$\frac{19.5 \text{ lbs.} \times 3 \times \$1.95}{100}$	= 1.141	
Waste, ½ of 1%		0.006	
Freight,	$\frac{19.5 \text{ lbs.} \times 3 \times \$0.75}{100}$	0.439	
Haul,	$\frac{19.5 \text{ lbs.} \times 3 \times \$1.25}{2000}$	= 0.037	
Shoes,	[illegible] lbs. × 3 × $3.50 / 100	0.315	
Waste, 1%		0.003	
Freight,	[illegible].5 lbs. × 3 × $0.75 / 100	0.079	
Haul,	[illegible].5 lbs. × 3 × $1.25 / 2000	0.007	
Bending (Fig. 3), 1.0[illegible] cts. × [illegible]		0.032	
Painting (Fig. 3), 1.90 cts. × 3		= 0.057	
Distributing (Fig. 3), 3.20 cts. × 3		= 0.096	
Assembling (Fig. 4), 1.50 cts. × 3		= 0.045	
Cinching (Fig. 4), 6.50 cts. × 3		= 0.195	[illegible]
Special connections, say		= 0.045	
Repairing leaks, say		0.025	0.070
Interest and depreciation on tools, say			0.015
Overhead charges, say			0.025
Actual cost per foot			$5.178
Total cost, $5.178 × 30,000			= $155,340 00

The cost of excavating for the bed or trench for the pipe has not been considered; that being practical only after conditions are thoroughly known. A number of other items of expense might be necessary, such as backfilling under and perhaps over the pipe, building roads along the pipe line, bridges to carry the pipe over water-ways, hoisting the material from a road in the bottom of a canyon to the pipe line on the mountain-side above, and others. These are special matters, outside our present considerations.

The next article will deal with the organization and methods of construction.

Failure of 60-in. Water Main at Cincinnati by Longitudinal Compression.

A 60-in. water main failed in the city of Cincinnati on Dec. 13, 1913. No very satisfactory explanation was given out by anybody at the time. The cause of the failure is here made public as determined and reported upon by John W. Alvord, consulting engineer, Chicago. Owing to the fact that there were lawsuits involving large damages in behalf of those dependent upon the three men who lost their lives, as a result of the failure of the main, the results of the investigation made immediately following the accident have not heretofore been made public since they were utilized in the trial of the law cases. Quite recently these suits have been settled and we are now pleased to publish this article which is based upon Mr. Alvord's report. An extremely interesting cause was found for the accident; one which will be of interest to all water works men.

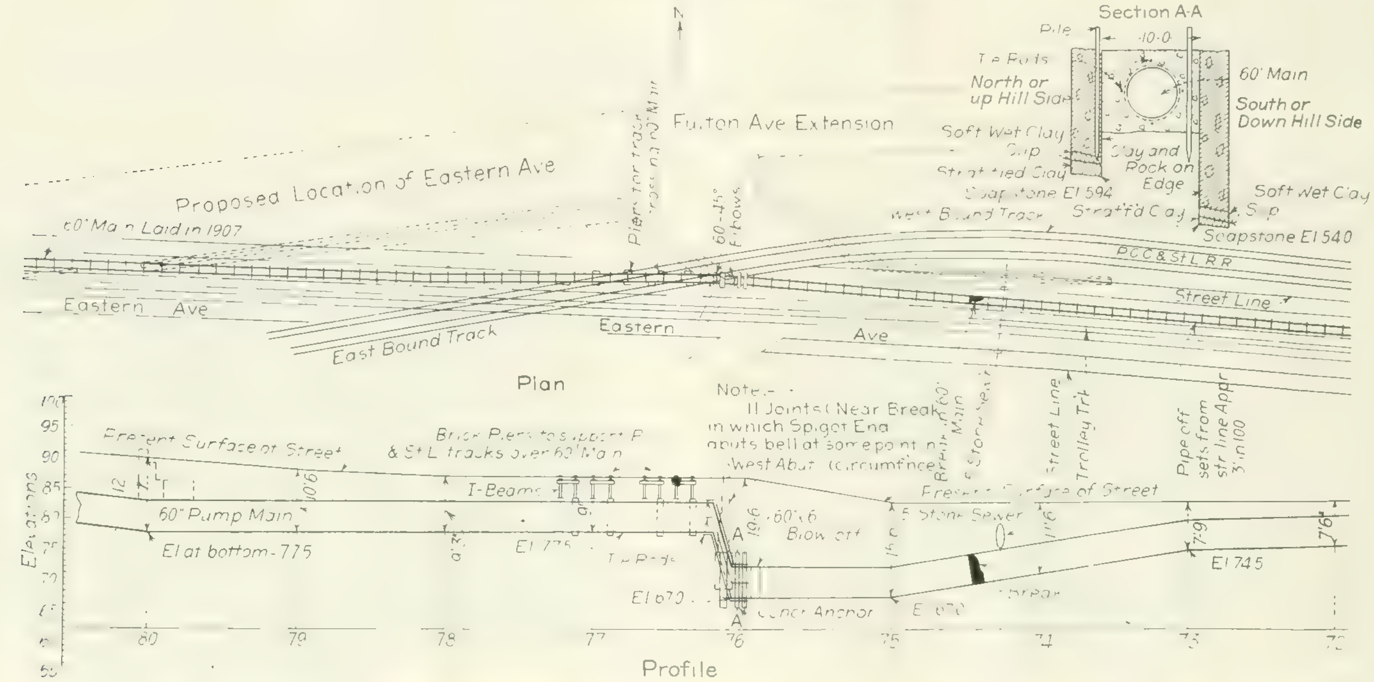

Fig. 1. Map of Rookwood Crossing Showing Location and Surroundings of Break in 60-in. Water Main, Cincinnati.

A BRIEF ACCOUNT OF THE ACCIDENT

At 6:45 a. m., Saturday, Dec. 6, 1913, the 60-in. main in Eastern Avenue near Lithebury street, supplying the city of Cincinnati with water was ruptured, flooding the surrounding district and drowning three men at work in a small excavation adjacent, and depriving the city of its full supply until repairs were completed on the following Wednesday, December 10.

The pumping engines at the main pumping station, about 1½ miles distant, were soon stopped and the water pressure was off in about an hour. It took most of the day Saturday to drain the pipes, and by Sunday morning the bodies of the drowned men were recovered. The city was partially supplied with water from Eden Park reservoir until repairs were completed the following Wednesday.

Excavation began Saturday morning, and the break was finally repaired with a short length of pipe and a sleeve. The repair excavation disclosed the fact that one length of pipe was ruptured from the bell end blowing a piece out of the north side of the pipe about 8 ft. long, as indicated in the accompanying drawing, Fig. 1.

THE SURROUNDING CONDITIONS.

Pile Work.—The accident occurred at a point about 140 ft. east of the center of a new subway which was being built to carry Eastern avenue under the Pennsylvania Lines. Piles had been driven to support the tracks during excavation, as shown in Fig. 2. Over fifty piles were in place, the nearest to the main being 5 to 10 ft. away, and the nearest to the break being about 50 ft. away. The subway excavation was not yet made.

Alignment.—The 60-in. main lay nearly parallel with the Pennsylvania tracks, and 20 ft. away at the point of break. About 200 ft. west of the break the tracks crossed over the pipe and were supported by piers and I-beams at that point. The pipe line lies in the north side of Eastern avenue, 20 ft. south of the north line. Examination of Fig. 1 shows that the pipe line was not straight, but from west to east had a slight deflection beginning at or near Lithebury St., amounting to an offset of about 3 ft. in 100 ft. for four or five hundred feet. The convex side of this curve was presented to the north or railway and bluff side of Eastern avenue.

Original Precautions.—The pipe line was constructed in 1906-1907, and was planned and laid to pass under a proposed Rookwood Crossing subway at this point. For this purpose it has a descending grade at the point of breakage which carried the pipe down below the proposed subway farther west. At the point of break the bottom of the pipe was 15.5 ft. below the surface of the street. Sheeting had been driven on both sides of the pipe during its construction from a point about 15 ft. west of the break, west at least as far as the west side of the proposed subway and perhaps farther. Piling had been driven outside of the sheeting from a point about 80 ft. west of the break for a distance west of at least 75 ft. All of this piling and sheeting was found in good preservation and without signs of movement when uncovered by the subway excavation in July and August, 1914, seven months after the accident.

Drain Pipe.—A drain of 24-in. vitrified pipe was under construction at the time of the accident. This drain was for the purpose of relieving the subway of rain water, and was being extended along the north side of the 60-in. main, its center line being 3 ft. 9 ins. away from the side of the water main. Its bottom was level with the bottom of the water main at a point 12 ft. west of the break, and dipped down so as to pass under the main at a point about 15 ft. east of the break. The excavation was in fairly stiff shaley clay, and was accomplished by excavating holes 22 ft. apart, with tunnels between, all as shown on the diagram in Fig. 2. The three men who were drowned were working in the holes east of the break at the time of the accident. The relative positions of the 60-in. water main, the street car tracks, and the 24-in. sewer tunnel are shown in Fig. 3.

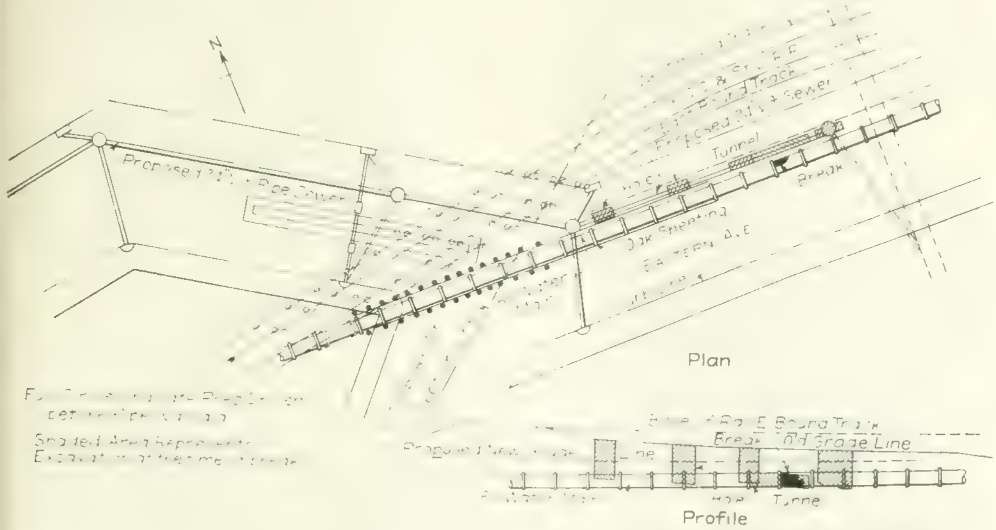

Fig. 2. Plan and Profile Showing the Break in 60-in. Water Main Near Rookwood Crossing at Cincinnati, Ohio.

The pits and the tunnel were sheeted and braced in the usual manner, and the tunnel was being driven by experienced men. It was timbered with 4-in. square inclined posts, placed close together, horizontal caps, and the usual running cleats to take the lateral earth pressure on the posts. Little or no water was encountered and the work was not thought "difficult."

Train Service.—Heavy trains were continually passing on the main line tracks of the Pennsylvania Railroad, and interurban service on the double track trolley line in Eastern Avenue. The ground was partly frozen at the time of the accident.

Gully.—An original survey of the section of land adjacent to the break, made in 1852 by R. H. Richy, Surveyor, and filed in the County Recorder's Records, shows a gully line passing across Eastern avenue at the point of the break and running southerly to the Ohio River. Filled ground was not especially apparent in the excavation at the break, however. Test pits made by the Railroad Company 25 ft. north of the break showed that all of this ground, down to a level below the bottom of the pipe in this vicinity, had been overturned and displaced by slips and slides.

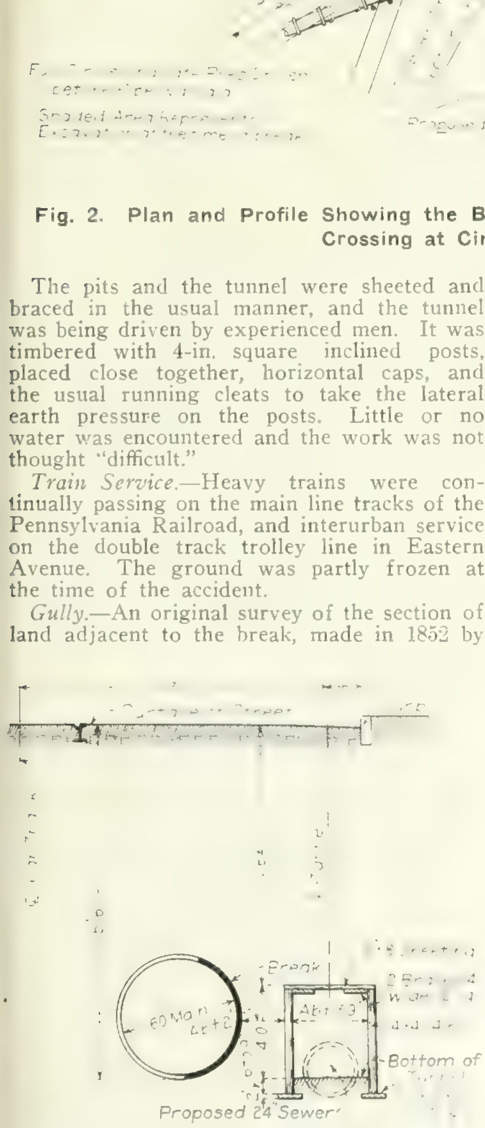

Fig. 3. Cross Section of Eastern Avenue Showing Relative Positions of Street Car Tracks and Sewer Tunnel to Break in 60-in. Main at Cincinnati, Ohio.

Landslides.—The bluff to the north of the Pennsylvania Lines and Eastern avenue rises steeply to a height of 150 ft. or more, and is composed of layers of shale, clay and rock. It is full of springs, and the surface is now, and has been for many years past, slipping directly toward Eastern avenue in an intermittent manner, causing on the side of the bluff the wreck of several houses and extensive street repairs to the road running up the bluff north of Eastern avenue. The soil in the excavations near by show evidence of earth overturn and sliding mixing. Visible evidence of recent displacement was not apparent to Mr. Alvord, however, in Eastern avenue, either to the trolley lines, the curbs, the pavement, or the 60-in. main.

TEST PITS.

Test pits show that all the ground from 12 to 20 ft. below the surface in the locality of the break had at some time or other been subject to slips, and the line between the sliding ground and the undisturbed soil below is usually distinct, the horizontal shale fragments being overturned.

SATURATION.

The elevation of the bottom of the main at this point is below high water mark of the Ohio River, and the ground under the main necessarily becomes saturated during high floods, and even floods which do not necessarily reach extreme high water.

VERTICAL BEND.

In the west abutment of Eastern avenue crossing there is a vertical rise to the 60-in. main, which has been embedded in concrete as shown in Section A-A of Fig. 1. This vertical bend and concrete anchor evidently holds the pipe at this point from either marked longitudinal or lateral movement, while to the east of this point, in the direction of the rupture, there is more opportunity for the lateral and compressive thrust to be brought into play. It is believed that this fact has an important bearing on the location and cause of the accident.

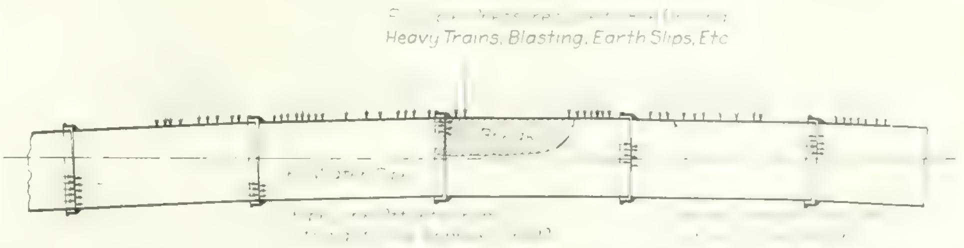

Fig. 4. Diagram Showing Longitudinal Pressure Brought About by Joint Contact and Lateral Thrust or Jar on Convex Side of Curve in 60-in. Water Main Adjacent to Break.

THE BREAK.

The break occurred at a point about 150 ft. from the vertical bend in the north side of the 60-in. water pipe, the side against the bluff and the Pennsylvania R. R. tracks, a piece approximately 8 ft. long and one-half the pipe at the bell being blown outward. The broken section was pushed out to the north, and the water issuing from the main forced its way into the tunnel, washed away the earth bulkhead at the east end of the tunnel, and filled the No. 1 pit, drowning the men working there.

The Pipe.—The condition of the main pipe on each side of the break was generally good. The pipe was apparently in good alignment and grade as when laid. In 1912, two years before the present break, a leak was discovered 75 ft. west of the recent rupture, and a crack about 13 ins. long was found in the spigot end of a section of the pipe, which was repaired. In the repairs to the present rupture, however, none of the lead in any adjacent joint required to be caulked, outside of those necessary to the actual repair itself. Since the break of Dec. 6, 1913, leaks have developed at the upper and lower joints of the vertical bend at Lithebury street.

Condition of the Cast Iron Pipe.—The condition of the cast iron, as shown by the break, was excellent. The length that broke was made by the U. S. Cast Iron Pipe Co., Addystone, Ohio, April 5th, 1905, Serial No. 803, and was nominally 1⅝ ins. thick in the shell. As actually measured, it was found to be 1 9/16 ins. near the bell, and 1 11/16 ins. at the farther end of the break. The thickness was remarkably uniform. The fracture showed no trace of old breaks; the iron was clean, gray and granular. There were no blow holes, and no evidence of old cracks that Mr. Alvord could observe, although others thought there was a slight crack at the bell, apparently an old crack.

The pressure on the main at this point was ordinarily 80 to 90 lbs., and this pressure could not be materially exceeded as the main had direct connection with the Eden Park reservoir.

Tests.—Tests were made of pieces of the broken length, under the direction of Mr. John W. Hill, C. E., of Cincinnati. They show no cause for any criticism of the material of which the pipe was made.

Opinion of City Officers.—Mr. H. M. Waite, at that time city engineer of the City of Cincinnati, stated before the Council Committee that no joint had been found in bad order near the break. In personal conversation with Mr. Alvord he denominated the accident "inexplicable." Mr. Raschig, assistant city engineer in charge of construction work, stated to Mr. Alvord that in his opinion the work being done gave no cause for such an accident to the pipe as occurred.

Blasting.—Some minor blasting had been done north of the crossing, 200 ft. away to the west, but this was only to break up fragmentary shale or loose rock found in the hillside, and, incidentally, to break the ledge rock interspersed with the shale. These operations were small in extent, with a stick or half a stick of dynamite to the hole. Conditions were not favorable to transmit shock in the unstable and overturned loose soapstone and shale and clay intervening between this work and the main. No blasting had been done for several days before the break occurred, and no piles were driven between Oct. 26 and the date of the break, Dec. 6, 1913.

Abutting Spigot Ends.—Mr. John W. Hill, C. E., of Cincinnati, who had opportunity to inspect the interior of the pipe for over 100 ft. east of the break at the time of its repair, states:

> The ends of all spigots at some point in the circumference had been butted up, metal to metal, against the shoulder of the bell, and under this condition of pipe laying, motion of the pipe in any direction might produce stresses in the spigot or bell, beyond those that the pipe could resist, and of a kind not anticipated in the design of the pipe.

Mr. Hill stated that his inspection showed the eleven joints east of the break all as having contact between bell shoulder and spigot end at some point of the circumference of the joint. To the west no examination could be made on account of standing water in the depressed section of the pipe. The condition of the main as to joint contact is shown in Fig. 4.

BREAK IN COLUMBIA AVE. WATER MAIN SEPT 13, 1914.

Since the compilation of Mr. Alvord's report and just at the date of its completion word came from Cincinnati of another break in Columbia avenue in a 48-in. main supplying high ground. Mr. E. E. Stetson, an engineer, who had opportunity to inspect both breaks, reports to the writer that the recent break was similar to the one in the 60-in. main on Dec. 6, 1913, at Eastern avenue. A section of pipe was broken out of approximately the same size and shape, and in both cases the bell of the pipe broke exactly in the middle of the pipe at top and bottom. The recent break in Columbia avenue tapered in wedge shape to within 1½ ft. of the next joint, and this pipe was laid in a rock cut, with nobody working about it. Much damage was done, and a large section of the city was without water for some days.

CONCLUSIONS.

From such study as has been made of all the facts herein summarized, Mr. Alvord concludes:

(1) That the 60-in. main was ruptured by longitudinal compression; that is to say, pressure acting along the direction of the center of the pipe line, and splitting a section out probably where some portion of a spigot end bore on the shoulder of the bell end.

(2) That the pipe line was thrown into longitudinal compression in large measure because the barrel of the pipes were in contact at some points in their circumference at the joints. This may have resulted from lack of end clearance in laying, or it may have resulted from closure since laying by lateral pressure from the north or bluff side of the pipe.

(3) The longitudinal pressure was possibly increased by the fact that all secondary influences, such as jar from trains, pile driving, landslips, occurred on the northerly side of the pipe, which side presented a slight convex curve in that direction all along the pipe line on both sides of the break.

(4) The particular influence which increased the longitudinal pressure to rupture point can hardly be identified; it probably was not a large force, taken by itself. Any increase of land pressure or accumulated jars would have been sufficient in the strained condition of the pipe line to have compelled the final rupture.

(5) It is not conceivable, from an engineering point of view, that the sewer trench could have been even the completing cause of the rupture. The trench was fully braced and did not reduce the supporting lateral pressure of the earth against the main. Its depth and position were not such as to cause even conservative criticism. There was no hammering of sheeting going on at the time of the rupture. The more plausible explanation is that the jar of a passing train or an increase of lateral thrust from the sliding bluff added the final few pounds of stress, which, in connection with the strain already present, caused the final break, and the fact that the trench for the drain was open at that time can only be regarded as an unfortunate coincidence.

(6) If the theory above outlined is correct, it is probable that some danger yet exists of another break in this vicinity unless the sleeve and short length used in the repair were so laid as to provide for play in the length of the pipe. The protecting effects of such play would not, however, extend very far away from its immediate vicinity.

Provision for Upward Pressure and Interior Drainage in Designing New Lock Raven Dam at Baltimore.

A study of the contour map of Lock Raven, the water impounded in the Gunpowder River by the new Lock Raven dam of the Baltimore water works, showed that the crest of the new dam can be carried to an elevation of 237 ft. above mean tide without making it necessary to flood certain railway tracks or the town of Cockeysville. To carry the flood line higher than this elevation would have caused a greatly increased expense. A dam with a crest elevation of 237 ft. would give a reservoir with a capacity of about 21 billion gallons. This would give an average daily water consumption of 175 million gallons, which was about 2½ times the consumption of the city at the time the new dam was placed under construction in 1912. This amount will probably be sufficient to meet the needs of the city until 1950 or later.

Owing to certain legal complications in connection with the purchase of property in the valley of the Gunpowder it was first decided to build the dam to a crest elevation of only 192 ft., which would give a storage capacity of a little over 2 billion gallons instead of 21 billion gallons. This dam, with a crest elevation of 192 ft., combined with the existing storage reservoirs in the city, which have an available storage capacity of about 1½ billion gallons, gives a total storage capacity of 3½ billion gallons. This would furnish a safe daily capacity of about 100 million gallons of water.

It also developed that it would not be possible to build a dam with a crest elevation of 237 ft. and a filtration plant out of the $5,000,000 loan available for improving the water supply. The city administration did not desire to ask for a further loan in order to build the higher dam, as the city was already greatly burdened with loans in carrying out the extensive improvements which had been made since the great Baltimore fire in connection with new docks, new sewerage system, new street paving for the entire city, extension of the parks and improvement of the fire department and school systems. It was, therefore, determined to build a reservoir which has a crest elevation of 192 ft. at the present time, although the foundations for this dam have been laid of sufficient width, not only to extend the dam to an elevation of 237 ft., but to extend it to a further elevation of 280 ft. if this should be deemed desirable in the future. The information here given on the design of the dam is from the report of the water board for 1913. Mr. Ezra B. Whitman was at that time water engineer.

DESIGN OF THE DAM.

When the crest is raised to an elevation of 233½ ft., it is proposed to secure a water level of 237½ ft. by placing flash boards upon this crest. In designing the dam, provisions were made for flood water 8 ft. over the top of the masonry of the spillway and an upward pressure is figured on the horizontal joints and on the bottom of the dam which is equivalent to two-thirds of the head of water at the upstream face diminishing in zero at the downstream face of the dam.

The failure of the dam at Austin, Pa., at about the time that the designs of the Loch Raven Dam were being completed, emphasized the necessity of taking every precaution to prevent upward pressure under the bottom of the dam and internal stresses within the body of the dam itself due to water making its way into horizontal joints.

In order to take care of upward pressure under the base of the dam, a system of underdrains has been provided beneath the main foundation and next to the rock. A 12-in. drain with open joints is placed on the downstream side of the cut-off wall along the line of the bottom of the foundation of the dam. Connecting to this drain are a number of 6-in. underdrains, surrounded by gravel, which rest on the rock foundation and it is expected that any water which may make its way through the cut-off wall or through the seams of rock on which the dam is built will enter this drainage system without causing any appreciable upward pressure on the base of the dam.

The 6-in. underdrains are placed at intervals of approximately 30 ft. and they find outlet in risers leading to the top of the foundation apron near its lower end.

Mr. Whitman was familiar with the vertical porous drains used in the construction of the Olive Bridge and Kensico Dams in connection with the improvements of the water supply of New York in order to intercept seepage through the body of the dam. It seemed more logical, however, that drains for the purpose should be placed horizontally across the construction joints where the seepage would most naturally occur.

The up-stream side of the dam for a thickness of about 7 ft., is built of 1-2-4 concrete laid in such a manner that horizontal joints occur at vertical intervals of 8 ft. At these horizontal joints, on the down-stream side of the 1-2-4 concrete wall, are laid conduits consisting of porous concrete tile laid in grooves left in this wall. These tiles are 14 ins. square, 3 ft. long and are made of a dry 1-4-8 mixture with the 6-in. interior diameter. Expansion joints are provided across the dam parallel to the axis of the stream at intervals of approximately every 60 ft. and at each expansion joint there is a vertical well to which the horizontal drains are connected. These vertical wells lead to a gallery, built throughout the length of the dam, which drains into the tail waters on the down-stream side of the dam.

The 48-in. drain pipes are provided at elevation of inverts of 164 ft. A. M. T., one on each side of the spillway, and these will make it possible to drain the lake should it ever be found necessary to do so. These gates were also used while filling the relief openings left in the first half of the dam to carry the water of the river during the construction of the second half.

ARRANGEMENT FOR BONDING HIGHER DAM TO PRESENT DAM

When it is decided to carry the new dam up to the height originally recommended, it is proposed to place several rows of porous drains along the steps of the present dam so that any water getting into the joint between the old and the new work will be intercepted before it can produce internal stresses which would threaten the safety of the dam.

In order to bond the new structure to the old, large plum stones are placed projecting above the finished surface of the present structure and these stones will be of great assistance to keep the new structure from sliding on the old.

If it is decided that these plum stones will not furnish sufficient strength to prevent the sliding of the dam, holes can be drilled at regular intervals along the crest of the present structure and iron bars can be grouted into these holes and extended into the new structure. It is believed that the system of drains, combined with the plum stones and the iron bars, will provide sufficient strength against sliding and provide for a sufficient bond between the new work and the old.

* * *

A new metal roofing is becoming popular in Kongo. It is of an aluminum substance imported in sheets about the size of the corrugated iron sheets used in that country. The roofing is very light in weight, and for that reason has the advantage of low freight charges and fewer native porters are required to carry it into the interior.

GENERAL

Plant Arrangement and Form Construction for Coon Rapids Dam, Minnesota.

The dam referred to here is a part of the hydro-electric plant recently completed by the H. H. Byllesby Co., Chicago, near Minneapolis, Minn. The description which follows is from a paper before the Western Society of Engineers by J. W. Link, hydraulic engineer for the builders. Figure 1 is a plan of the works. The spillway for which the forms to be described were devised is of simple ogee section 1,005 ft. long surmounted by piers dividing it into 28 openings, each 33 ft. wide, in which operate Tainter gates.

Construction Camp and Plant.—Starting near the north end of the dam and extending some distance upstream is a bench or terrace from 15 to 20 ft. high. This bench, being sandy and covered by a grove of oaks, furnished an excellent location for the construction camp, which was planned for the accommodation of at least 800 men. The camp was laid out with streets and was provided with water works, sewerage, and electric lights. A number of cottages were built for the use of foremen and mechanics who had their families with them, but the other workmen were taken care of in bunk houses. The buildings were all light frame structures covered with shiplap and heavy roofing paper, and owing to the severity of the climate the bunk houses which were occupied during the winter were heated with hot-air furnaces. The buildings were all well separated so as to reduce fire risk, and, with the exception of the superintendent's office, the hospital, the store and the foremen's and engineers' bunk houses, they were one-story structures. The camp was supplied with a club and a moving picture show, and on account of the large number of children in the camp the county of Anoka opened a public school for them, the building being furnished by the company. The water supply for the camp was obtained from a 4-in. artesian well 210 ft. deep, but, as the water did not flow with sufficient pressure for distribution through the camp, pumping was necessary. The electric current for lighting and general construction purposes was obtained from Minneapolis over the permanent transmission line, which was built as quickly as the necessary materials could be secured and delivered on the ground.

The Minneapolis & Northern Ry., an interurban line between Minneapolis and Anoka, passes within about one-half mile of the power house. Arrangements were made with this company for delivering materials on the work, and a spur was built from their tracks to the power house site for this purpose. This track is to be maintained for use in receiving supplies and additional equipment, but a track for construction purposes only was built from this spur up on the terrace to the cement storage house (Fig. 1), and thence on a trestle to the sand and stone bins.

The sand and stone was dumped from the trestle into the bins. The platform of the mixing plant was under the trestle but higher than the bottoms of the sand and stone bins; the two 1½-cu. yd. motor-driven cube mixers were set so as to dump directly into cars on the track which ran out on a trestle along the upstream side of the dam. A steam hoist, operating dump cars on inclined industrial tracks running under the bins, brought the sand and broken stone to the mixer platform. The cement was brought from the storage house on push cars operating on the high trestle. The cement was taken from storage on the opposite side of the house from the receiving track, thus readily permitting the use of the cement in the order in which it was received.

The trestle along the back of the dam carried three tracks. One of these, a standard gage track was for the operation of a 12-ton locomotive crane, which was intended principally for handling forms and Tainter gates but which, on account of its convenience, was probably used more for other purposes. The other two tracks were 3-ft. gage and were used for placing concrete. One of these tracks was formed by placing a third rail 3 ft. from one rail of the standard gage track. The narrow gage tracks were connected at several points by crossovers, and the locations of the crossovers were changed as the work progressed to facilitate the handling of the concrete.

All concrete for the spillway and the lower parts of the retaining dam and power house substructure was taken from the mixers in side dump cars with dinkey engines and was dumped into chutes, which conveyed it directly into the forms. For the spillway apron the concrete was run into a hopper by chutes from the trestle and distributed with buggies. Where the forms were so high that the chutes could not be used, the concrete was taken from the mixers in cylindrical buckets on flat cars and the buckets were swung into position for dumping by the locomotive crane or a derrick. A good quality of sand for the concrete was obtained on the ground but the broken stone had to be brought from Minneapolis.

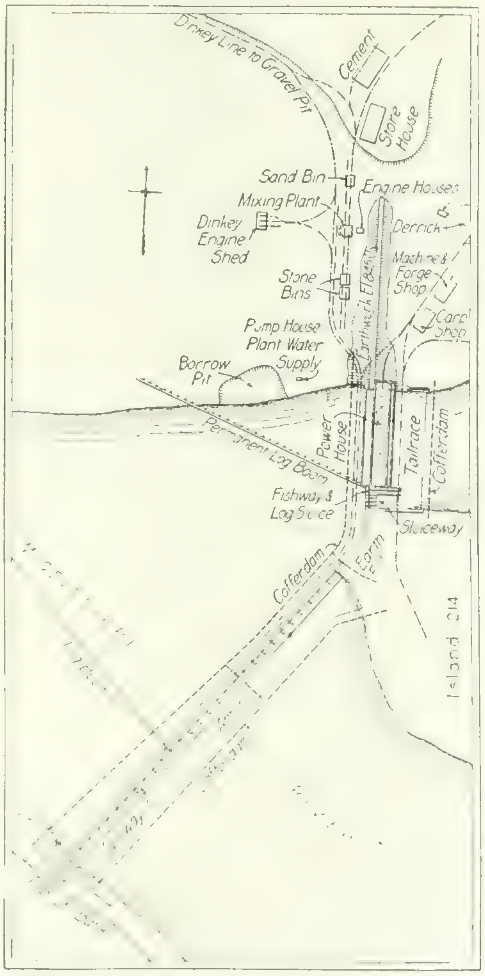

Fig. 1. Plan of Works and Construction Plant, Coon Rapids Hydro-Electric Plant.

Forms.—Another feature of this work which is worthy of notice is the collapsible forms for the dam, the scroll cases and draft tubes. The forms for the dam (Fig. 2) were made of sets of vertical and inclined steel ribs with horizontal wooden lagging. The vertical ribs, which were built up of two 12-in. channels spaced ¼ in. apart back to back and riveted together through the webs, were used on the upstream side; while the inclined ribs, made up in the same way but of 7-in. channels, were used on the downstream side. The inclined and vertical ribs were bolted together by a gusset plate connection at the upper ends and were held in place longitudinally of the dam by bolts and pipe separators. The two vertical ribs at each end of a form unit were fastened rigidly together by angle iron bracing to furnish longitudinal stiffness to the forms when being erected. Attached to the under side of the inclined ribs by angle iron furring were pairs of angles bent to the proper curvature for the downstream face of the dam. The ribs were spaced 4 ft. 2½ ins. on centers and one form unit embraced a section of the dam 54 ft. long.

The lagging used was 3⅝ ins. thick, finished size, by about 4 ins. wide, and approximately 13 ft. in length. Malleable iron clips were used to secure the lagging to the ribs. These clips were of proper form to fit around the flanges of the ribs and leave space for small wooden wedges. The clips were fastened to the lagging with lag screws, and as the lagging was laid in place, the wedges were driven in between the clips and the flanges of the ribs. This method of attaching the lagging to the ribs not only facilitated the assembling of the forms but also their removal after the concrete was set.

In order to reduce the cost and facilitate the work of making the final closure in the dam, the forms were designed to take the place of a cofferdam in these openings. This was accomplished by framing part of the vertical ribs with web plates projecting far enough on the upstream side to receive light angles and thus, in connection with the upstream flange of the rib, form a groove to hold stop planks.

To hold the lower ends of the ribs in proper position, it was originally intended to build, in place, small concrete blocks, each containing a pocket to receive the foot of a vertical rib, and to leave pockets near the upstream edge of the apron to receive the feet of the inclined ribs. This latter provision was carried out in all cases and proved satisfactory, but before any of the blocks were built it was realized that a timber, with wooden strips spiked to it, would hold the feet of the vertical ribs just as satisfactorily and cost less; and this method was pursued except in the openings left for passing the water during construction. In these latter openings a continuous concrete sill was built as an integral part of the block of concrete in which the heads of the steel sheet piles were embedded. Pockets were left in this concrete sill to receive the ribs so that they could be set in place and accurately spaced in the running water. A timber sill was embedded in the concrete sill to receive the stop planks.

When the time came for making the final closure in the dam, all of the ribs were set up and secured in place by bolting to the heads of the foundation piles or to the Tainter gate sills in the adjacent finished sections of the dam, before any of the stop planks were put in.

On the upstream side the end ribs of each form unit were so arranged as to bolt to the face of the concrete in the adjacent finished sections of the dam, with a thin wooden block between the rib and the concrete to form a tight joint. The space between the stop planks and the lagging furnished a place for any water which passed the stop planks, to accumulate and to be pumped out, but pumping from this space proved to a large extent to be unnecessary, as the stop planks were so tight that the leakage was not sufficient to cause trouble in most cases.

Owing to the fact that the final closure had to be made in higher water than was originally anticipated, wooden cofferdams, consisting of timber cribs with sheeting, had to be used on the downstream side instead of dams made with sacks of sand as was first planned. The method used for stopping off the water proved very satisfactory, as did also the arrangement and design of the forms.

For convenience in construction, the spillway dam was divided by expansion joints into sections 54 ft. long and these joints were so arranged that half of the sections have two Tainter gate piers, while the alternate sections have only one pier each. The sections which were left for the final closure were the sections having only one pier. In all cases notches were left in the top of the dam to receive the piers and the piers were built after the body of the dam was completed.

As it was intended under some conditions to fill the forms for the dam at the rate of at least 4 ft. per hour, they were designed to sustain a pressure of 1,000 lbs. per square foot. This pressure was determined for temperatures around 60° F., from experiments made by Major Shunk, U. S. Army, at what is known as the High Dam on the Mississippi River at Minneapolis. In order to secure the forms from being lifted by the upward pressure of the concrete on the curved part, the ribs were secured by rods to the heads of the piles.

By making a horizontal joint in the retaining dam 5.5 ft. below the full reservoir level and building the upper part with separate forms, it was possible, with slight modifications, to use the spillway forms for the lower part of the retaining dam. This modification consisted in making joints in the inclined ribs, so as to reduce their length, and attaching projecting plates to connect with the gusset plates at the tops of the vertical ribs. For use on the retaining dam the inclined ribs were turned over so that the shoe would have a better bearing, and as it seemed probable that the furring and curved angles might be troublesome these parts were bolted to the ribs so as to be readily removed. This provision proved to be unnecessary.

The draft tube forms (Fig. 3) were built up on a central rib or keel. Transverse ribs were made up of two or more thicknesses of 1¼-in. plank and spaced not to exceed 2 ft. at the outer edge where the lagging attached. These transverse ribs were made in quadrants, and were bolted by angle iron clips rigidly to the central rib, but on the horizontal axis a 3-in. space was left for wedges so that in removing the forms the upper quadrants could be dropped 3 ins. and thus be loosened sufficiently to permit of being removed from the draft tubes. Three or more of the quadrants of adjacent ribs were fastened together with cross bracing and after being lagged composed one section of the form.

The complete draft tube form was composed of sixteen of these sections and contained 20,000 ft. B. M. of lumber, yet it required only two days to take it apart, move it a distance of about 300 ft. and reassemble it in final position for concreting. The scroll case forms were built on practically the same plan as the draft tube forms, but in this case the keel or central rib lay in a horizontal instead of a vertical plane, and as this rib was placed at the horizontal center line of the wheel gates, the part of the form coming below the rib was considerably larger than the part above. The transverse ribs and the sections of the form were made up in the same way as for the draft tube forms and were bolted to the central rib by angle iron clips; wedges were placed under the upper sections. A grill work of 8x8-in. timbers placed directly on the top rib of the draft tube form carried short vertical posts, which supported the central rib of the scroll case form. On top of the central rib rested a short cylinder, so to speak, made of two circular ribs with posts between; to these posts and the posts supporting the central rib were attached the transverse ribs of the forms. Lagged cylinders, which were divided into quadrants, separated by narrow parallel sections and wedges, completed the wheel pit forms.

This method of constructing the draft tube and scroll case forms proved to be eminently satisfactory, as the forms were easily assembled for concreting, were readily removed from the concrete, and in the process were damaged very little. In many cases, however, the sections were so large and heavy that it required considerable ingenuity on the part of the workmen in removing them from the concrete to transport them to points where the derricks could lift them. Smaller sections would have made this part of the work considerably easier but, on the other hand, the assembling and the adjusting of the forms would have been considerably more difficult.

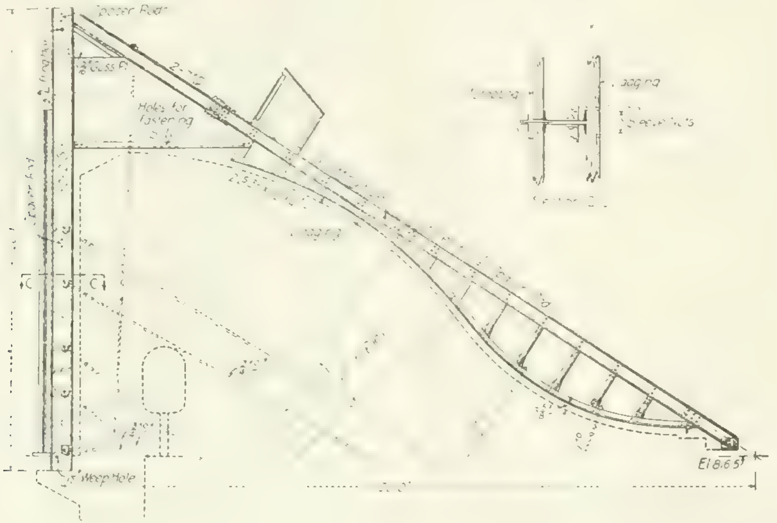

Fig. 2. Steel Ribs for Forms for Spillway Section of Coon Rapids Dam.

Rapid Construction of a Mine Tunnel —Methods and Costs.

The tunnel, 9,792.2 ft. long, is known as the Sheep Creek Adit to the mines of the Alaska Gastineau Mining Co., Juneau, Alaska. The records given here cover the 8,707 ft. driven between Dec. 1, 1912, and April 1, 1914. The tunnel section was 10x8 ft.; driving proceeded from the portal on an upgrade of 0.65 per cent following the strike of the formation. The rocks penetrated are greenstone, slate and metagabbro alternating in stretches of from a few feet to several thousand feet. The rock was very hard and except the greenstone broke badly. The methods and costs of driving given are taken from an abstract of the engineer's report as printed in "Engineering & Mining Journal," Oct. 17, 1914.

Plant.—The construction plant comprised quarters, magazine, blacksmith shop, compressors, ventilating plant and drill plant. The drills were Ingersoll-Rand E 44, 3¼-in. piston machines. Six were kept on hand, four at the face, one in the tunnel and one in the shop being overhauled. In use they were mounted on 4½-in. horizontal bars 9 ft. long. Of the drill steel the starters were made of 2-in. cruciform, with 2¾-in. gage, 32 ins. long. The seconds were of 1¾-in. cruciform, with 2½-in. gage and 52 ins. long; the last three pieces were made of 1½-in. steel, gages 2 5/16 ins., 2⅛ ins. and 1 15/16 ins., length 74 ins., 94 ins. and 116 ins. About 750 pieces were kept up, sharpening being done on the day shift only and over 500 pieces frequently being dulled per day.

Force and Shift Arrangement.—The force employed consisted of 70 men. Working on day shift only, there was a general foreman, a timekeeper, a tool sharpener, a tool-sharpener helper, a blacksmith, a blacksmith helper, a carpenter, an electrician, a powderman, and an outside man. Two compressor men worked 12-hr. shifts each. Divided into three shifts there were three shift bosses, 12 upper-bar machinemen, 12 lower-bar machinemen, 18 muckers, three carmen, three locomotive engineers, three locomotive brakemen and four pipe and trackmen.

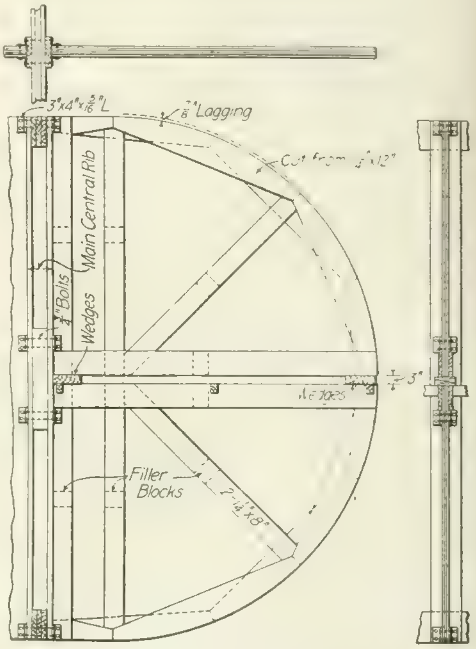

Fig. 3. Transverse Rib for Draft Tube Form, Coon Rapids Plant.

The arrangement of shifts was unusual. The cycle was completed in 18 instead of 24 hours, during this time each of the three crews into which the force was divided worked 6 hours and rested 12, so that in each 24 hours there was 8 hours of work for each man. The incoming shift would relieve the outgoing shift at the working face and there was no intermission in the work for the purpose of eating a meal; this eliminated the delay of the meal time and the slackening of work following heavy eating. The plan was eminently successful and acceptable to the men; the only objection was the complication in the meals at the boarding house; eight meals had to served every 24 hours, two for each 6-hour shift; each shift got a meal about three-quarters of an hour before it went on and another when it came off.

Routine of Drilling.—After spitting the round, the men walked back in the tunnel about 1,000 ft. The holes were counted and immediately after the last lifter went off the men started toward the face again. The fans being in full operation continuously, no smoke was encountered until within about 60 ft. of the face. One man then carried to the breast a water hose, previously connected to the water line and sprayed the muck. Meanwhile the manifold was connected to the air line and the air hose attached thereto. The top bar was next brought up and jacked into place; two machines were placed on the bar, the air hose connected as soon as possible and drilling started. At the beginning of tunneling operations it required about 30 minutes from the time the last lifter was fired until the top-bar machines were running. By the end of the undertaking this took frequently only 10 minutes and seldom more than 15. With the top machines in operation, the four lower-bar machinemen started mucking out to make room for the lower bar. They threw back to the slick sheet, from which the muckers loaded into the cars. It was usually possible to set the lower bar and finish drilling the lower holes by the time the top machines were finished, so that all of the machines were torn down together.

Routing the Mucking.—While the machines were being placed in position, mucking began. The empty car was brought ahead and the track cleaned up to the slick sheet. Of the six muckers, four were shoveling continually and two resting. The average output of the force was 10 to 12 tons per hour. On a slick sheet beside the track, within 50 ft. of the face at all times, an empty car was kept. Whenever a car was loaded, the carman took it down the track and brought back the empty. There was thus only a fraction of a minute lost in changing cars. A few hundred feet back from the face another slick sheet was maintained and when the locomotive brought in a train of empties, they were thrown off the track onto this sheet. The loaded cars were run back to this point, made up into a train and hauled out. From this latter sheet the empty cars were run one at a time up to the sheet near the face. The empty cars weighed about 1,100 lbs. and were handled by a man using a crowbar. The sheets were kept about the same height as the top of the rail so that the car required to be lifted only the height of the flange. No switches were used anywhere. At no time did the removal of the muck limit the speed of drifting or interfere with the drilling cycle. The steel plates used for the slick-sheet sidings were ¼x18x140 ins. The siding some distance from the face was 48 to 60 ft. long; directly opposite it were ¼x22x140-in. sheets, resting on planks down the center of the track, and also flush with the rail heads.

TABLE I. COMPARATIVE DATA ON SHEEP CREEK AND LOETSCHBERG TUNNELS

	Sheep Creek.	Loetschberg.	Ratio.
Size of tunnel, ft.	8x10	6x10½	
Area of cross-section, sq. ft.	80	63.5	1.26 : 1
Best monthly record, ft.	661	1,013	1 : 1.53
Record on entire length, ft.	544.2	490	1.1 : 1
Average progress per round, ft.	4	3.97	
Average length holes, ft.	6.37	4.54	1 4 : 1
Number of holes per round	22	13.4	1.64 : 1
Total footage holes per round	140	61.3	2.28 : 1
Drilling time per round, hour	1.58	4	1 : 2.53
Drilling time per ft. of hole, min.	1.72	1.55	1.1 : 1
Entire duration one round, hr.	5.3	4.48	1.18 : 1
Strength of dynamite used	60%	85%	
Pounds used per ft. advance	34	15.5	
Number of drills used	4	4	
Support for drills	Horiz. bars.	Carriage	

The data on the Loetschberg tunnel are based on a paper, "Tunnel Driving in the Alps," by W. L. Saunders, A. I. M. E. Trans., 1911. Detailed data are given only for a period from January, 1908, to July, 1910. The tunnel was started Oct. 1, 1906, and finished Mar. 31, 1911. The details given would probably be slightly modified if a complete record were available. The record of 1,013 feet was made subsequent to July 1, 1910.

Track-Laying.—After practically all the muck was cleaned out, the shovelers laid ties to grade as the tunnel advanced, thus facilitating the subsequent laying of the rails. A 25-ft. false track was advanced over the ends of the rails as necessary, so that the cars were always next to the muck pile. When the advance permitted the insertion of a set of rails, the foreman and muckers did the work in 15 to 20 minutes, without disturbing the machinemen.

Blasting.—On the completion of the round, shovelers, machinemen and everybody helped to tear down the machines and bars. Then ¼x36x140-in. slick sheets were spread out for 30 ft. back from the face and covered with a little muck. These sheets were handled with grappling hooks through holes in each corner. When the machines were removed, an air hose was attached to a blow pipe and the holes cleaned. The shift boss, machinemen and foreman then did the loading. Double fuse was used on the lifters. The explosives were Bear Brand fuse, California 8X caps and Hercules E. L. F extra 60 per cent powder. Spitting the fuses completed the cycle. There is no relation whatever between the shift and the drilling cycle, the machinemen relieving each other without stopping drilling.

Time Schedule.—Beginning with the time the last hole was heard to explode, the average time schedule for the last five months' operations would be about as follows:

Operations.	Time consumed. Min.
Returning to face	4
Setting top bar	6
Mounting and starting up two machines.	3
Shoveling back for bottom bar	30
Drilling 20 to 25 holes	210
Tearing down machines	5
Blowing out holes	4
Loading holes	6
Cutting and splitting fuses	2
Interval to report of first hole	4
Interval from report of first hole to report of last hole	3
Total	4 hrs. 37 min

The Round.—In drilling the round the standard center cut, generally with six holes, was used; these cut holes varied from 7½ to 8 ft. The side holes and lifters, which averaged 5½ ft., were put in to suit the ground. Variations in the nature of the information necessitated a good deal of variation in the layout of the holes. A good many relievers and "kickers" were frequently necessary. The usual round required 21 to 23 holes, although at times 29 were necessary. For a 22-hole round the total footage was about 140; the average rate of drilling dry holes was 6 ft. per hour, of drilling wet holes, 7 to 10 ft. per hour; the average time for a complete round was 3½ to 5 hours; the average advance per round was about 4 ft.

Tramming.—The muck from the face was hand-trammed at first, subsequently a storage-battery locomotive was used, transporting material, men and waste rock. This was a 4-ton Jeffrey machine, equipped with 63 Edison, A-8, nickel-steel cells. The cells were charged from a 14-kw. motor-generator set, consisting of a 20-hp., 400-volt, alternating-current motor, direct-connected to a 125-volt, compound-wound, direct-current generator. The Matheson side-dumping roller-bearing cars had a capacity of 30 cu. ft.; they were made by the Joshua Hendy Iron Works, of San Francisco. Drill steel and miscellaneous material were handled principally on small flat cars. The 30-ft. capacity cars were the largest that could be used on the slick-sheet sidings. They were loaded heaping full, since when loaded they did not require to be derailed. The track gage was 24 ins., the widest for which the side-dump cars could be built and allow the loaded car on the track to pass the empty on the siding. At the beginning of operations, the locomotive hauled out 12 cars in a train, but as the length of the tunnel increased, it became necessary eventually to handle trains of 30 cars. The material was used for fills on the surface railroad between the tunnel portal and the mill site, the filling being dumped from temporary trestles constructed for the purpose. One motorman and one brakeman handled and dumped the trains.

Pipe, Track and Wiring.—The ventilating pipe was carried on 4x6-in. vertical posts spaced 15 ft. It was kept close to the face and protected by a bulkhead of ties. A compressed-air line was carried along the bottom on 4x4-in. sills, which also supported the board walk; the end of this pipe was protected by the same bulkhead. The main line was always thus within a hose length of the face. An extra manifold was kept on hand and when it was necessary to extend the pipe line, this manifold was attached to the new length of pipe before the latter was put on; this considerably facilitated the operation. The rails used were 50-lb. and were laid on 6x8-in. by 6-ft. ties. When the track is widened to its permanent gage of 36 ins., one rail only will be moved.

Six wires were carried the length of the tunnel; three of these were used for the single-phase, 110-volt lighting system, the purpose of the third wire being to give equal voltage at all points in the tunnel. The other three wires constituted the three-phase, 440-volt alternating circuit for the ventilating-fan motors.

Speed of Advance.—Drilling was started November, 1912, but the work was not considered as completely organized until December, 1912. Between Dec. 1, 1912, and April 1, 1914, a period of 16 months, the tunnel was advanced 8,707 ft. with a single heading, an average of 544.2 ft. per month. During the last six months, the average monthly advance was 596 ft. The greatest monthly advance was 661 ft. made in November, 1913. At various times advances of 24 ft. per day were made. It is believed that this constitutes the world's record for sustained progress in extremely hard rock with an 8x10-ft. tunnel section. Monthly records have been made considerably in excess of 661 ft., but we know of no record which equals the average advance of 544.2 ft. over the entire period of operation covering 16 months and of no American record which equals that of 596 ft. maintained for six months. Table I compares progress with that of the Loetschberg tunnel.

Wages and Bonus.—On account of the peculiar shift arrangement, the men were paid by the hour, and in addition a bonus was distributed. The wages were as follows:

Machinemen, muckers and carmen	$0.50
Shift bosses	0.58
Blacksmith	0.60
Tool sharpeners	0.50
Tool-sharpener helpers	0.40
Blacksmith helpers	0.35
Compressor men	0.40
Electricians	0.50
Timekeepers	0.45
Carpenters	0.60

A bonus was paid as follows: For 300 ft. per month or under, no bonus; for 300 to 350 ft. per month, $7 per ft. for the 50 ft.; for 350 to 400 ft. per month, $8 per ft. for the 50 ft.; for 400 to 450 ft. per month, $9 per ft. for the 50 ft. This increased $1 per ft. for every additional 50 ft.

The foreman distributed the bonus according to his judgment. It was his practice to give the lower-bar machinemen $30 a month bonus, independent of the total amount received. The muckers, carmen and motormen each received $10 to $15 per month bonus at the foreman's discretion. The tool sharpeners received $45 per month bonus. The amounts noted above were deducted from the total bonus of any one month and the remainder divided equally among the top-bar machinemen and the shift bosses. His idea was to give the greatest reward and the greatest incentive to the men chiefly responsible for the rate of progress. The result was thoroughly satisfactory.

Costs.—The following cost data apply to the 8,707 ft. driven between Dec. 1, 1912, and April 1, 1914, this representing the distance driven under the standard conditions described:

Wages	[illegible]
Bonus	[illegible]
Explosives	[illegible]
Lighting	[illegible]
Tool replacement	1.35
Lumber and miscellaneous supplies	0.75
Store expense and transportation	[illegible]
Power and compressed air	2.53
Loss on boarding house	1.17
Depreciation on mining tools	1.29
Total	$31.08

A $1 charge per man per day for board did not cover the cost, inasmuch as the food was of high class and expenses of transportation and help were excessive. Nearly all the men ate four meals per day. Under "power and compressed air" is concluded the operating expense of furnishing the compressed air and of ventilating. The labor of installing pipes is included, but not the cost of the pipes themselves, since they became permanent equipment.

Sectional Planking or Track for Drag Line Excavator Work.

The illustrations show a sectional planking or track devised by J. S. Whitley of Hearin & Ryan, contractors, Mt. Olive Levee work, and described in the "Excavating Engineer," January, 1915. This track was used with a Bucyrus drag line excavator.

The section is 24 ft. in length over all. Ten of these sections are used, five under each side of the machine, giving a track of about 100 ft. in length. Each section consists of three 5 x 16-in. x 20-ft. stringers laid side by side, thus forming a roller bed 4 ft. wide. Under these are placed ten 6 x 8-in. x 8-ft. standard railway cross-ties, spaced 2 ft. apart, as shown in Fig. 1. Under these are three 2½ x 16-in. x 20-ft. flooring planks, to serve as a stiffener, to elevate the roller bed and to keep the mud from forcing itself up between the ties. These three sets of timbers are bolted together by thirty ¾ x 13-in. machine bolts with heads countersunk below the surface of the top timbers. Four 1-in. U-bolts in the ties serve for hooking the swinging chains.

The chief feature of the section is the staggered arrangement of the top timbers, as the sketch shows. The advantage of this is, first, to break the joint and make a more rigid connection; and secondly, to make it possible to take a sharp curve in the shortest possible space. The rollers, in so doing, always have a solid bearing over the joint.

The machine can roll in either direction on these sections, but preferably in the direction of the arrow in Fig. 1. The reason is that the rollers won't strike a projecting joint, since the top timbers on the section the dragline is on project over the ties on the section onto which it is moving and the weight of the machine serves to press it down. This is especially important on soft ground. Furthermore, it is easier to pick up and place the sections under this condition. For very soft ground the bottom flooring may be extended to the end of the ties, thus giving more bearing surface.

An important point for the successful handling of these sections is the chain rigging for picking up and swinging. This is shown in Fig. 2. This consists of two pieces of ⅝-in. chain, 3 ft. 9 ins. long, and two pieces 3 ft. 3 ins. long. The sketches show the arrangement. It will be observed that two of these chains, towards end *B* in Fig. 2, are 6 ins. longer than those hooked to end *A*. The reason for this is that in swinging, one end is higher than the other, thus making it easy to make a perfect joint. All sections must be placed in the runway just as they came out. Under ordinary circumstances the act of swinging them from the rear to the front of the machine would set them wrong end for end. The long chains, therefore, should be given one-half twist. When the section is in the air, its own weight will naturally swing it to the correct position. When the pit men put on the chains, the end nearest the operator should have the short chains so that after swinging around, the long chains or low end, is nearest the operator.

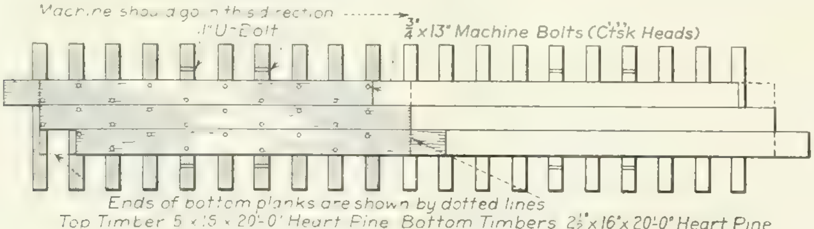
Machine should go in this direction
1" U-Bolt
¾"x13" Machine Bolts (C'tsk Heads)
Ends of bottom planks are shown by dotted lines
Top Timber 5"x15"x20'-0" Heart Pine Bottom Timbers 2½"x16"x20'-0" Heart Pine
Cross Ties 6"x8"x8'-0" Std. R.R. Ties
E.&C

Fig. 1. Sectional Platform Track for Drag Line Excavators.

For ordinary service, two cable clamps are put on the dragline cable, 3 ins. apart, and about 10 ft. from the end. The large hook is hooked between these. In moving any distance the chains are fastened to the dragline by means of an ordinary cable clamp around the shank of the hook (see Fig. 2) thus preventing it from coming unhooked. The sections, if properly managed may thus be swung ahead and placed in 1½ minutes each. Mr. Whitley states that the sections enabled him to move his machine 2,600 ft. in 10 hours.

Methods and Costs of Electric Shovel Work Removing Slides and Side Cutting for Electric Railway.

The shovel used was a 14-B Bucyrus electric operating at 575 volts. A 30-hp. hoist motor and two 15-hp. swing and thrust motor equipment used on this shovel with a ⅝-cu. yd. dipper. The shovel weighs 19 tons. The work recorded was on the electric lines of the Wilkes-Barre Ry. Co., and the data given here are taken from the "Excavating Engineer" for January, 1915.

HANDLING A 3,500-CU. YD. SLIDE.

In May, the shovel tackled a 3,500-cu. yd. slide on the short line on Harvey's Lake Division. Work was started April 19 and was completed on May 8. The material removed was hard-pan, loosened by the action of the frost. It contained a considerable amount of gravel and small boulders. The latter running in size up to 2 and 3 cu. ft. When dry this material answered perfectly to the definition of hard-pan. In the winter months, the frost penetrated this slope, which varied from 20 to 60 ft. in height above the track for a distance of about 1,000 ft. In the spring when the frost came out, a layer of this material, averaging perhaps 1½ ft. in thickness, slid down the slope, covering one of the tracks to a depth of from 2 to 10 ft.; the outside track was kept open by hand with some difficulty. When this material was dried out somewhat, the shovel was started at the end of the slide, operating from the covered track and loading into cars on the outside track.

Two motor cars and two 10-yd. all-steel Western side air-dump cars were used. One motor car was used for spotting one car, while the other motor car was hauling the other car to and from the dump. The distance to the nearest switch was about 800 ft. and the shovel was idle while the spotting car was taking the loaded car to the switch and returning with an empty. On this account considerable time was lost. The record of a typical day's run shows that the shovel was in actual operation 225 minutes out of a 10-hour day. The material was hauled an average distance of about a mile and dumped along the fills for the purpose of strengthening the embankments, and preparing for a double track. When the cars were dumped the bulk of the material was precipitated down the side of the embankment. A thin layer of ashes spread on the steel bottom of the cars before loading greatly facilitated this free dumping.

Although probably not more than 20 per cent of the material excavated was actually spread by hand on the dump, yet it will be noted that this part of the operation represents nearly 50 per cent of the labor cost. Approximately 3,500 cu. yds. of material was removed in 11 working days. The work was considerably hindered by several trees that came down with the slide, which had to be cut up and removed. This material is particularly difficult and expensive to remove by hand, and when wet, it is almost impossible to handle by reason of it adhering to the shovels. The cost of removing a smaller slide that occurred at this location, the previous season, was approximately 50 cts. per cu. yd.

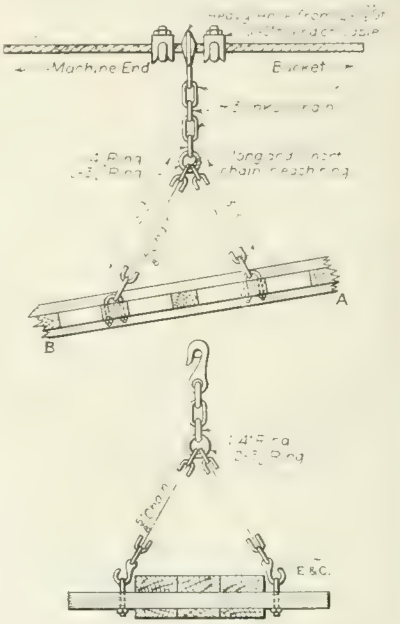

Fig. 2. Method of Hitching in Swinging Ahead Sectional Platfrom Track.

The total cost of the shovel operation in this instance, as shown in the table below, including, spreading on the dumps, spotting cars, hauling, etc., was 12.15 cts., less than one-quarter of the hand labor cost. One of the principal advantages of the shovel was that the material could be handled when in a semi-fluid state, thereby making it possible to get the track in operation. As an indication of the output obtained under these conditions, on May 4, 23 10-yd. cars or approximately 345 cu. yds., were loaded in 227 minutes, the shovel moving ahead in this time 36 ft. On May 7, 22 10-yd. cars were loaded in 225 minutes, moving ahead 40 ft. on a curve. The material weighed 125 lbs. per cu. ft.

The cost of handling this slide as given by Mr. Hoffman, steam shovel engineer, was:

LABOR.

	Cts. per cu. yd.
Excavating and loading	2.1
Spotting cars	1.3
Hauling and dumping	1.8
Spreading on dump	4.0
Total labor	9.2
Including supervision, about	10.0

POWER.

Estimate of power used by shovel is 160 kw.-hrs. per day @ 1½ cts., equals $2.40 per day, or	.75
Power used by motor car hauling to and from dump—175 kw.-hrs. per day, or	.80
Total for power	1.55

Repairs, supplies, etc., were negligible on this job, but assumed to average $2.00 per or 60 cts. per cubic yard.

SUMMARY.

	Cts. per cu. yd.
Labor, including supervision	10.00
Power, excavating and hauling (1 mile)	1.55
Repairs, supplies, etc	.60
Total	12.15

Note.—No allowance for interest and depreciation on equipment.

COST OF GRADING SIDE CUT.

This was a side hill cut about 800 ft. long with a depth on the center line ranging from 1 to 6 ft., averaging about 3½ ft. The cut on the high side ranging from 3 to 10 ft., averaging about 6 ft. The cut contained 2,450 cu. yds. The preliminary work consisted of grading a temporary roadbed parallel with and about 14 ft. distant from the center line of the permanent track. Upon this temporary roadbed the ties and rails were laid and used for hauling the material to the dump, after which the track was thrown to its permanent location.

A motor car and a Western 10-yd. steel side dump car were used for hauling the material. The grade was very steep and the track in poor line and surface, necessitating slow running to and from dump. The power on this line was weak and very unsatisfactory. It is probable that the output would have been increased at least one-third, if satisfactory power had been available. Generally the material was loam and good digging. Shale rock was encountered, however, in the bottom of the cut and about 25 per cent of the material excavated was shale ranging from soft, easy digging to very hard. The time required to make the cut was 12 working days during which time the shovel work was delayed 44 hours principally by lack of power. The material was dumped on a fill about 600 ft. in length, ranging in depth from 2 to 8 ft., averaging about 5 ft. About 200 lin. ft. of crib trestle was erected over the deeper portion of the fill. On the remainder of the fill the track was laid on the original surface and gradually jacked up to grade. The cost figures follow:

LABOR.

	Total.	Per cu. yd
Grading for temporary track....	$ 50.00	$0.0204
Moving shovel into position......	13.24	.0051
Excavating and loading material.	107.74	.0438
Hauling and dumping material...	60.74	.0247
Building crib trestle..............	25.00	.0102
Spreading material on dump and raising track	134.20	.0547
Watchman (⅔ of watchman's time charged to this job).......	12.80	.0052
Blacksmith	5.90	.0024
Throwing track to permanent position	30.00	.0122
Total	$439.62	$0.1790
Supervision ...	43.96	.0179
Total	$483.58	$0.1969

POWER.

To operate shovel, 1,260 kw.-hrs. @ 1½c	$ 18.90	$0.0088
Hauling material, 480 kw.-hrs. @ 1½c	7.20	.0029
Total	$ 26.10	$0.0117

SUMMARY.

Labor, including supervision..............	$0.1969
Power (shovel and train)................	.0117
Total	$0.2086

Note.—No allowance for interest and depreciation on equipment.

A Method For Finding the Annual Charges for Ties.

The method for figuring the annual charges for railway ties which is presented here was given by Harrington Emerson and T. T. Bowen in a paper before the American Wood Preservers' Association, Jan. 19-21, 1915.

To determine the annual cost of maintaining any tie all we need to know is: (a) First cost in track. (b) Annual interest and tax rate. (c) Life of tie.

The first cost of the tie consists of three main charges, some of which may be still further subdivided. The three main charges are: (1) First or wood cost of tie, including foreign freight, preservatives and mechanical protection. (2) Labor and other costs of putting ties in the track. (3) Overhead supervising charge. The sum of these is the cost of the tie in track.

On the first cost of the tie there is a tax charge and an interest charge. In our calculations we assume a tax rate of 1 per cent on value and an interest rate of 6 per cent, making a total of 7 per cent. Any other rate can be used.

The annual maintenance charge for all ties is the sum of annual interest and tax on first cost of all ties in track and of the replacement cost in track of all ties removed.

Over a series of years the replacement accurately determines the average life of all ties. If one-tenth of all the ties is replaced each year the average life is running at the rate of 10 years. If one-twelfth is replaced the average life is running at the rate of 12 years. If one-eighth is replaced, the average life is running at the rate of eight years. If in 10 years as many ties have been replaced as the total in service, the average life is 10 years, irrespective of variations in different years.

The annual maintenance cost can be expressed by the formula:

$$A = \frac{C}{Y} + C(i + t)$$

A=Annual maintenance charge.
C=First cost of tie in track.
Y=Average years of life determined by number of removals.
i=Rate of interest on investment.
t=Tax rate on investment.

By means of the above formula the diagram, Fig. 1, has been constructed for solving instantly as to a single tie or classes of ties, all ties for a year or series of years, the fundamental question of the relation existing between:

A First cost of tie.
B Life of tie.
C Annual cost of maintenance.

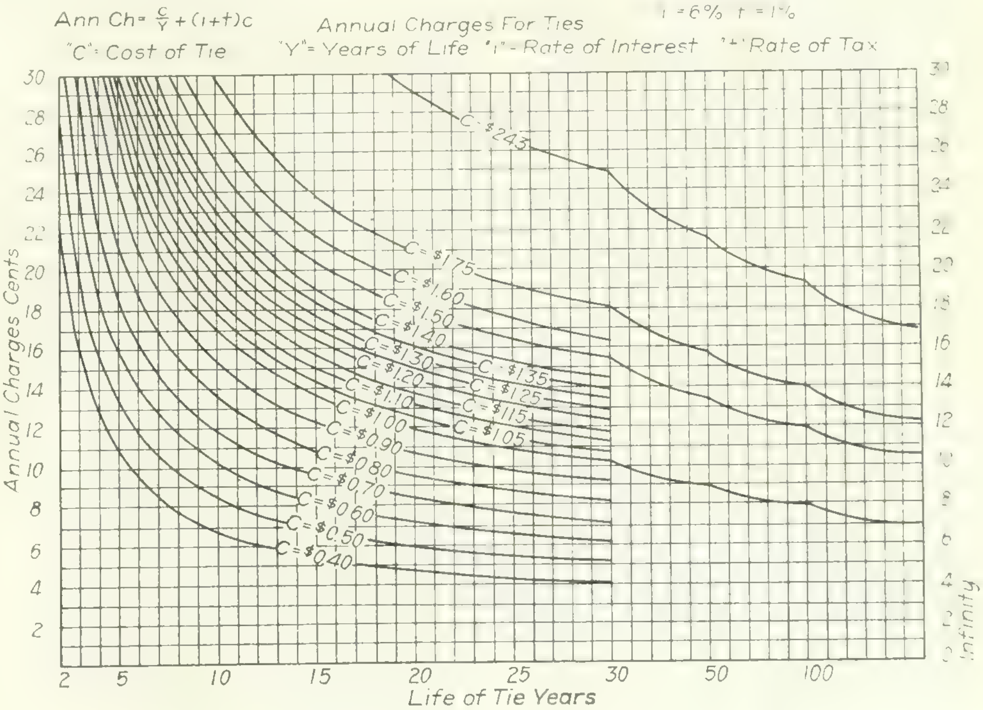

Diagram for Figuring Annual Charges for Railway Ties.

Three distinct problems may be solved with this diagram:

Fixed annual cost with first cost and duration of life, both variable.

To illustrate: Take the horizontal $0.15 line of annual charge as the standard annual cost. Along this line there are numerous intersections with the curved lines of first cost and the vertical lines of duration. Therefore, if ties are kept up on an allowance of $0.15 per tie per annum, there are many solutions as follows:

First cost.	Duration, years.	Annual cost per tie.
$0.40.	3.2	$0.15
0.60................	5.5	0.15
0.75.	7.6	0.15
1.00................	12.5	0.15
1.25................	20.0	0.15

But we may take another problem, namely that of first cost fixed, but annual cost and time variable.

First cost.	Duration, years.	Annual cost per tie.
$1.00..	2	$0.57
1.00.	3	0.403
1.00..	4	0.32
1.00....	5	0.27

First cost, $1.00; 2 years' duration.

Interest	$0.07
Annual cost	0.50
Total	$0.57

Finally, we can assume an average standard life, say 15 years, and determine first cost and annual costs.

First cost.	Duration, years.	Annual cost per tie.
$0.40..	15	$0.0546
0.60..	15	0.0820
0.75..	15	0.1025
1.00......	15	0.1366

The first illustration given here, that of fixed annual cost with varying duration and first cost, is by far the most valuable of the three. This solves definitely the economic question of the value of tie treatment.

Suppose a tie without treatment costs $1 in the track and lasts 10 years. How much may be spent for treatment to prolong its life to 18 years? The annual cost of $1 tie lasting 10 years is $0.17. The intersection of the $0.17 horizontal line with the 18-year vertical line falls on the $1.35 curved line of first cost. Therefore, it will pay to spend $0.35 for chemical treatment or mechanical protection, or both, on the $1 tie to prolong its life from 10 years to 18 years.

The diagram also illustrates graphically, by the steepness of the curves, the great economy in prolonging the line of ties that ordinarily last but a few years.

It is, of course, understood in this theoretical diagram and tables that tie maintenance is a continuous performance; that nothing takes place suddenly and that there are great individual variations.

The advantage of the cost formula used is its extreme simplicity. The conclusions it forces on us are, however, not invalidated by any other formula, however complex.

Annual maintenance is cheap when good ties cost little and when they last many years. This was the condition 20 years ago. White oak ties cost in certain regions as little as $0.20; the standard rails were about 60 lbs., the axle loads about 15,000, the cars with only 40,000 lbs. capacity, trains comparatively few. Ties were rarely rail-cut and lasted indefinitely. The annual cost of a $0.20 tie ($0.40 in track) lasting 20 years, was $0.48 per year.

Now inferior woods cost more than best white oak formerly did, axle loads have increased, car loads have increased, trains are more frequent and heavier. It is a race between fungus and rail to see which will destroy the tie sooner. A good tie in main track costs at least $1 and, unless treated, wears out in seven years. Annual cost $0.213. At this rate it would cost a road with 25,000,000 $4,000,000 a year more than it did 20 years ago. Creosote, at a cost of $0.25, put on heavy tie plates at a cost of $0.35 more, and the first cost rises to $1.60. Such a tie, would have to last 16 years to give a yearly cost of $0.213. Will it? Assume that it lasts 10 years, the annual cost becomes $0.273. This is $5,500,000 a year more than it was about 1905.

There is at present no immediate prospect of any economical substitute. In 1904, at St. Louis, I was shown a cast-iron tie, which the patentee thought could be made for $3.50. The interest and tax charges alone on this tie would be $0.245. Assuming the tie to last 30 years and to have a scrap value of $1, the tie would cost $0.328 to maintain. There is still nothing fulfilling the purpose as cheap as a good wood tie. It is at present unreasonable to consider any substitute, even with a certain life of 20 years at a higher cost than $1.67, since $0.20 a year is sufficient to maintain best main-line ties.

Tie expense is reduced to a minimum by five rules: (1) Buy the ties carefully. (2) Spend all on protection that the gain in life justifies. (3) Use them at once. (4) Do not take them out before they are used up. (5) Assort them for proper use.

Careful buying insures a price reduction of about 10 per cent and a quality increase of about 20 per cent.

To allow ties to lie fallow for two years shortens the life two years and adds about $0.14 to first cost.

Many ties are removed from one to five years before they are really gone.

A new, rotten tie costing to lay in track $0.80 and lasting two years, costs per year $0.456, or more than twice as much as the maintenance of the best main track tie, plated and preserved.

Comparative Water Power Resources and Utilization of European Countries, Canada and the United States.

The accompanying table has been compiled by Mr. Arthur Surveyer from various European sources from the reports of the United State Geological Survey and from the report of the Canadian Commission of Conservation. It shows the total available and developed water powers in the different countries of Europe, in the United States, and in Canada; it also indicates the percentage of the utilization for each country and the horse-power per square mile.

The data contained in this table refer to conditions in the year 1911. It would have been more interesting if complete figures for 1914 had been available. Unfortunately, nothing authentic could be obtained except in a few instances. The inclusion of the new Shawinigan development, the Canadian Light & Power Company's plant, and the large development at Cedars would raise the figures for the Province of Quebec to over 500,000 developed horse-power. Switzerland's present figures are about 550,000 h.p., Norway's over 1,000,000 h.p., and that of the United States between 5,500,000 and 6,000,000 h.p. These data are reported by Mr. Surveyer in a paper presented to the Canadian Society of Civil Engineers.

	Hydraulic power available on turbine shafts.		Percentage of utilization.	Available power per square mile.
	Available. HP.	Developed. HP.	Per cent.	HP.
Great Britain	963,000	80,000	8.3	1.00
Germany	1,425,000	445,000	31.2	1.18
Switzerland	1,500,000	380,000	25.0	3.71
Spain	5,000,000	300,000	6.0	3.86
Italy	5,500,000	565,000	10.2	4.22
France	5,857,000	650,000	11.1	5.80
Austria-Hungary	6,460,000	515,000	8.0	7.34
Sweden	6,750,000	550,000	8.2	7.72
Norway	7,500,000	920,000	12.3	14.12
Europe	40,955,000	4,405,000	10.6	5.44
United States	26,736,000	4,016,000	15.0	7.49
Canada*	17,764,000	1,013,045	8.2	6.55

ROADS AND STREETS

The Selection of Hauling Machinery and a Graphical Method of Estimating the Comparative Cost of Hauling.

The factors entering into the selection of road machinery and a method of determining the comparative cost of hauling by various methods were discussed by T. R. Agg in a paper before the American Road Builders' Association. The paper is given here.

The wide range of machinery and appliances available for road and pavement construction makes advisable a careful selection for any particular class of work and yet many types of machinery are so much alike in general design that a selection must be based on a careful study of their operating characteristics. Probably there is no one best type for any given set of conditions nor any one best make of a given type, as a general rule. It is not within the scope of this paper to discuss the many kinds and varieties of good, bad and indifferent road building machinery, but it is proposed to discuss a few principles applicable to its selection, operation and maintenance.

SELECTION OF TYPE OF MACHINE

We find a group of machines available for earth road work, another for macadam construction, and so on through the various classes. These groups overlap to some extent.

Of the machinery offered for earth road work certain types such as the leveler are for a rather limited kind of work while others, such as the blade grader and elevating grader, are for more diverse uses. When a selection is to be made for a special work for which only one class of machine is made, one has only to choose the best bargains from the limited offerings of the class. But when machinery is to be chosen for more diverse uses, operating characteristics and adaptability must be considered. It will usually be found that the selection may be narrowed down to two or three makes and the final choice will depend upon price and personal preference.

The leveler has already been mentioned as an example of a specialized machine, and the mixer for concrete pavement construction is another. For this work it seems to be agreed that the traction type with boom delivery is the best. Of these, several makes are available and which to select will depend upon the purchaser's opinion as to the value and suitability of individual machines.

On the other hand the choice for earth road construction will be between the elevating grader and the blade grader and between traction haulage and team haulage and between the steam tractor and the gas tractor. Here the purchaser must decide between the classes first of all, and then between individual makes of the class.

This is typical of the machinery available for many classes of road work and the basis for a proper comparison is not easy to state. It is believed, however, that the following factors must be taken into account: (a) purchase price, (b) rate of depreciation, (c) maintenance cost, (d) cost of operation and (e) speed, all of which enter into the cost of doing work with any piece of machinery.

To properly estimate these factors there are at present but incomplete and contradictory cost data available and engineers and contractors can do a great service by giving publicity to any reliable and conclusive cost data that comes into their hands.

Purchase Price.—Some kinds of machinery will save their cost in comparatively short time and such may unhesitatingly be chosen because the user can readily foretell whether he has enough work ahead to make the investment profitable. Other kinds require a large outlay and must be used with reasonable regularity for a term of years before they will prove profitable. Eventually, if they can be kept busy they will pay; but before such machinery is purchased, there must be some assurance that the necessary work can be secured. It would often be cheaper in the long run to use a machine which operated at a higher unit cost, but which could be purchased at a much lower price.

Depreciation.—Depreciation is probably the most difficult factor to estimate because the carefulness of the operator has such a marked influence on the life of a machine. With most machinery the average life is fairly well established and hence depreciation can easily be estimated. This is a very important cost item and is probably more often placed too low rather than too high.

Maintenance.—The influence of maintenance on unit costs is well understood, and needs no special comment. Probably this item is also more often underestimated than overestimated. It should be borne in mind that maintenance cost really includes not only the charge for making repairs to a machine but also the cost of delay due to the idle time of the machine. When a large gang is working around a machine such as a concrete mixer any delay on account of the machine is expensive.

Cost of Operation.—The cost of operation for a machine should be taken from the average of many runs under normal conditions and not from exceptional runs made under the most favorable conditions. This cost will include the pay of all men needed to run the machine and the cost of all supplies regularly used in its operation.

Speed.—The rapidity with which a machine performs its work is a very important consideration not only from the standpoint of cost per unit of work done but from the impetus it gives to the entire job. This is particularly true in road and pavement construction where favorable weather conditions must be utilized.

Skill Required to Operate.—The skill required to operate a particular machine should be given consideration because expert operators are not always easily obtained and if a machine requires considerable skill in operation to produce the maximum output, its average may be low due to the difficulty of securing and retaining expert operators. Such machinery should usually be purchased only because of its marked superiority in other respects.

Adaptability.—Adaptability of a machine to various classes of work is an important consideration because it is rarely possible to foretell just where it will be used next and it is better to use a reasonably efficient machine continuously than it is to use a special and highly efficient machine for a certain kind of work and have it idle a large percentage of the time.

Having estimated as accurately as possible the various factors enumerated as above, preference should be given to the one type showing up the best.

The adoption of certain types of machinery for various classes of road work has been largely a survival of the fittest although on account of the new types that are continually being marketed, the process of weeding out is going on constantly. For most classes of highway work the preferred types are fairly well known and to enumerate them here would serve no useful purpose.

In rural communities, labor is usually scarce and the contractor in highway construction will find it to his advantage to utilize every machine that will facilitate his work even though it may not in all cases reduce his unit costs. In the long run, he will profit because of a greatly increased yardage for his season's output.

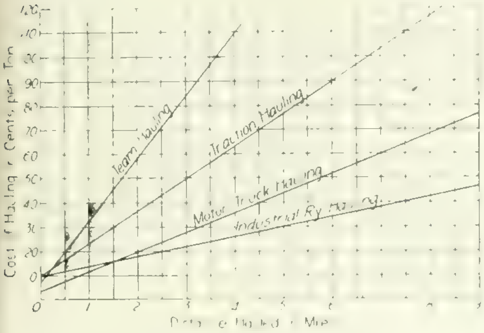

Fig. 1. A Graphic Comparison of the Cost of Hauling Under Assumed Conditions.

METHODS OF HAULING ROAD MATERIALS.

Those engaged in constructing roads and pavements have long realized what a large item of cost is incurred in hauling materials, and some discussion of the methods available is pertinent to this paper. Many factors involved in determining the cost of hauling are variable for work in different localities but for a given piece of work the amount of each of these can usually be selected with reasonable accuracy, and the economy of various methods thus compared.

The cost of hauling varies with the following factors:

1. Length of haul.
2. Rate of travel of the outfit used.
3. Amount of time lost at cars while loading and at road while unloading.
4. Amount of time lost on account of bad roads.
5. Capacity of the outfit per trip.
6. Cost of operation of the outfit.

Length of Haul.—Length of haul for a given piece of work is, of course, the same no matter what method of hauling is used.

Rate of Travel.—The rate of travel varies somewhat between outfits of the same kind and yet there is a value that is reasonably near an average for all outfits of a type. For teams 2½ miles per hour, traction outfits 3 miles per hour, motor trucks 10 miles per hour, and for the industrial railway 10 miles per hour may be taken as typical speeds, assuming half the distance is traveled empty and half loaded.

Lost Time.—The amount of time lost at cars depends upon the method of loading the outfit. If hand shoveling is resorted to the time will be relatively long but extra units of the outfit may be loaded while the others are on the road. This is advisable for all classes of hauling outfits and is a necessity in traction hauling and with the industrial railway. Bins at the sidings with capacity for a full load for the outfit may be used instead of extra units of equipment and are a necessity when the motor truck is used. For team hauling the loading chute may be employed instead of extra wagons. In any case time lost at the cars is expensive, especially on short hauls, and should be eliminated as far as possible.

Records of loss of time in loading and in unloading are exceedingly diverse, but the following amounts lost per trip are near enough the average to give comparable results: With team hauling 18 minutes, motor trucks (loaded from bins or hoppers), 6 minutes; traction outfits, 30 minutes; and with the industrial railway, 30 minutes.

Time lost due to the condition of the road cannot be evaluated in a discussion like this because it varies throughout the season, differs with the locality and with the kinds of roads over which the hauling must be done. It is the greatest with the traction outfit, is about the same for team and motor truck hauling and is a negligible factor for the industrial railway.

The capacities of these outfits per trip are also exceedingly diverse and perhaps no particular one is typical, but equipment of the following capacities are in common use and will serve as examples: Wagons for team hauling, 2 tons; motor trucks, 5 tons; traction outfits, 15 tons; industrial railway trains, 20 tons.

The cost of operation of each of these outfits will vary with the skill of the superintendent, the character of the operator, the kind of weather encountered and the nature of the road that is used. Cost of operation should include the following items: Interest on investment; depreciation on outfit; maintenance of outfit; fuel, oil and other supplies used, and labor cost of operation.

These various items must be evaluated in estimating the cost per hour for operation, and a careful study of the subject has led to the assignment of the following values: Cost of operation per hour for teams $0.50, for motor truck $2.00, for traction outfit $3.00, for industrial railway $4.00. If any inequalities exist here they will of course change the entire relation, but the method of comparing costs of hauling as outlined is applicable and that is the principal object of this discussion.

Knowing the relation that exists between these various factors that enter into cost of hauling an equation may be written to show the cost per ton which is as follows:

$$C = \frac{rd}{us} + \frac{Tr}{u},$$

where

C = cost per ton for a length of haul = $\frac{d}{2}$.

d = distance in miles traveled per round trip.

u = number of tons hauled per trip.

s = speed of vehicle in miles per hour.

T = time lost loading plus time lost unloading.

r = cost of operation in dollars per hour.

If, in the general expression given above, we insert the values of the various factors for each method of hauling we get the unit cost of hauling by that method for any length of haul $\frac{d}{2}$.

These are as follows:

$C = 0.1\,d + 0.075$, for team hauling.

$C = 0.01\,d + 0.01$, for motor truck hauling.

$C = 0.666\,d + 0.10$, for traction hauling.

$C = 0.02\,d + 0.10$, for industrial railway hauling.

For convenience of comparison the unit costs for various lengths of haul have been computed and the diagrams in Fig. 1 constructed. It is easy to see at a glance the most economical method for any length of haul. If the assumed values of the various factors are in any case inapplicable to a given set of conditions the proper ones may be selected and similar curves drawn for use in comparing the costs for these conditions.

It is also convenient to know the capacity of these various outfits per working day and the diagrams in Fig. 2 have been drawn to show the amount of material each outfit will deliver per hour and per day when working under the assumed conditions.

The important thing in this discussion is not the relative costs shown by these diagrams but the possibility of reducing to definite data the probable costs for any piece of work, thus obtaining a basis for determining which method to use.

In all of this discussion one factor has of necessity been omitted which is of greater importance than any other and that is the personality of the superintendent. One man fails to make certain equipment pay out and another succeeds in accomplishing remarkable results with it. Two sets of cost data are obtained, the one showing abnormally high costs, the other showing costs that are exceedingly low. No general discussion can ignore these facts but they cannot be put into data for use in average cases.

INSTRUCTIONS TO ENGINEERS.

States, municipalities and a few construction companies seek to insure that no engineer in their employ will allow the organization of which he is superintendent to fall below the average in efficiency. To that end instructions regarding the use and capacity of various kinds of machinery and as to methods of organization are furnished. Some of these manuals of instruction are excellent treatises on highway construction. Three phases of the use of machinery are usually presented and these cover the normal requirements of such instruction.

The general organization of the work is first outlined. Ordinarily some one machine or operation is the pacemaker for the whole job and when that is true the engineer in charge of construction must build up his whole organization about that machine or operation. The instructions can outline a workable organization but the live engineer will usually be able to improve upon the details.

The instructions next deal with the capacities of machines, rate of construction that can be attained and quality of work that should result. Such matter serves admirably as a yard stick by which the engineer may measure his efficiency. Here again, a man's personality will often enable him to do much better than the average set down in the instructions.

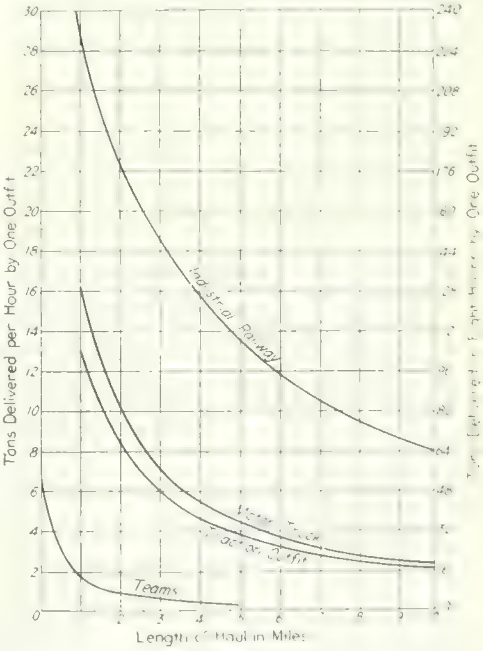

Fig. 2. Amount of Material Delivered Working Under Assumed Conditions.

And finally the instructions deal with reports, cost data and records of progress that are required. In this respect the instructions will be specific and lay down exact requirements.

Instructions to engineers are not, nor can they be, a series of exact rules that must be followed, because no one can foresee all phases of the multitude of detail that enters into the prosecution of construction work and competent engineers would be hampered by instructions that attempted to prescribe exactly how each machine should be utilized.

INSTRUCTION TO OPERATORS.

In the widespread use of costly machinery there always lies the danger of loss through incompetent operation. Delays due to breakdowns are costly and often avoidable. Here again many states and municipal organizations seek to avoid trouble by furnishing to machine operators complete instructions.

These instructions deal first of all with the operation of the machine and since the work is largely mechanical though skilled, the instructions can say in detail just how the machine is to be handled. Here minute instructions are justifiable and they would include besides suggestions on operations, others on the care of the machine, the making of repairs, methods of adjustments and renewals of working parts.

The matter of personal conduct should also be dealt with in these instructions since the public often obtains its impressions of a department by the conduct of some irresponsible subordinate.

The construction of highways involves the handling of much bulky material and consideration of efficiency and economy requires that the machinery shall be well adapted to the work for which it is used, that the operations be systematized so that each machine will produce to capacity, that the machinery shall be handled in an intelligent manner so as to have normal life, and that the problem of transportation be studied in all its relations before a system is adopted.

Service Tests of Stone Block Pavements in Brooklyn.

Results of a detailed study of stone blocks under various conditions of traffic are given by H. H. Schmidt, chief engineer, Bureau of Highways, Borough of Brooklyn, New York City in a paper before Section D of the American Association for the Advancement of Science at the Philadelphia meeting, Dec. 30, 1914, as follows:

Granite block pavements have been extensively used in the Borough of Brooklyn for the past 25 years. The life of these pavements is generally given as 20 to 30 years. Many of them have not been down more than 5 or 10 years, but there has been such a marked improvement in the character of granite pavements, and such added demands placed upon them by the advent of automobile traffic, that it is safe to say many of these old-style granite pavements, which, though not worn out, have outlived their usefulness, and are not fitted for modern requirements.

The improved granite pavement, which is now quite generally used in our larger cities, is of very recent date, having been in actual use only about five years. Whereas very little improvement in the character of wood, asphalt, and other standard pavements has taken place within recent years, in the granite pavement many of the objectionable features have been removed.

About five years ago studies were begun of the various granite pavements in the Borough of Brooklyn, with a view to determining, if possible, the causes which created the objectionable features. Observation showed that certain granite blocks polished under traffic, so that they became extremely slippery; some wore down rapidly at the edges, causing the top of the block to become turtle-backed, which made the pavement extremely rough; some blocks were found which disintegrated under traffic, and still others were extremely rough and not well-shaped, owing to the fact that they were made from a granite which had improper cleavage planes. On the other hand we found certain streets where the blocks had worn down smoothly and squarely, often in spite of exceedingly wide joints, and again we found blocks which were smooth, had parallel faces, and were well-shaped, so that they could be paved with close joints, showing that they had been made from granite which was well adapted to be split into paving blocks. It was further ascertained that certain granites did not polish under traffic, but retained a gritty surface. Practically all of the pavements examined, notwithstanding the wide variation of results obtained, were laid under specifications which were identical. The studies made it plain that one of the principal features to be considered was the character of the granite used for the purpose of making blocks. Before taking up, therefore, the general question of construction, a thorough study of the various available granites was made.

TYPES OF GRANITE BLOCK.

Granite is an unstratified, igneous rock. It has a speckled appearance, and is composed of distinct crystals of different colors. The constituent minerals are mostly quartz, felspar, mica, and hornblende, although mica and hornblende are sometimes missing. The opaque white, reddish or greenish crystals, with glistening surfaces, are felspar; the transparent bluish, glassy spots are quartz, and the black ones are usually hornblende. The mica when present, is usually distinguished as the glistening scales of various shades. The composition of granite, its constituent minerals, and their character, all require investigation.

At the time that our studies were made, there was practically no data available which gave us any idea as to the relative merits for paving purposes of the various kinds of granites. We learned from the service tests of the stones actually subjected to traffic, that the mineralogical composition of the granite, the presence or absence of certain minerals, and the proportions in which they occur, as well as the size of the crystals, all had a direct bearing on its value for paving purposes. It was also recognized that to procure a smooth, well-shaped block, it is absolutely essential that the cleavage planes be such as to cause the granite to split readily into paving blocks.

After a conclusion had been reached as to the most desirable granite, a study of the size, dressing, and paving of the block was taken up. With the use of a concrete base, the extreme depth of the block was unnecessary, and the depth was therefore reduced from eight to five inches. This not only reduced the cost of the work, but also enabled the paving of the blocks with closer joints, as it was possible to procure a better shaped block when the lesser depth was used. The question of the cushion course, the joint filler, and the other matters which had to be considered to draw up a standard specification, were all carefully looked into, and on this knowledge, acquired almost entirely from actual service tests, we first built our standard specification. This specification has since been slightly improved upon each year as more and more data becomes available, and has been made to cover all of the various features before referred to.

AMOUNT OF GRANITE BLOCK IN BROOKLYN.

The first granite pavement in the Borough of Brooklyn on a concrete foundation, was laid in 1894. It is still in fair condition, as compared with the condition when originally laid, although being composed of the old style of granite block, it cannot be compared with one of our modern pavements. We have in the Borough of Brooklyn 160 miles of stone pavement. Of this mileage 25 miles are of the improved modern granite. The amount of the improved granite laid each year in the Borough of Brooklyn is as follows:

Year.	Miles.
1010	0.11
1911	2.16
1912	6.18
1913	10.35
1914	6.02
	24.82

In addition to the above we have 3.5 miles of granite pavement, made of blocks recut from the old blocks to the new specifications. This latter work, though a vast improvement over the old blocks, is not always satisfactory, because the old blocks are so often made of granite which is inferior for paving purposes, and we have found some cases, on heavy traffic streets, when new granite block were paved adjacent to the recut blocks, where even after two or three years' service, the new blocks remained in perfect condition, whereas considerable disintegration of some of the recut blocks had taken place. We have, therefore, made it a rule not to use recut blocks on heavy traffic streets, but find that on other streets they can often be used to advantage, on account of their lesser first cost. There were no expenditures for maintenance on the 25 miles of improved granite in the Borough of Brooklyn during the year 1914.

CHARACTER OF TRAFFIC.

In order to give a clear idea of the character of traffic in this borough, and what is meant by heavy traffic, medium traffic, and so on, it is necessary to mention the traffic standards adopted by this Bureau:

	Weight in tons.	Traffic value.
Rubber tired vehicles.		
Large auto trucks loaded	9	5
Large auto trucks empty	4	4
Small auto trucks loaded	3	3
Small auto trucks empty	1½	2
Pleasure automobiles	1¾	1
Rubber tired carriages	2	2
Steel tired vehicles.		
Loaded trucks	7½	10
Empty trucks	3½	7
Loaded wagons	2½	7
Empty wagons	1½	4
Carriages	1	2
Trolley cars	..	10

To obtain the traffic unit the following formula is used:

Number of vehicles passing a given point in 8 hours x traffic value divided by 8 x 60 x the width of the roadway = density = traffic units per minute per foot width of roadway.

The density of traffic may be divided roughly as follows:

Maximum	1.16 to 1.74
Medium	0.58 to 1.15
Minimum	0.00 to 0.57

This represents in a rough way, in accordance with the above formula, what is known as a maximum, medium and minimum density of traffic in the Borough of Brooklyn.

If we take into consideration merely the tonnage to which the pavement is subjected, leaving out of consideration congestion caused by trolley cars, the following table shows approximately what is meant by heavy, medium, and light traffic in the Borough of Brooklyn, reduced to the tonnage per foot, width of roadway, per day of eight hours:

Maximum	200 to 325 or over
Medium	100 to 199
Minimum	0 to 99

Practically all of our granite pavements are laid on those streets where the traffic and density are classed as maximum, although improved granite is used almost entirely by the street railway company between the tracks.

JOINTS.

The question of joint fillers is one which deserves considerable study, and one which is still capable of improvement. My experience has been that whereas in some cases a cement grout filler has given splendid results, it cannot well be used in busy growing cities, where pavements are constantly ripped up for the purpose of installing subsurface work. The grouted granite block pavement is very difficult to restore, and I have often noted that patches in this pavement are very easily discernible, and even mar the looks of the street. For the first few years, before the cement grout wears off, and before the pavement has been opened to any extent, the pavement laid with the cement grout filler generally looks better and is smoother than the pavement laid with the bituminous joint filler; but my observation has been that after the lapse of a few years the cement grout pavement is generally marred by patching, and further by the fact that the cement grout, which is allowed to a slight extent to cover the blocks, wears off in patches, disfiguring the street to a considerable extent. With a bituminous joint filler, on the other hand, the patches can hardly be seen, and the pavement often improves in appearance after a few years of service.

With modern granite block it is possible to obtain joints averaging from ¼ to ⅜-in. The blocks are laid so close together that a considerable area of the blocks touch one another, thus giving stability to the pavement, even without the joint filler. I do not think it is necessary to fill the small space which is left between these blocks with cement grout, as ample rigidity is obtained with a bituminous filler. It is unnecessary with the modern granite block pavement to use paving gravel, and the modern practice favors the use of a mixture of tar or asphalt with hot sand, poured into the joints.

CONCLUSIONS.

So many examples of extremely rough and poorly laid granite pavements exist in almost all of our large cities, that there is a strong prejudice in the minds of many against the use of this class of pavement. The vast improvement which has taken place in its character is not generally known and appreciated. Granite pavement is capable of a still higher development, but block cutters and pavers must be further educated before perfection can be attained. One of the great difficulties is the necessity for eliminating from general use blocks produced by certain quarries where the nature of the granite is such that good results cannot be obtained. The second difficulty lies in the fact that very few pavers are sufficiently careful, and have a sufficiently good eye and judgment to pave the courses with properly selected blocks. The durability of a granite pavement is, after all, its chief asset, and must not be sacrificed in the attempt to still further improve the other features.

Some Features of Brick Road Construction in Illinois.

A discussion of the results of experience in brick road construction in Illinois was presented as a paper before the Illinois Society of Engineers and Surveyors at its recent meeting by Rodney L. Bell, a division engineer of the Illinois Highway Commission, and his paper is given here in part.

The best type of brick pavement is laid on a concrete base with grout filler, a longitudinal expansion joint on one side for roads and narrow streets, and on both sides for wide streets, and with no cross expansion joints, and this sort of pavement will be discussed.

In a brick road, as well as any other type of construction, you can hardly expect to get any better work than specifications call for, but assuming that your specifications are all that are to be desired, the perfect job is obtained only by careful, sensible attention to the little points in construction. This sort of inspection not only assures a good, durable pavement, but a well-appearing piece of work as well, and when we pay the price necessary to obtain a good brick pavement, it is worth some care and money to see that it is presentable. A good job is worth what it costs, while a sloppy job has no excuse for its existence.

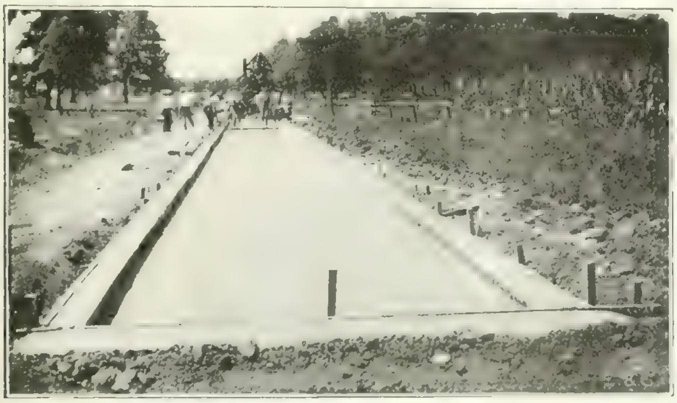
Fig. 1. Laying Concrete Base—Note Method of Constructing Curb.

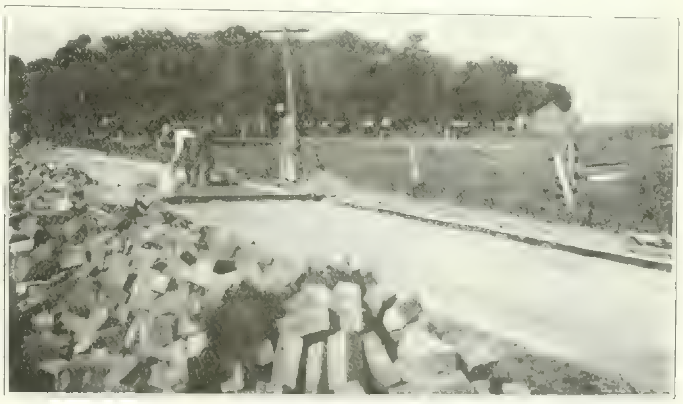
Fig. 2. Spreading and Striking Sand Cushion—Note the Placing of Brick Along the Roadside.

SUBGRADE.

The subgrade should be parallel to the finished road, giving a uniform thickness of concrete base under the entire pavement, rather than make the base thinner at the edges, to secure the required crown. This latter method is wasteful of base concrete, as it makes the center excessively heavy in order that the edges be not weakened. When we are using a concrete base only 4 ins. or 4½ ins. thick, it is necessary that the subgrade be reasonably true. The only way that I know to insure a uniform thickness of concrete base is to go over the subgrade with a template after the side forms are set and men will dress just as much subgrade, using a crowned template as a flat one. Most contractors realize that it is the economical thing to do. No engineer wants less concrete than the plans call for and no contractor can afford to fill up depressions with gravel and sand and cement, with earth at the present price.

We generally set grade stakes at 25-ft. intervals on each side of the road, and I have noticed that a gang of men using these stakes will not leave a subgrade flat, but always crowned a little for a flat subgrade looks hollow to the eye.

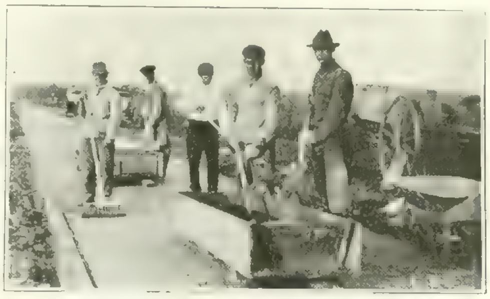
Fig. 3. Mixing and Placing Grout Filler—Note the Use of Two Grout Boxes.

COMBINED CONCRETE BASE AND CURB.

The concrete for the base must be laid between the side forms and struck off with a template before the inside form for the curb can be placed. In making a template for this work, it should be cut true to the crown of the finished road and the cutting edge shod with metal. The ends of the template that rest on the side forms should be raised at least ¼ in. to allow for settlement when the base is floated. Where crushed stone is used as the coarse aggregate, the template may have to be raised to ⅜ in.

The base should be finished so as to not vary more than ¼ in. and if the template is properly made this will work no hardship on a contractor. The entire purpose of the inspection is to secure as nearly a perfect surface as possible and care is needed at all stages. To get this surface, a road doesn't have to be sandpapered, on the other hand, a job which has all its parts thrown together can't expect to be very presentable as a whole.

The inside forms for the curbs rest on the concrete and are held by clamps and dividers, the dividers being removed as soon as the concrete is placed. The outside of the curb is rounded with ordinary sidewalk edger, but the inside is left square, thus securing a better joint between the curb and the brick. The inside form is likely to settle slightly in the soft base, so it is often necessary to remove the small ridge of concrete with a pick before the sand cushion is placed.

One of the first difficulties met when starting the concrete base is to get the proportions adjusted, so that you are getting the proper amount of cement. No matter how willing the contractor may be, it is necessary to keep a close watch on the men until they get used to the proper charge. This is especially true when changing to a different mixture from that which they have been accustomed. Using the graded material required under the specifications of the Illinois Highway Department. In calculating the amount of cement required, allowance should not usually be made for more than 40 per cent voids.

The specifications of the Illinois Highway Department for a concrete base now call for 1 part cement, 3 parts fine aggregate and 5 parts coarse aggregate. It is probable that these will be changed the coming year to 1 part cement, 3½ parts fine aggregate and 6 parts of coarse aggregate, as it is believed our present base is unnecessarily rich. Most of the concrete base laid is probably made from pit run material. There is no doubt but this practice tends to cheapen the construction, both as to cost and to quality, and I believe it also cheapens the quality of the work faster than it does the cost. There are only a comparatively few places where a suitable pit run material can be obtained; and by suitable I mean having the proper proportions of fine and coarse aggregate. Assuming that we have a pit run material such that when your specifications for 1 part cement to 3 or 3½ parts of sand are complied with, it still is an economical material to use. You may ask, what is the objection to using it? My objection to pit run material is that it is impossible to get a uniform product.

Material when loaded in the cars tends to separate into coarse and fine aggregate and when dumped from the wagons the coarse aggregate runs to the edges so that part of the time most of the charge is fine aggregate and at other times it is mostly coarse aggregate. A mixture of this kind can be handled in a bridge abutment where you have a sufficient depth of concrete to spade but a 4-in. layer spread out on the ground is not conducive to spading and a batch of cement and coarse aggregate means a porous place in the base. When using fine aggregate and coarse aggregate from separate piles, each batch is the same as every other batch, which insures a uniform mixture throughout the base.

SAND CUSHION.

The specifications of the Illinois Highway Department require an inch sand cushion under the brick as finished. This means about 1½ ins. of compacted sand when the brick are laid. After the brick are rolled they are left practically flush with the curb and the sand cushion will not be rolled up between the courses of brick more than ½ in. One might say that the sand cushion absorbs the little irregularities in the brick and the concrete base, assuring us of a more nearly perfect surface than we would otherwise secure. If this is the purpose of the sand cushion, I fell that the tendency should be for a less rather than a greater thickness of sand cushion. The thicker the cushion the more likelihood of securing an uneven surface. Then, again, the thicker the sand cushion the more chances of rolling the sand up between the courses of brick. I firmly believe that if there is more than ½ in. of sand between the courses of brick they should be taken up and relaid; if this is not done where a grout filler is used a pavement is almost sure to buckle. A brick pavement will take care of the compression if it has a chance, but it hasn't a fair chance with a yielding filler like sand for the lower portion and a solid filler like grout for the top portion.

LAYING BRICK.

When using a grout filler all brick should have some sort of lug or raised letters and these should always be laid the same way. If this is done you are assured that the grout will reach to the sand cushion at all places. If this is not done there are certain to be some places that will not be grouted. The longitudinal expansion joint should be placed on the side from which the laying starts.

Brick should be carried onto the road on pallets, instead of wheeling in barrows and dumping on the brick already laid. Enough men should follow the laying gang to keep the brick culled up ahead of the men who do the batting. A large portion of the brick that are rejected are plainly culls that the ordinary laborer can detect as well as an inspector. Most of these are misshaped or badly chipped brick which can be used for bats on the unfinished side. Incidentally this saves a considerable amount of work for the inspector.

GROUT FILLER.

An otherwise good pavement may be ruined by poor grouting and a good job of grouting may insure a fair pavement out of what was in other ways an inferior piece of work. One of my inspectors told a contractor this summer that he admitted that a good filler, like charity, covered a multitude of sins.

One of the main points in grouting is to get the first application so thin that it can't help but penetrate to the bottom of each and every course. Fool-proof, in other words. If there is any place that perfect work is required, the placing of the grout filler is that place. The Illinois Highway Department specifies the use of rattan brooms to brush in the first application and squeeges for the subsequent application. Three applications may finish the job and it may take five. The grouting must be continued until the filler is brought flush with the top of the brick and just as little surplus grout on top of the brick as possible. In ending a day's work care should be taken to end with a square joint. This can be accomplished by the use of tin headers, 5 ins. wide by 24 ins. long. These headers can be placed between two courses of brick and removed after the grout has had a chance to stiffen, but not set.

CROSS EXPANSION JOINTS.

I realize that some engineers still believe in the cross expansion joint, but experience generally seems to show that they are not only a useless, but a detrimental appendage. The belief is prevalent now that instead of preventing buckling they encourage it, and you know that within two years from the time the road is finished there will be a low place at each point. In the eastern division no state aid brick roads have been constructed with cross expansion joints. The theory is that they are not needed and experience has proven the theory to be correct.

The brick road between Buffalo and Niagara Falls, 17 miles long and 18 ft. wide, has no cross expansion joints. There is a brick road leading east from Livingston, N. Y., along the south bank of the St. Lawrence River, 7 miles in length, that has no cross expansion joints. All of the better work around Cleveland, Ohio, was and is being constructed without cross joints. At Paris, Ill., we have one road, 2½ miles long, with no cross joints and it is in perfect condition.

MISCELLANEOUS DETAILS.

The main objection to the brick road is the cost and any means of reducing the cost of construction without impairing the quality is much to be desired. It seems to me that a brick wearing surface should last 40 years on our country highways and to put that sort of wearing surface on an inferior foundation is not only poor judgment, but borders on the foolish.

Many engineers doubt the advisability of curbs for country highways, and considerable work has been constructed without them, but 40 years is a long time for a brick edge to stand the turning on and off of the traffic and the additional cost of the curb is so small that I do not see how we can afford to leave it off. A road without a curb might be in perfect condition after 25 years and then if the brick on the edge started to loosen it would cost more to keep them replaced than the original cost of the curb. If the concrete curb should wear out completely in 25 years you would then be just where you started with the other type of construction.

Any sort of construction work develops along two lines: (1) To improve the quality. (2) To cheapen the cost.

Brick roads have been developed to a high point, and the tendency now seems to be to try and cheapen the cost to compete with concrete and to me it seems to be a step in the wrong direction. I never heard anybody claim that a natural soil foundation, a macadam foundation or a gravel foundation was as good as a concrete foundation, nor pit run gravel was better than separated aggregate; nor a road without a curb was better than one with a curb. The only argument is that it is cheaper, and, to my mind, when cheapness takes the place of quality it ceases to be a virtue. "The satisfaction in the quality remains long after the price is forgotten."

Everything else being equal the life of the pavement depends directly upon the quality of the brick that make up the wearing surface. Brick are manufactured at a large number of places and from many different kinds of shale. The shale from these different deposits require different amounts of burning and the resulting brick are of different colors and of varying hardnesses. I believe that our present method of applying the rattler test leaves something to be desired. Each shale deposit should be made the basis of scientific investigation as to the burning required to produce the best results with that material. After this is determined each plant would know exactly what was expected of it. I believe this is a step in advance of anything yet attempted, but it is feasible and would work no hardship on the manufacturer. A maximum average loss would need to be required just as now, but brick made from one shale that will show an average loss of 22 per cent in the rattler, might be better than brick from another plant that only shows a loss of 20 per cent, because the first were properly burned and the latter were underburned. A common standard for all is the easy, but not the scientific way.

Comment on the Purchase of Asphalt and Asphaltic Cement on the Bituminous Basis.

To the Editors:—Referring to the article on "The Purchase of Asphalt and Asphaltic Cement on the Bituminous Basis," which appears in your issue of January 27th, there are aspects of this question which it seems worth while to comment upon, as they are not brought out in the report of Mr. Broadhurst's paper as published by you. Mr. Broadhurst says that "to place all asphalts in competition on an economically sound or even basis the same should be bought on the basis of the contained bitumen." To accomplish this specifications are drawn outlining requirements "first as to quality and second as to the quantity of contained bitumen."

Although the requirement as to quality of bitumen is mentioned, it is nowhere apparent that quality cuts any figure whatever in the purchase of asphalt according to the method described by Mr. Broadhurst. It is perfectly true that the number of square yards of roadway that can be laid per ton of asphalt will depend upon the percentage of bitumen that the asphalt contains; but this has no regard whatever for the quality of the bitumen or the quality of the pavement laid with it. If consideration is given to quality rather than quantity an entirely different point of view is opened up.

In the case of Trinidad lake asphalt the bitumen of which is combined naturally with impalpably fine mineral matter, portions of which are in colloidal state, its purchase under the method recommended by Mr. Broadhurst would be virtually prohibited, although the superiority of the material for paving purposes might be conceded. The service given by this material has indeed proved that the increased price per unit of bitumen is more than overcome by its longevity. The fact that Trinidad contains mineral matter carried in a form which cannot be supplied artificially by the mere addition of fine dust and that recent investigations have shown that this mineral matter plays a most important part in the life of an asphalt surface mixture—this advantage becomes a reason for barring out instead of for preferring this bitumen. In addition to the peculiar quality of the mineral matter of Trinidad lake asphalt, it possesses adhesive and cohesive properties which so far as known are not found as permanent or unchangeable characteristics of other asphalts. Nevertheless, these qualities are entirely neglected when the purchase of asphalt is undertaken purely on the basis of the lowest price that can be obtained per unit of bitumen. Indeed it is hard to see how the question of quality enters into the transaction if the method described by Mr. Broadhurst is literally followed.

The writer is well aware that the method recommended by Mr. Broadhurst is not new and that it has been adopted here and there, mainly by municipal plants, but it has seemed worth while to point out that while the matter of quality is mentioned as one of the requirements of the specifications, in fact and in practice there is no consideration of quality when the price per unit of bitumen is the controlling factor.

So great is the disparity between the price of the lake asphalts and the oil residuals that it is not perhaps of vital importance to point out some minor discrepancies in Mr. Broadhurst's figures; but this may be done in the interests of absolute accuracy. It is stated that the price bid per ton of Bermudez asphalt is $24.80, but Mr. Broadhurst does not consider that this material will be fluxed and that the price of asphalt cement produced will be much less than $24.80. Assuming the cost of flux at 5½ cts. per gallon and 28 lbs. of this to every 100 lbs. of Bermudez, the cost of the asphalt cement would be $22.20 per ton; and figuring that this contains 96 per cent bitumen the cost of bitumen would be $23.13 per ton. Trinidad refined asphalt at $18 per ton would be equivalent to $32.73 per ton of bitumen. When, however, the refined asphalt is fluxed with 53 lbs. of heavy flux to the hundred the cost of the asphalt cement would be reduced to $16.41 per ton and the unit cost of bitumen to $23.80.

The more important consideration, however, that the writer wishes to emphasize is that by the purchase of asphalt on a bitumen basis, a very low price may be obtained per ton of bitumen, but the purchaser may be, nevertheless, getting a very bad bargain since he is entirely ignoring the question of the quality of the bitumen he buys.

Very truly yours,
D. T. Pierce,
Executive Assistant, Barber Asphalt Co.
Philadelphia, Pa., February 5, 1915.

Engineering and Contracting

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Wire Rope.—Firm in Great Britain wishes to purchase in lots of 10 coils at a time, wire rope. The rope should be ¾-in. in circumference; bore galvanized flexible steel wire rope, made of crucible steel wire 90 tons per square inch breaking strain, 6 spans of 12 (or 11) wires, with hemp core to each, and hemp main heart. It should be in coils in 100 fathoms each, price to be quoted per 600 fathoms and not per hundredweight. The gage of the wire should be 27 (0.016). Samples should be submitted. No. 15570. [For address see first paragraph.]

Electric Mountain Railway.—Firm in Norway is asking bids for construction of an electric mountain railway. Plans and specifications will be on file at the Bureau of Foreign and Domestic Commerce and its branch office. No. 15571. [For address see first paragraph.]

Railway Cars.—Tenders will be received until July 29, 1915, for supplying 159 "goods wagons" for the Siamese State railways, Broad Gage. Copies of the specifications and drawings may be seen at the Bureau of Foreign and Domestic Commerce or its branch offices, or may be purchased from the Siamese Legation at Washington.

Sheet Steel for Tanks, Etc.—Business man in Central America wishes to correspond with makers of sheet steel for tanks, piping and fittings. No. 15598. [For address see first paragraph.]

Mechanical Appliances and Supplies.—A firm in England wishes to take up agencies for American products. It is especially interested in mechanical appliances and supplies, such as engines and parts, weighing bridges for railroads, railway rolling stock, etc. It desires to secure exclusive agencies. No. 15556. [For address see first paragraph.]

Motors.—European firm wishes to import electrical goods, especially electric motors for driving motors. Correspondence, catalogs, etc., should be in Spanish. No. 15582. [For address see first paragraph.]

Iron and Steel Products.—Firm in Far East desires to receive catalogues, prices, freight rates, shipping weights, etc., on all kinds of hardware, iron and steel products, etc. No. 15585. [For address see first paragraph.]

Iron Girders.—Egyptian agent of business firm in United Kingdom has called for quotations on iron girders. Specifications, etc., may be had on application to the Bureau of Foreign and Domestic Commerce or its branch offices. No. 15587. [For address see first paragraph.]

Cement.—An American consular officer in the Far East reports an opportunity to sell 36,000,000 lbs. of cement for delivery during March and April, 1915. A detailed report covering this inquiry may be had on application to the Bureau of Foreign and Domestic Commerce or its branch offices. Negotiations should be conducted by wire. No. 15592. [For address see first paragrpah.]

Wire and Steel Products.—A general commission agent in Europe wishes to import glassware, wire, and steel products. Catalogues and correspondence should be in Spanish. No. 15593. [For address see first paragraph.]

INDUSTRIAL NOTES

The Lake View Sand & Gravel Co., of Lake View, Iowa, has purchased a 1½-yd. cableway excavator as well as a complete washing, screening and crushing plant, from the H. Channon Co., Chicago. This plant will be in operation about the middle of April.

The Broderick & Bascom Rope Co., of St. Louis, New York and Seattle, manufacturers of the Yellow Strand powersteel wire rope, adopted a highly helpful plan of factory operation during the recent general business depression, due to the European war. The company decided it was best to employ all its force, day and night shifts, even if only part time—rather than to work one-half of the force full time. Last spring the St. Louis plant was running full force at least 85 per cent of its full time. Later in the year it was operated three-fourths time, but kept the entire day and night force. Finally, during part of October and all of November, it ran one-half time—still keeping all the men employed. During December, that the men might have some extra money for Christmas, the company operated the entire St. Louis plant full time, day and night—even though that meant piling up large stocks of wire rope. This resulted in no little expense, for increasing one's stock several million pounds is no small matter. Now, with improving conditions, the matter of employment, time, etc., is working itself out naturally.

NEW CATALOGUES

Centrifugal Pumps.—Paper, 7¾x10 ins.; 8 pp. Van Wie Pump Co., Syracuse, N. Y.

Bulletin No. 300, describing Van Wie gasoline driven water and dredge centrifugal pumps. Several types are shown and described in detail with data as to sizes, capacities, weights, etc.

Comptometer.—Paper, 6x9 ins.; 26 pp. Felt & Tarrant Mfg. Co., Chicago.

Explains the operation of the comptometer and its application to engineering calculations. Gives examples of its value in drafting room, architects' office, in making estimates, figuring costs, etc. Illustrated.

Dump Wagons.—Paper, 9x12 ins.; 4 pp. Champion Wagon Co., Inc., 100 Railroad Ave., Owego, N. Y.

Pamphlet calling attention to the advantages of the Champion dump wagon, its light weight, spreading device, short wheel base, easy loading height, etc. Illustrated.

Sheet Metal Products.—Paper, 6x9 ins.; 184 pp. The Berger Mfg. Co., Canton, Ohio.

General Catalogue No. 10, complete illustrated and descriptive catalogue and price list of the numerous sheet metal products of the company containing also considerable data on pipes, roofing, sheet metal weights and thickness, etc.

Steel Forms.—Paper, 6x9 ins.; 18 pp. Blaw Steel Construction Co., Pittsburgh, Pa.

Bulletin No. 65, describing Blawforms for concrete sidewalk, curb, curb and gutter, road and similar construction. Illustrated with views of actual installations. Points out the advantages of steel forms and the special features of Blaw steel forms.

Cement Gun.—Paper, 9x12 ins.; 2 pamphlets, 4 and 8 pp. Cement-Gun Co., 30 Church St., New York City.

Bulletin No. 60, reprint of article on experimental levee work on the Mississippi, and Bulletin No. 90, reprint of an article on the work of the cement gun in construction of a government hospital in Ontario. Both are well illustrated and give interesting details of the method of construction with the cement gun.

Structural Steel, Sheet Metal Products and Machinery.—Paper, 3½x6½ ins.; 48 pp. Minneapolis Steel and Machinery Co., Minneapolis, Minn.

"What We Do," a booklet containing an illustrated outline of the works of the above company. Just a suggestion with typical views of the structural steel, steel bridges, sheet metal products, machinery products, oil tractors, ornamental iron work, etc., handled by them.

CATALOGUE REVIEWS

Water Wheels.—Paper, 6x9 ins.; 64 pp. The Pelton Water Wheel Co., San Francisco, Cal.

The Pelton water wheel as displayed in Bulletin No. 8, entitled "The Pelton System of Power," shows the great adaptability of water wheels to the driving of every type of machinery. The bulletin contains a great deal of hydraulic information which the company claims has not been previously published.

Pelton wheels particularly adapted to driving mining, sawmill, industrial and other machinery, are described in detail, and numerous illustrations show various typical installations.

Pages 37 to 40 inclusive are devoted to tabulated data pertaining to the speed, power and water discharge of type "C" motors and standard single nozzle Pelton wheels. The following pages contain data required for estimates; weir measurement table with example of use; data on water wheel governors, and hydraulic pipe lines; pipe friction tables, working heads and weights, etc.

Cast Iron Pipe.—Cloth, 8½x10¾ ins.; 222 pp. United States Cast Iron Pipe & Foundry Co., Burlington, N. J.

The new general catalogue of the United State Cast Iron Pipe and Foundry Co. has been prepared with a view to giving general information of value to users of cast iron pipe as well as to illustrate the specific products of the company. The tables cover full lines of pipe and fittings with accompanying specifications which have been adopted in the United States as the manufacturers' standards, and represent those most commonly used. Notes are included regarding the history and importance of cast iron pipe, the forms of joints, recent developments in high pressure piping, and other data of interest to those using pipe. Some tables have been added which will be helpful in determining pipe sizes and capacities.

The book is of unusual general interest, is well compiled and handsomely illustrated. Beginning with a brief history of water pipe from the baked clay of the ancients to the Catskill and Wachusett aqueducts, it then takes up cast iron pipe, describing types of joints, high pressure systems, submerged pipe, gas pipe, and other uses such as culverts, drains, etc. Then follows a comparison with concrete, wood, etc., with table of costs, protection of mains, and jointing materials.

The greater part of the book is taken up by the tables mentioned. These include in addition to standard bell and spigot pipe and fittings made to the American Water Works Specifications, a corresponding line of flanged fittings together with a summary of the new American Standards for flanges. Complete specifications and standards of the American Gas Institute for both bell and spigot and flanged pipe and specials are also included. A few pages at the end are devoted to description and views of the various plants of the company.

Hoisting Equipment.—Paper, 9¼x12¼ ins.; 68 pp. The John F. Byers Machine Co., Ravenna, Ohio.

A new Byers Catalogue, No. 21, has recently been issued, which comprises a very complete illustrated list of Byers' equipment.

The first few pages are given over to a general description giving the main points of construction of Byers' hoisting engines, arranged alphabetically and briefly detailed. Pages 7 to 63 show engravings of various Byers' machines in actual service, with revised and up-to-date tables of weights and dimensions.

Pages 58 to 63 describe and illustrate Byers' excavators and derrick cars. Capacities and dimensions are given for these also.

On page 64 statistics on wire rope and the rope capacities of the various sizes of Byers' drums. The following pages consist of a brief outline of Byers' builders' material, elevators and a list of repair parts.

CURRENT NEWS

The Doings of the Week.

The past week has been a very satisfactory one as regards developments affecting construction operations. Basic trade conditions continued to show improvement. The railroad outlook was improved by the decision of the Interstate Commerce Commission in the transcontinental rate case. Exports so far this month show further heavy gains over imports. Cotton shipments continue to be large, those for the week ending Feb. 6 amounting to 483,000 bales, the largest weekly export on record with one exception. In the four weeks ending Feb. 11, cotton shipments from Atlantic ports totaled 1,361,000 bales, as compared with 715,000 bales in 1914. New financing for the week amounted to $179,000,000, making the grand total since the first of the year $345,000,000. There was an excellent demand for municipal bonds, and many new issues are to be placed on the market shortly. Railroad buying was lighter than in the previous week, rail orders for only about 44,000 tons being placed. Inquiries are pending for about 55,000 tons. In the construction field the volume of new work reaching the call for bids stage was the greatest of any week so far this year. Municipal undertakings in particular made an excellent showing, there being an unusually large number of these projects advertised. Many of these are small but in the aggregate they represent a large amount of construction business. They are widely scattered, this indicating that all sections of the country are feeling the return of better times. Further improvement was developed in the iron and steel trade. Mill operations of the Steel Corporation are now on the basis of 60 per cent capacity, while some of the independent companies are running at 75 per cent capacity. The U. S. Steel Corporation reported an increase of 411,928 tons in unfilled orders in January. Structural material orders were lighter than usual. Orders for about 20,000 tons of this material were placed in New York and vicinity, 3,500 tons at Cleveland, and 1,700 tons at Columbus. The Rapid Transit Commission of Boston, Mass., is asking bids on 1,700 tons of reinforcing bars. The *Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Feb. 10 were as follows:

Finished Iron and Steel.	Feb. 10.	Feb. 3.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.20	1.20
Iron bars, Pittsburgh	1.10	1.10
Iron bars, Chicago	1.02½	1.00
Steel bars, Pittsburgh	1.10	1.10
Steel bars, New York	1.26	1.26
Tank plates, Pittsburgh	1.10	1.10
Tank plates, New York	1.26	1.26
Beams, etc., Pittsburgh	1.10	1.10
Beams, etc., New York	1.26	1.26
Skelp, grooved steel, P'gh	1.10	1.10
Skelp, sheared steel, P'gh	1.15	1.15
Steel hoops, Pittsburgh	1.20	1.20
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No 28, P'gh	3.00	3.00
Wire nails, Pittsburgh	1.55	1.55
Cut nails, Pittsburgh	1.50	1.50
Fence wire, base, P'gh	1.35	1.35
Barb wire, galv., P'gh	1.95	1.95

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railroads.—No developments of particular importance in the railroad field have taken place during the past week. There is a pretty general belief among railroad contractors that something will happen about March 1 and from thence on there will be quite a bit of activity. The Boston & Montana Development Co. is reported to have financed its proposed 109-mile railroad for the Big Hole County in Montana, and it is believed that the contractors MacArthur Bros. Co. will start work in April. This is a $3,500,000 proposition.

Roads and Streets.—In both the highway and municipal paving fields a considerable amount of work made its appearance last week. The Illinois Highway Commission is taking bids on its first letting of the year. This covers 7 contracts—five for concrete roads, one brick road and one gravel road. Milwaukee County, Wisconsin, is advertising two road jobs, one calling for 26,580 sq. yds. concrete paving, and the other for 62,224 sq. yds. of concrete. The County Supervisors at Stockton, Cal., are calling for bids on 16 miles of road work, and the County Commissioners at Davenport, Wash., open proposals March 2 on 12½ miles of road. New York State will ask bids in a few days on a considerable amount of work, and the California Commission also will soon advertise a good sized letting. In the way of municipal work, Geneva, N. Y., is calling for bids on a $94,000 paving job; Painesville, O., on 17,428 sq. yds. brick pavement; Flint, Mich., for an asphalt plant. The contracts let include a $200,000 job to the Consolidated Engineering Co., Baltimore, Md., for a second section of the Key Highway; a California State Highway contract to Whitlock & Gorrill, San Francisco; and a $101,000 state rural road job in Minnesota.

Bridges.—A large amount of bridge construction is being advertised for bids. One of the larger undertakings calls for a reinforced concrete structure at Broad St., Philadelphia, estimated to cost $300,000. Bids are also being asked on a 3-span reinforced concrete bridge to be erected over the Blackstone River at Central Falls, R. I.; a $40,000 bridge at Pine St., Lima, O.; a $20,000 steel bridge at Renton, Wash.; a $25,000 steel bridge at La Conner, Wash., and a 270-ft. reinforced concrete bridge at Nelson, Neb. The contract for the second Narrows bridge at Vancouver, B. C., has been let to C. A. P. Turner, Minneapolis, Minn., and the Western Foundation Co., at $1,744,831. The Dominion Bridge Co., Montreal, Que., was awarded the contract at $298,555 for the Rosedale Section of the Bloor St. viaduct at Toronto, Ont.

Drainage and Irrigation.—No particularly large undertakings in either the drainage or irrigation fields appear to have been advertised during the past week. Bids are being asked on a 250,000-cu. yd. job in Matagorda County, Texas.; a 133,000-cu. yd. contract near Westover, La., is being advertised; and the County Commissioners at North Yakima, Wash., open proposals Feb. 26 on 543,000 cu. yds. of excavation for an open ditch and 6 miles of pipe drains. I. C. Sherwood, Terrell, Tex., has been awarded the contract for a $476,000 reservoir in Ward County, Texas; Reynolds-Ely Construction Co., Springfield, Utah, at $82,625, was low bidder for 8 miles of the highline canal of the Strawberry Valley Reclamation Project.

Waterworks and Sewerage.—A considerable amount of work in both the waterworks and sewereage fields is being advertised for bids. Many of the smaller municipalities began asking proposals on new work or extensions. Kensington, Md., opens bids Feb. 20 on sewerage and waterworks; Lyons, N. Y., is asking proposals until March 3 on waterworks and a sewer system; Dallas, Tex., is calling for bids on three units of its sewage disposal plant; Magnolia Park, Tex., will receive bids until Feb. 23 for waterworks; Schoolcraft, Mich., is calling for proposals for waterworks; Columbia, S. C., is asking bids for an $85,000 extension to its sewer system.

Railway Construction.

At the beginning of 1914 railroad contractors were not particularly optimistic regarding the outlook for work in their particular line. They hoped for the best, but they realized also that under the then existing conditions prospects were not good for the undertaking of much construction. This year the feeling is different. The favorable decision in the Eastern rate case and the success of the roads in disposing of their securities have brought about a marked change of belief. Nearly everyone interested in railroad construction now believe that a considerable amount of betterments, extensions and new line will be placed under contract this season. There is more than optimism behind this belief. Some of the larger contractors have received definite assurance that certain pieces of work will be started shortly. One of the biggest labor agents in the country, a man who ships out thousands of laborers yearly, already has closed contracts with two railroads that will keep him busy all the season. There are rumors aplenty of what will be done, but there are also certain definite facts that it make it practically certain that this spring will see the opening up of some real old-fashioned activity in the railway construction field.

Time for Opening Bids.

A rather interesting question came up at a recent road letting. The official advertisement stated that bids would be received until 3 p. m. At the designated hour six bids were in the hands of the official in charge. Two minutes later another contractor submitted his proposal. The bids were opened and it was found that the late bidder had offered to do the work at a price about $100 less than the figures of any of his competitors. The supervisors awarded the contract to the next lowest bidder on the ground that the low bid was submitted after the specified time. It was then claimed that the clock in the room of the official in charge of the letting might be wrong. A telephone inquiry was made to the office of the Western Union Telegraph Co. and it was found that the clock was 4 minutes fast as compared with the Western Union clock. If the latter time was to be accepted the contractor had submitted his bid two minutes before the closing hour. The supervisors decided, however, that their clock was official time as far as they were concerned and refused to change their decision regarding the award of the work. Last minute bidders might draw a useful moral from the episode.

Resumption of Building Construction.

An encouraging sign of better times is the number of large buildings that are to be erected this spring. Reports from various cities indicate that there will be an unusual number of office buildings, hotels and other large structures placed under contract this season. In Chicago alone announcement has been made since the first of the year that work would be started soon on five buildings in the loop district, the aggregate cost of which will be in the neighborhood of $4,000,000. Building operations, especially the erection of large office structures, are the first construction works to feel the pinch of a tight money market. A general resumption of work in this line is an excellent indication that there is plenty of capital available for investment purposes.

Highway Legislation.

Two favorite objects of attack by state legistures are the railways and road construction. Everyone believes he can build highways and every statesman has certain definite ideas as to how they should be built. As a result, each session of the legislature sees the introduction of many bills for improving the roads of the state. No matter how satisfactorily this work has been carried out on their part, there is always some one to suggest a change. It is unfortunate that much of this proposed highway legislation is destructive rather than constructive.

HIGHWAY CONSTRUCTION IN IOWA.

Details of Work to Be Done This Year in 36 Counties.

Mostly Earth and Gravel Road Construction.

Highway construction in Iowa at the present time is confined mostly to the building of earth roads. In some localities a considerable mileage of gravel surfaced road is being constructed, but very little of the more expensive types of road construction is being undertaken. A considerable part of the earth and gravel roads construction is carried out by the day labor plan. In some counties practically all of the work is done by this method. The county is a unit for highway improvements in Iowa and all work is in direct charge of the County Board of Supervisors. The county engineer has direct supervision of all road and bridge work. Iowa at the present time appears to offer a better field for the dealer in road machinery than it does for the road contractor. In the way of bridge and culvert construction a great deal of work is being undertaken by the various counties and this offers many opportunities to contractors. In Table 1 is given a summary of the highway work contemplated for the present year by 36 Iowa counties. Further details regarding these improvements follow:

Black Hawk County has $35,000 available for road construction during the present season. Its program has not been decided upon as yet, but most likely will include several miles of earth and gravel road. Some of the work probably will be done by contract. Nathan B. Barber, Waterloo, Ia., is County Engineer.

Buchanan County proposes to construct 50 miles of earth road and 5 miles of gravel road during the present season. Part of the work will be done by contracts and these will be let in March. R. W. Gearhart, Independence, Ia., is County Engineer.

Butler County has $30,000 available for road construction and proposes to build 15 to 20 miles of earth roads and 8 to 10 miles of gravel road. No contracts will be let. Frank E. Cane, Clarksville, Ia., is County Engineer.

Cerro Gordo County proposes to construct 20 miles of earth road and 3 miles of gravel road during the present season. The county has $25,000 available for construction purposes. The work probably will be done by contract. R. E. Robertson, Mason City, Ia., is County Engineer.

Chickasaw County's construction program for the present year includes about 30 miles of earth road and 10 miles of gravel road. The sum of $23,000 is available. Part of the work will be done by contract. A. F. Kemman, New Hampton, Ia., is County Engineer.

Clarke County has about $44,000 available for construction purposes in 1915 and will do considerable preparatory work on its earth roads. This will be carried out by day labor. The improvements for this county are at present mostly bridge and culvert work. J. L. Hyland, Osceola, Ia., is County Engineer.

Clay County proposes the construction of earth roads this season. Surveys for these have not yet been completed. The improvements will be done by day labor. The sum of $29,000 is available for construction purposes. Walter Barber, Spencer, Ia., is County Engineer.

Clayton County will not undertake much new work during the present season. The county will keep up its present patrol system of maintenance and repair work and will not attempt permanent construction until more funds are available. It is possible that bonds for bridge and culvert work may be issued but nothing definite regarding this has been decided. About $27,203 is available for road construction and maintenance in 1915; and $6,162 is available for bridges. E. B. Tourtellot, Elkader, Ia., is County Engineer.

Crawford County has $48,000 available in its road fund and $6,000 in its bridge fund. It will construct 15 miles of permanent grade for earth roads. The work will be done by contract and the letting will be held in the next two months. H. B. Fishel, Denison, Ia., is County Engineer.

Davis County proposes to bring about 100 miles of earth road to standard 36-ft. section during the present season. The work will be done by county forces. The sum of $22,000 is available for construction. H. O. Wray, Bloomfield, Ia., is County Engineer.

Dickinson County has $29,000 available for road purposes and proposes to construct 40 miles of earth road and 8 miles of gravel road. The work will be done by contract; date of letting has not been set. C. S. Arthur, Spirit Lake, Ia., is County Engineer.

Dubuque County proposes to construct 20 miles of gravel road this year. This is a portion of the Hawkeye highway (U. S. Post Road), for which the U. S. Government bears one-third of the cost and the county the remainder. The county has $90,000 available for its work. The work will be done by contract; date of letting not yet decided. W. B. Gurley, Dubuque, Ia., is County Road Engineer.

Fayette County has not yet decided upon its program for the present year. It will have $55,000 available for construction purposes. G. A. Blunt, West Union, Ia., is County Engineer.

Floyd County will undertake 30 miles of tractor work with county machinery during the present season. G. H. Elliott, Charles City, Ia., is County Engineer.

Franklin County will construct 30 to 40 miles of earth road in 1915, the work being done by day labor. About $52,000 is available for construction. A. G. Baker, Hampton, Ia., is County Engineer.

Greene County has about $20,000 available for construction purposes. It will build 10 miles of earth road, the average yardage of which will be about 4,500 cu. yds. per mile. It also will construct about 10 miles of gravel road. The work will be done by contract, the lettings for the grading being held about March 1. E. W. Thomsen, Grand Junction, Ia., is County Engineer.

Grundy County has $30,000 available for construction purposes this year. It will build by day labor about 40 miles of earth road. E. A. Crary, Grundy Center, Ia., is County Engineer.

Guthrie County has $70,000 available for construction. No contracts will be let. P. E. Wylie, Guthrie Center, Ia., is County Engineer.

Hardin County will construct 20 miles of earth road. The work will be done by contract, and the letting will be held about March 1. The county has $20,000 available for construction purposes. S. B. Gardner, Eldora, Ia., is County Engineer.

Henry County has $10,000 available for construction purposes and will build 5 miles of earth road requiring about 25,000 cu. yds. of grading. The work will be done by contract, the letting to be held about April 1. C. E. Smith, Mt. Pleasant, Ia., is County Engineer.

Humboldt County has not yet completed its plans for its road work for this season. It is probable that some earth roads and gravel surfacing will be constructed. The work probably will be done by contract. About $30,000 is available for construction purposes. H. N. Legreid, Humboldt, Ia., is County Engineer.

Ida County has $19,000 available for construction purposes and will improve about 60 miles of earth road. No contracts will be let. C. A. Woodworth, Ida Grove, Ia., is County Engineer.

Iowa County will construct 6 miles of earth road. It has $30,000 available for construction purposes. The work in part will be done by contract, and the letting will be held about April 1. Byron Goldthwaite, Marengo, Ia., is County Engineer.

Jefferson County has about $60,000 available for construction. About 1½ to 2 miles of earth road will be built. There also will be some hill cutting undertaken, and two 80-ft. steel bridges will be constructed. Contracts for the bridges will be let in February or March; for the earth work contracts probably will be let in May. A. F. Fischer, Fairfield, Ia., is County Engineer.

Keokuk, Ia., has $36,000 available for road construction and $43,000 for bridges. It will grade 6 miles of earth road. The work will be done by contract, the lettings to be held in March or April. R. H. Seymour, Sigourney, Ia., is County Engineer.

Lyon County proposes to construct 45 miles of earth road. It has not yet been determined whether the work will be done by contract. The county has $26,000 available. W. C. Wyckoff, Rock Rapids, Ia., is County Engineer.

Madison County has $19,000 available for road construction and repair. The mileage of earth roads to be constructed has not been determined. No contracts will be let. E. B. Hiatt, Winterset, Ia., is County Engineer.

Mahaska County will construct 8 miles of earth road. It has not been determined whether the work will be done by contract. The amount available is $27,000. A. E. Rommel, Oskaloosa, Ia., is County Engineer.

Mills County will grade 6 to 19 miles of earth road this year. The work probably will be done by day labor. About $10,000 is available. F. M. Jackson, Glenwood, Ia., is County Engineer.

TABLE I.—ROAD WORK FOR 1915 IN 36 IOWA COUNTIES.

County.	—Type of road. Earth, miles.	 Gravel, miles.
Black Hawk	?	?
Buchanan	50	5
Butler	15¹	8²
Cerro Gordo	20	3
Chickasaw	30	10
Clark	?	...
Clay	?	
Crawford	15³	...
Davis	100⁴	...
Dickinson	40	8
Dubuque	...	20
Fayette	?	?
Floyd	30⁵	...
Franklin	30⁶	?
Greene	10⁷	10
Grundy	40	...
Guthrie	?	?
Hardin	20	...
Henry	5⁸	...
Humboldt	...	?
Ida	60	...
Iowa	6	
Jefferson	2	...
Keokuk	6	...
Lyon	45	...
Madison	?	
Mahaska	8	...
Mills	12	...
O'Brien	100	
Page	?	
Palo Alto	20	...
Pocahontas	?	?
Pottawattamie	205⁹	?
Story	20	10
Woodbury	...¹⁰	...
Worth	75¹¹	10¹²

[1] 15 to 20 miles. [2] 8 to 10 miles. [3] Permanent grade. [4] Standard 36-ft. section. [5] Tractor work. [6] 30 to 40 miles. [7] Average yardage about 1,500 cu. yds. [8] Requires moving of about 25,000 cu. yds. [9] Wagon, shovel and wheeler, 5 miles; crowning to standard section, 200 miles. [10] Widening roads to standard width. [11] 75 or 80 miles. [12] 10 or 15 miles.

O'Brien County will grade 100 miles of earth roads this year. The work will be done by day labor. The county has $25,000 available for roads and $46,000 for bridges and culverts. J. C. Kerrigan, Primghar, Ia., is County Engineer.

Page County will probably do considerable bridbe and culvert work the present season. The amount of this has not yet been determined. The road work probably will be rather light, consisting mainly of blade grader work and fills at culverts. Some of the work will be done by contract; the remainder by day labor. The sum of $16,000 is available. I. H. Taggart, Clarinda, Ia., is County Engineer.

Palo Alto County has $25,000 available for highway purposes and will construct 20 miles of earth road. Part of the work will be done contract and part by day labor. Time for awarding contracts has not been fixed. T. R. Martin, Emmetsburg, Ia., is County Engineer.

Pocahontas County has $50,000 available for construction purposes and will construct a considerable mileage of earth road and a few miles of gravel road. The work will be done by day labor. A. L. Thornton, Pocahontas, Ia., is County Engineer.

Pottawattamie County proposes to construct about 5 miles of earth roads and to crown to standard section about 200 miles. The 5 miles will be wagon, shovel and wheeler work. In addition 1½ to 2 miles of concrete road will be constructed by the state and county. Part of the work will be done by contract. The first contracts were to be let Feb. 6 and the balance probably in March. The county has $40,000 available for construction of county roads, and $70,000 for bridges. H. M. Howard, Council Bluffs, Ia., is County Engineer.

Story County proposes to construct 20 miles of earth road and 10 miles of gravel road. The work will be done by contract, the letting to be held about March 15. The county has $60,000 available for roads and $45,000 for bridges. Sam Steigerwalt, Nevada, Ia., is County Engineer.

Van Buren County does not contemplate any permanent road construction this year. It will, however, undertake some culvert and bridge construction. No contracts will be let. The county has $30,000 available for its work. Geo. H. Craig, Keosauqua, Ia., is County Engineer.

Woodbury County has $42,647 available for this season. It will widen its earth roads to standard width and uniform section. This work will be done by day labor. B. L. Taylor, Sioux City, Ia., is County Engineer.

Worth County proposes to construct 75 or 80 miles of earth road and 10 or 15 miles of gravel road. No contracts will be let. About $30,000 is available. F. R. Lyford, Northwood, Ia., is County Engineer.

SEWER CONSTRUCTION AT MILWAUKEE, WIS.

Bids Asked on First Contracts of $10,000,000 System of Intercepting Sewers.

Brick and Concrete and Terra Cotta Pipe Sewers.

The city of Milwaukee, Wis., is about to begin construction work on its new system of intercepting sewers. This improvement involves the building of about 35 miles of sewer and a disposal plant, and will require an expenditure of approximately $10,000,000. Bids are now being asked on the first two contracts. The bids are asked upon two separate types of circular sewers: one having a concrete base and brick arches; the other being of concrete throughout. This latter type may be used for all circular sewers over 30 ins. in diameter. Proposals also are asked upon two separate types in tunnel: egg shaped and circular. The contracts now advertised are Nos. 9 and 10.

Number 9 embraces the construction of an intercepting sewer and branches on the east side of the Milwaukee River from a point below the dam to the intersection of Broadway and Detroit Sts. The approximate quantities include the following:

Combined section, all concrete, in open cut, 36-in. and 51-in., lin ft.	[illegible]
Combined section, all concrete, in tunnel, 36-in. and 51-in., lin ft.	[illegible]
Sewer with concrete invert and brick arch, in open cut, 36-in., lin. ft.	4,427.5
Sewer with concrete invert and brick arch, in tunnel, 36-in., lin. ft.	1,116
Sewer with concrete invert and brick arch, in open cut, 30-in., lin. ft.	1,892
Sewer with concrete invert and brick arch, in tunnel, 30-in., lin. ft.	1,863
Terra cotta pipe sewer in concrete, 10-in. to 24-in., lin. ft.	3,841
Manholes, lin. ft.	1,762
Special pile foundation, lin. ft.	27,050
Steel reinforcement, lbs.	60,000
Plank foundations, ft. B. M.	50,076

Alternate bids on the above quantities for Contract 9 will be taken on 4,427.5 ft. 30-in. all concrete sewer in open cut, and 3,009.82 ft. 44-in. by 66-in. brick and concrete sewer in tunnel.

Contract No. 10 embraces the construction of an intercepting sewer and branches on the west side of the Milwaukee river from the Holton St. viaduct to the intersection of West Water and Fowler Sts. The approximate quantities include:

Brick and concrete invert sewer, 48-in., lin. ft.	2,023
Brick arch and concrete invert sewer, 42-in., lin. ft.	2,667
Brick arch and concrete invert sewer, 36-in., lin. ft.	2,719
Brick arch and concrete invert sewer, 30-in., lin. ft.	1,071
Terra cotta pipe sewer in concrete, 10-in. to 18-in., lin. ft.	2,340
Special pile foundation, lin. ft.	19,820
Steel reinforcement, lbs.	[illegible]
Plank foundations, ft. B. M.	[illegible]

All the above sewer is in open cut. Alternate bids will be taken on an all concrete sewer for the 48-in., 42-in. and 36-in. sizes.

Each contract is to be completed in 250 working days. The liquidated damages for not completing the work within the time agreed upon, will be for each day's delay, an amount equal to ½ per cent of the aggregate cost of the work embraced in the contract. Each proposal must be accompanied by a cash deposit or a certified check on a Milwaukee bank of $38,500 for Contract No. 9 and $25,000 for Contract No. 10. The surety required is 25 per cent of the amount of the contract. Payments will be made monthly on basis of 75 per cent of the whole amount due under the chief engineer's approximate estimate for the preceding month.

The specifications provide that not more than 450 ft. of trench shall be opened at any one time in advance of the completed sewer, except with special permission of the chief engineer. The ground is to be excavated in open trenches when the depth of flow line of completed sewer is 25 ft. or less. Where more than this depth, tunneling will be permitted when approved by the chief engineer. The contractor will be required (except when permission is otherwise granted by the chief engineer) to close sheath or shore the trenches and sides of all excavations with good substantial timber or steel sheathing.

All concrete used upon the work is to be proportioned approximately as follows: 1 cement, 2½ sand and 5 parts crushed stone or gravel (of which 50 per cent is to be crushed). The brick work will be composed of whole, sound, clear ringing bricks of uniform size, free from cracks and of true and even face. Clay or shale bricks when placed in oven for 24 hours and subjected to temperature of 200° F. and then immersed in water at 70° F. for 24 hours must not absorb more than 12 per cent of their weight of water. Wet process concrete brick, when subjected to the above test must not absorb more than 8 per cent of their weight of water. The work will be in charge of the Sewerage Commission of Milwaukee, of which G. H. Benzenberg is chairman and T. Chalkley Hatton is chief engineer. Bids on Contracts 9 and 10 will be received until 2 p. m., Feb. 24.

$6,000,000 OF PUBLIC WORK CONTRACTS.

Improvements To Be Let This Spring by Philadelphia.

Bridges—Sewers—Water Mains—Grade Crossing Elimination.

Extensive public improvements will be started this spring by the city of Philadelphia, Pa. Work estimated to cost $6,000,000 has already been decided upon, and a few of the contracts have been let, while bids on others will be opened this month or early in March.

The Bureau of Highways, of which W. L. Connell is chief, has already awarded contracts aggregating $600,000 for street and country road repairs, and on Feb. 15 opened bids for the construction of the Parkway to its full width from Logan Sq. to 22nd St. For this work the sum of $800,000 is available.

The Bureau of Water opened bids on Feb. 9 for improvements to the water supply of West Philadelphia, the work calling for larger mains to cost about $150,000, and for the construction of a sedimentation basin at the Torresdale filters. This latter improvement will cost about $400,000 and will require about 600,000 cu. yds. of earth excavation. Bids will be opened in the near future on improvements to the water supply of South Philadelphia that will call for an expenditure of $500,000.

The Bureau of Surveys has awarded a contract for an extension of the Gunner's Run sewer in Indiana Ave., under the bids received early this month, and also has ordered work started on $150,000 worth of branch sewers, bids for which were received recently.

Bids will be opened on Feb. 25 for the construction of a reinforced concrete bridge and approaches to carry Broad St. over the joint four track railroad. This is a portion of the South Philadelphia track elevation. This bridge will be 350 ft. wide with a 105 ft. span and will cost about $300,000. It is expected also that bids will be opened next month for grade crossing elimination in various sections of the city that will cost over $1,000,000. This work will include the opening of Tulip and Emerald Sts., under the Richmond Branch Ry., which will cost the city about $500,000; the abolition of all grade crossings on the Chestnut Hill branch railway north from Chelton Ave., the cost to the city being about $350,000, and the abolition of all grade crossings in Lehigh Ave. between Richmond St. and Aramingo Ave., representing an expenditure for the city of about $150,000.

In preparation for the construction of the central loop of this proposed $40,000,000 subway system, contracts will be let soon for the relocation and rebuilding of sewers in the central part of the city. The sum of $500,000 is available for these improvements.

Preliminary details are well advanced for the extensive construction program contemplated for the South Philadelphia section, and the work will be placed under contract in the near future. The working plans for the general revision of the street system have been practically completed for the entire area of about 5,000 acres. Plans for revised lines and street grades covering 1,000 acres have been finished. Specifications for the removal of building preliminary to the construction of the freight yards at Federal and Reed Sts. have been completed. Specifications also are under way for the relocation of tracks in Delaware Ave. and for the construction of sewers and water mains, preparatory to the permanent paving of the avenue. The belt line around the southern section of the city, likewise, is an improvement of no small size that will come up soon. Surveys for the right of way for this line have been made and steps are being taken to acquire the necessary property. Plans are being worked out for the viaduct from Point Breeze Ave. to Magazine Lane. A considerable amount of work is contemplated in connection with water front developments. An expenditure of $800,000 is to be made for completion of municipal piers and for the construction of a new pier at McKean St. A summary of some of the large undertakings that will be placed under contract soon is as follows:

Broad street bridge	$300,000
South Philadelphia water supply improvements	500,000
Opening of Tulip and Emerald streets under Richmond Branch Ry.	500,000
Reconstruction and relocation of sewers in central section of city	500,000
Abolition of grade crossings on Chestnut Hill Branch Ry. from Chelton avenue north	350,000
Grade crossing abolition in Lehigh avenue	150,000
Completion of municipal piers and construction of new piers at McKean street	800,000

Minnesota Surveyors and Engineers Society.—The annual meeting of the Minnesota Surveyors and Engineers Society will be held in St. Paul, Minn., February 19-20, headquarters at the Ryan Hotel. An excellent program has been arranged including a number of good papers and banquet at the close.

The Engineers' Club of Memphis at their annual meeting held at Memphis, Tenn., elected the following officers: J. H. Weatherford, president; E. H. Bowser, vice-president; C. C. Pashby, secretary-treasurer; directors: H. S. Gladfelter, John McCleary, F. G. Proutt, C. K. Chapin, H. N. Pharr, W. M. Gardner.

Large Buildings to Be Erected at Chicago.

The building field, especially as regards the construction of large structures, has been for several months in a rather unsatisfactory condition. Parties proposing the erection of large buildings found it extremely difficult to finance their propositions. A decided change for the better has taken place since the first of the year. The improved condition of the money market has made available large sums for building purposes, and as a result prospects are excellent for much activity in this line of work.

In Chicago the improvement has been marked. In the downtown district alone since Jan. 1 plans have been announced for five big buildings. These include a $2,000,000 building to be erected for the W. W. Kimball Co., at the southwest corner of Wabash Ave. and Jackson Blvd.; a $700,000 building to be erected for Buck & Rayner at the southwest corner of State and Adams Sts.; a $350,000 building to be erected at the northwest corner of Randolph and Dearborn Sts., for E. Elger Bros.; a $250,000 building for the B. P. O. Elks to be erected at 174 W. Washington St.; and a $750,000 building to be erected at Wabash Ave. and Jackson Blvd. for Lyon & Healy. The contract for the last mentioned structure has been let to Wells Bros. Co., Chicago. It is planned to commence active construction on all of these structures early in the spring. In addition to the above, a contract was let three weeks ago for a $600,000 warehouse, to be erected along the right of way of the Chicago Junction Ry., between W. 15th St. and W. 15th Pl. The Stone & Webster Co., 383 S. Dearborn St., Chicago, Ill., and Boston, Mass., has the contract.

Present Status of State Highway Construction in California.

State highway construction in California will offer opportunities to contractors for some years to come. The system now being built under the $18,000,000 bond issue will comprise about 3,000 miles of road. On Jan. 15, 1915, over 1,000 miles of this had been completed or was under contract. The greater portion of the work is being done by contracts, 121 of these having been let up to Jan. 15. In addition there were 19 day labor jobs.

Surveys have been made for 2,150 miles of highway, and layouts have been made for 1,101 miles. Some 382 miles of road have been completed and accepted, and over 250 miles of the work had been completed but not yet accepted. These figures relate to the condition on Jan. 15. Details of the work completed or under contract, for that date are as follows:

	Miles.
Graded only	270.1
Waterbound macadam	12.9
Oil macadam	19.1
Cement concrete (thin bituminous top)	664.3
Macadam (asphaltic top)	16.5
Cement concrete (asphaltic top)	20.9
Bituminous concrete	0.3
Timber and concrete trestle	4.4
Total	1,008

The construction in 1914 was as follows:

Pavement laid (minimum thickness is 4 ins.):	Miles.
Portland cement concrete, 12 ft. wide	6
Portland cement concrete, 15 ft. wide	208
Portland cement concrete, 18 ft. wide	43
Portland cement concrete, 20 ft. wide	8
Portland cement concrete, 24 ft. wide	5
Macadam, waterbound	1
Macadam, oilbound	3
Graded roads	142
Surfacing:	
Thin bituminous	85
Asphalt	21

The cement purchased up to Jan. 1, 1915, by the commission for use in road construction amounts to 895,643 bbls., the purchases by year being as follows: 1912, 132,955 bbls.; 1913, 190,622 bbls.; 1914, 572,066 bbls. The highway system is being constructed under the direction of the California Highway Commission, of which Austin B. Fletcher, Sacramento, is highway engineer.

Canadian Government Public Works Estimates for 1915.

The Canadian Government probably will start few new public work undertakings of importance during the present year. It will, however, undoubtedly provide funds for continuing the more important improvements already started. The main estimates for the coming fiscal year are now before parliament. They provide for a total appropriation of $190,329,352, a decrease of $17,789,320 as compared with the amount last year. Supplemental estimates, however, are yet to be included, so that it is likely that the appropriations for this year will at least equal those for 1914. The chief items of expenditure on public works and railways and canals in the main estimates, as submitted to the House of Commons, include the following:

Intercolonial Railway	$8,128,250
Prince Edward Island Railway	1,938,925
Hudson Bay Railway	5,000,000
National Transcontinental Railway	5,000,000
Quebec bridge	3,500,000
Welland ship canal	5,500,000
Other canals	1,821,500
Harbor works under way	9,459,000

The last item provides for the continuance of the work already underway at Esquimalt, Halifax, Port Arthur, Quebec, St. John, Toronto, Victoria, Vancouver and other harbors.

Canal Excavation and Lining With Concrete.

The U. S. Reclamation Service will open bids next week for excavating a new lateral canal in the Strawberry Valley Project, Utah, and for lining the canal with concrete. The work is located near Payson City, Utah, on the San Pedro, Los Angeles & Salt Lake R. R. and the Tintic branch of the Denver & Rio Grande R. R. It involves about 49,000 cu. yds. of canal excavation and 3,670 cu. yds. of reinforced concrete and provides for the construction of about 9 miles of canal. The estimated quantities include the following:

Excavation, class 1, cu. yds.	40,625
Excavation, class 2, cu. yds.	7,225
Excavation, class 3, cu. yds.	305
Rolled embankment, cu. yds.	6,429
Concrete in structures, cu. yds.	310
2½-in. concrete canal lining, sq. ft.	436,000

A portion of the concrete lined section will have a 4 ft. bottom, the remainer will have a 3 ft. bottom. The section will have side slopes of 1 on 1. The concrete lining will be reinforced with woven wire reinforcement and will have a smooth, steel trowel finish. The cement and reinforcing steel will be furnished by the Government.

Bids for the work will be received at the office of the U. S. Reclamation Service, Provo, Utah, until 2 p. m., Feb. 24.

First Illinois State Highway Letting of 1915.

Bids are now being asked on the first Illinois state highway contracts to be advertised this year. Seven contracts are included in this letting, the total estimated cost of the work being about $120,943. This does not include the cost of the cement, which will be furnished by the state. Details of the work are given in Table I.

TABLE I.

County.	Sec.	Route.	Type.	Length, ft.	Estimated cost, exclusive of cement furnished by state.
Cook	G	3	Concrete	12,957	$34,471
Madison	A	1+11	Brick	9,000	33,367
Winnebago.	B	11	Concrete	6,200	18,583
Winnebago.	A	10	Concrete	5,280	15,563
Whiteside	B	1	Concrete	4,400	8,816
Whiteside	C	1	Concrete	2,000	4,152
Alexander	A	1	Gravel	5,100	*5,992

*No materials to be furnished by the state.

Bids for the work will be received by the State Highway Commission, Wm. W. Marr, Chief State Highway Engineer, Springfield, Ill., until 11 a. m., Feb. 23.

NEWS LETTERS

St. Louis Items.

M. L. Windham at Johnston City, Ill., will be able to use a few 5 to 8-team outfits between now and March 15.

A bill to fix the curb lines of streets in East St. Louis was passed by the East St. Louis City Council last week. This allows the city of St. Louis to draw specifications for the piers of the east side approach of the free bridge, a matter which was delayed because the ordinance granted by the East St. Louis City Council for the approach provided that the piers of the bridge should be built at the curb line, and the curb line of East St. Louis had never been fixed by ordinance. This was discovered by St. Louis officials when they started to draw specifications for the piers of East St. Louis approach. The East St. Louis city officials requested in return for amending the ordinance that St. Louis should concede that all roads using the free bridge should maintain an adequate passenger station and stop all trains in East St. Louis for passengers. The St. Louis officials agreed to the request.

C. F. Nagel was in from La Grange, Mo., getting more supplies and equipment for his new Government revetment work on the Mississippi River near that point.

The Board of Local Improvements of the city of Alton, Ill., has ready for public hearing, plans and specifications for 5½ miles of street paving with combination concrete curb and gutter in District No. 2, in which the Western Military Academy and Shurtleff College are located. Pavements will have a 4-inch concrete base and Alton brick will probably be used. There has just been completed a sanitary sewer system in this paving district, 18½ miles in length.

Sam Lazarus of St. Louis, president of the Quanah, Acme & Pacific Railroad, has held a conference with members of the State Railroad Commission of Texas in regard to certain matters connected with the plans for extending the line from Roaring Springs, its present western terminus, to the Texas-New Mexico line, a distance of about 150 miles. While the Railroad Commission has authority only over the Texas part of the property, it is proposed by Mr. Lazarus and associates to build the road into Roswell, N. Mex., and later on to extend it to El Paso. It is understood that the route across the western part of the state will be through the town of Lubbock, where connection will be made with the lines of the Santa Fe system. The territory that is to be traversed is settling up with farmers rapidly.

L. J. Smith of the L. J. Smith Construction Co., of Kansas City, was with us a couple of days last week. Nothing new, but something coming up shortly.

That the Missouri, Kansas & Texas intends to develop and utilize extensive deep-water facilities at the mouth of the Brazos River, with Velasco and Freeport as its ocean-traffic ports, is indicated by the extensive improvements which it is preparing to make with that end in view. Besides the joint railroad and wagon bridge which is being built across the Brazos River at Austin, Tex., and by which means Freeport and its extensive sulphur mining industry will be given a direct transportation outlet, the announcement is made that the entire line of the Houston & Brazos Valley Railroad, which is owned by the Missouri, Kansas & Texas, will be rebuilt. The grade will be raised, the track relaid and well ballasted, and an extension constructed from Freeport to Bryan Mound, 3 miles. Betterments will also be made to the road's port terminals, it is stated.

G. B. O'Reilly has prepared a bill to be introduced in the Missouri General Assembly requiring sub-contractors who desire to avail themselves of the present lien law to file notice on the owners of property on which the lien is to apply 30 days after the purchase of material by the original contractor, stating material is unpaid for. O'Reilly said the subcontractor now has four months to file such notice. Sometimes the original contractor obtains payment for the entire work from the property owner before the four months is up, and if the contractor has failed to pay for any of the material used in the building, the owner sometimes has to foot the bill, O'Reilly said. He said the bill meets with the approval of all the agents with whom he has discussed it.

M. C. Bartels of St. Louis was awarded the contract for building the new St. Louis County Producers Company's commission house, to be erected at Sarah St. and Laclede Ave. here. Contracts price $22,585. The building will be completed by May 1. Numerous steel sheds will afford shelter for the farmers' wagons while they are selling their wares.

James K. Cochran and the Ozark Valley Railroad Company filed an application with the State Public Service Commission on Feb. 1, asking authority to issue $200,000 of stock and $150,000 of notes to purchase the Williamsville, Greenville & St. Louis Railroad Company in Wayne County for $300,000.

Concrete was adopted at last week's session of the St. Clair County, Illinois, Board of Supervisors for the construction of the first hard road under the state aid fund. This action was taken regardless of the fact that the special committee appointed had recommended the use of brick. The state highway experts are expected to begin shortly to make the final survey of the road, which begins near French Village and runs easterly towards O'Fallon.

A. Webb, formerly general manager of the Missouri, Kansas & Texas Railroad, was promoted to vice-president last week. W. E. Williams, formerly general superintendent, was appointed general manager with headquarters at Parsons, Kan.

A special election will be held at Staunton, Ill., this week to vote upon a proposition to adopt the one highway commissioner system in Staunton Township. The plan has been agitated at mass meetings, and is fathered by members of the Good Roads Association. Workers for the change claim better roads at a lower cost will result with a single commissioner. Staunton last month voted on a proposition to issue bonds to improve the water works system, but the plan was defeated.

Col. C. McD. Townsend, U. S. Engineer, St. Louis, Mo., is asking for bids for 10,000 lin. ft. of river bank protection, to include material and work. Bids will be opened on March 10 at 11 a. m.

The Kaw Valley Drainage Board, corner Pyle and Osage Aves., Kansas City, Kan., will receive sealed proposals in duplicate until 10 a. m., Feb. 26, 1915, for approximately 1,000,000 cu. yds. of drainage ditch work. T. E. Myers is president and P. J. Broll is secretary of this board.

D. C. Stephens passed through St. Louis the other day on the way to his big drainage job in Cape Girardeau County, Mo. Stephens will start work as soon as the weather permits, which he expects will be within a week or ten days. A. B. Koenig.

PERSONALS

Mr. Blaine S. Smith has been appointed general sales manager of the Uniiversal Portland Cement Co., succeeding Mr. Benjamin F. Affleck, who has been elected president of the company.

Mr. H. H. Lindemuth of York, Pa., has resigned as president of the York Engineering Co., which position he has held since the incorporation of that company. Mr. Lindemuth will again engage in business in York, having incorporated the Lindemuth Engineering Co., of which he is manager. The firm will specialize in the installation of steam and electrical power plants, heating and ventilating and refrigerating systems, sprinkler systems and piping equipments.

Mr. B. F. Beckman has been made engineer for the Fort Smith & Western Railroad and of the St. Louis, El Reno and Western Railway, with headquarters at Fort Smith, Ark. Mr. Beckman entered the service of the Chicago, Burlington & Quincy in 1898 as assistant engineer, and two years later was made roadmaster for that company. In 1905 he became engineer of maintenance of way for the Fort Smith & Western, and in 1907 was made superintendent for that road.

Mr. Clifton Brannon has been made division engineer for the Chicago & Eastern Illinois Railroad with headquarters at Evansville, Ind. Mr. Brannon is a graduate of the Rose Polytechnic Institute in civil engineering, class of 1904. For two years following graduation he was assistant engineer at Vandalia on the engineering corps of the Evansville & Terre Haute, afterwards consolidated with the Chicago & Eastern Indiana. Since 1906 he has been assistant engineer at Evansville or Chicago.

Mr. H. J. Goodale has been chosen as superintendent of public works of Attleboro, Mass., and will have full charge of all water works, sewers, highways, sidewalks, drains, etc., subject only to the mayor. Mr. Goodale has been in engineering work for twenty years. For five years of this time he was with the Boston & Maine Railroad. For fifteen years he has been employed in municipal work. For the past eight years he has been first assistant to the engineer of public works at Pittsfield, Mass.

Mr. R. M. Briner, junior engineer with the supervising engineers' office, northern division, United States Reclamation Service, has been advanced to the position of assistant engineer in the service with headquarters at Great Falls, Mont. Mr. Briner obtained his civil engineering education at the Pennsylvania State College, leaving in 1911 to enter the Reclamation Service. His first work in the supervising engineer's office was that of drafting, indexing, cement inspection, etc. In 1912 he was office engineer on contract work on the Hunter project, and during the latter part of that year was engaged in field and office work in connection with the building of an earth fill dam at Two Medicine Lake, on the Blackfeet project. Since that time he has been in the supervising engineers' office at Great Falls, being made junior engineer in April, 1913.

Mr. H. C. McRae has resigned as division engineer for the Baltimore Sewerage Commission to accept a position as district engineer with the International Joint Commission, at Detroit, where he will have charge of special investigations involving studies of the problem and cost of collecting, transporting and treating the sewage of Detroit and near-by cities. The object of this work is to relieve the pollution of the Detroit and St. Clair rivers, and it is under the direction of Prof. Earle B. Phelps, consulting engineer to the commission. Mr. McRae has been connected with the Baltimore Sewerage Commission since 1907, when he entered that service as a cement tester. The following year he was chemist at the sewage testing station, and in 1909 was an assistant engineer. From 1909 to 1911 he was an assistant division engineer, and since that time has been division engineer in charge of the disposal plant at Back River. He was in entire charge of the disposal division, the work of which involved expenditures of approximately $2,500,000. He also had charge of the operation of the Baltimore treatment works as well as construction. Between twenty-five and thirty million gallons are being treated at present.

Mr. E. B. Van de Greyn has opened an office as consulting and constructing engineer at 725 Chronicle building, Houston, Texas. Mr. Van de Greyn was for a time consulting engineer for the Board of Public Works of Denver, Colo., and later, city engineer and member of Board of Public Works of the city and county of Denver. His connection with Denver was severed in June, 1913, when a change in the form of government occurred. For three years he was with the firm of Waddell & Hedrick, later Waddell & Harrington, consulting engineers of Kansas City. For five years he conducted a general engineering business near Kansas City. Mr. Van de Greyn graduated from the University of Illinois in municipal and sanitary engineering, and has had a varied career. He was for a time in the contracting business in Chicago. Among other enterprises with which he has been connected in his private practice were: the reclamation of about 3,500 acres of overflow marsh land in Texas, some important extensometer tests on a new patent reinforcing for concrete, superintendence of work for a large contracting firm in Denver and numerous other projects. In his new office he will handle general civil engineering work, paying special attention to municipal and sanitary work, drainage and bridges.

CONTRACTORS.

The E. R. Harding Co., 400-410 Robinson Bldg., Racine, Wis., the contracting firm which was recently awarded several large sewer construction contracts in that city, totaling about $259,000, is one of the oldest firms in the middle west handling this class of work, and has been engaged on similar projects in many of the larger cities in the region of Lake Michigan. Mr. E. R. Harding, the president and general manager, has been in sewer, paving and general municipal contracting business for the past 25 years, and has done work of this kind in numerous towns and cities of Wisconsin, Illinois and northern Michigan. Mr. E. R. Waggoner, the secretary-treasurer, has been with the company for several years past. During the past 22 years the company has been instrumental in the building up of a number of such thriving communities as Fond du Lac, Oshkosh, Beloit, Janesville, Rockford, Peoria and many others. The following list of sewer contracts have all been carried out by the company since 1908: Canton, Ill., $75,000; Pekin, Ill., $120,000; Danville, Ill., $65,000 and $85,000; Fond du Lac, Wis., $75,000, including disposal plant; Highland Park, Ill., $45,000; East Moline, Ill., $100,000; Stoughton, Wis., $75,000; Rockford, Ill., $100,000. These in addition to numerous smaller contracts of various kinds of municipal work. The present Racine contracts are as follows: The Twenty-first St. brick trunk sewer, $89,000; Twelfth St. sewer, $75,000, and the Augusta St. sewer, $95,000.

OBITUARIES

Charles H. Ladd, construction engineer for the Stone & Webster Engineering Corporation, died at El Paso, Tex., Jan. 29. He had been engaged on work at Fort Worth for the company and had recently removed to El Paso.

John Everill, a noted road builder of Salt Lake City, died at his home in that city, Feb. 2, aged 69. He had been in the road contracting business for many years, and many of the good roads in the vicinity of Salt Lake and the streets of that city were of his construction.

Frank Olin Marvin, advisory dean and founder of the School of Engineering at the University of Kansas, died in San Diego, Cal., Feb. 7, aged 62. Dean Marvin had been in ill health for several years and went to California last December in an effort to recover. He had been connected with the Kansas State University since 1875, when he went there as assistant in mathematics and physics. He became professor of engineering in 1883, and was dean of the school of engineering since 1891. Dean Marvin was also a member of the Kansas State Board of Health, the Kansas Academy of Science, the Kansas Water, Gas and Electric Light Association, the Kansas Engineering Society, the American Society of Civil Engineers, the American Society for Testing Materials, and a member and in 1901 president of the Society for the Promotion of Engineering Education. He was a frequent contributor to the technical press and to the proceedings of the various technical societies.

RAILWAYS

PROSPECTIVE WORK.

Alabama:

Gadsden, Ala.—Preliminary surveys will be started in about 30 days for proposed interurban from Gadsden to Center, Ala., 30 miles. R. L. Totten, Birmingham, Ala., is engineer.

Arizona:

Clifton, Ariz.—Arizona & New Mexico Ry. proposes 3½-mile spur from Lordsburg to 85 Mine.

Arkansas:

Crossett, Ark.—Arkansas, Louisiana & Gulf R. R., contemplates extending its line to Pine Bluff, Ark., but does not anticipate commencing work in the immediate future.

California:

Glendale, Cal.—Glendale & Montrose Ry. (electric) has applied to State Railroad Commission for permission to increase its capital stock from $25,000 to $250,000. J. Frank Walters, 508 Grant Bldg., Los Angeles, is President.

Illinois:

Murphysboro, Ill.—Murphysboro & Southern Ry. proposes extension of its electric railway from Murphysboro to Carbondale, 8 miles. Work will include 131,000 cu. yds. earth excavation and embankment, 12,800 lin. ft. of trestle, 937 cu. yds. masonry, one 175-ft. span single track bridge and a 60-ft. plate girder span. Date of letting contracts is uncertain; probably will be 3 months or more. Edward Flad & Co., St. Louis, Mo., is engineer.

Taylorville, Ill.—Chicago & Illinois Midland Ry., H. M. Hallock, General Superintendent, Taylorville, is reported to have secured right of way for spur to connect with Wabash R. R.

Chicago, Ill.—Chicago & Northern Interurban Ry. Co. has applied for certificate of convenience for constructing line from city limits to Wheeling, Ill., 12 miles. Jordan E. Van Natta, Chicago, is attorney for company.

Kentucky:

Irvine, Ky.—Illinois Central R. R. has made surveys for double track from 3 miles north of Irvine to Princeton.

New Jersey:

Camden, N. J.—Philadelphia & Reading Ry. will construct new terminal and ferry house at Kaighn's Point, Camden.

New York:

Geneva, N. Y.—Geneva & Auburn Ry. contemplates double tracking on Exchange St., from Seneca to Lewis St.

Pennsylvania:

Philadelphia, Pa.—Philadelphia & Reading Ry. has plans under way for extension of track elevation on Richmond branch to permit of opening of Tulip and Emerald Sts.

South Dakota:

Rapid City, S. Dak.—Chicago, Milwaukee & St. Paul Ry. is reported to have completed plans for extension of its South Dakota line from Rapid City, via Sundance to Sheridan, Wyo. It is stated that contracts will be let as soon as money market loosens up.

Texas:

San Benito, Tex.—San Benito & Rio Grande Valley Ry. is reported to contemplate extension up the valley to coal fields of Zapata County and possibly to Laredo.

Dallas, Tex.—Southwestern Traction Co., Dallas, is considering constructing line between Cleburne and Ballinger.

Utah:

Ogden, Utah.—Ogden, Logan & Idaho Ry. (electric) has started construction on its Brigham City-Wellsville link.

Salt Lake City, Utah.—Union Pacific R. R. may let contracts soon for double tracking on Castle Rock Hill. Company is reported to plan expenditure of about $1,500,000 for work this spring and summer between Ogden and Evanston.

Wisconsin:

Elkhorn, Wis.—Milwaukee Electric Ry & Light Co., Milwaukee, is reported contemplating line from Elkhorn to Delavan.

BIDS OPENED; CONTRACTS LET

California:

Fresno, Cal.—Chadwick & Sykes, Inc., San Francisco, have contract for 3-mile extension of Chowchilla-Pacific R. R. to new town of Robertson.

Kansas:

Bonner Springs, Kan.—Kansas City, Kaw Valley & Western Interurban Co. has let contracts for grading for its extension from Bonner Springs to Laurence, and work is said to have been started last week.

Montana:

Butte, Mont.—Boston & Montana Development Co. is reported to have financed its projected Southern Montana Ry. and it is said that construction will be started in April. MacArthur Bros. Co., New York and Chicago, has the contract. The line will be about 109 miles long, will extend from Divide through the Big Hole country to Jackson, and will cost about $3,500,000.

North Carolina:

Shelby, N. C.—W. T. Clement, Greensboro, an official of Broad River Lumber Co., and J. H. Hawley, Rockingham, N. C., have entered into contract to build a 21-mile standard-gage railroad from Shelby to Casar.

Utah:

Ogden, Utah.—Utah Construction Co., Ogden, has been awarded contract for 600 ft. tunnel near Ashton on Yellowstone line of Oregon Short Line R. R.

Washington:

Spokane, Wash.—Dixon & Oliver, 10th Ave., city, have the contract for drilling and blasting for grade separation here. Parker, Moran & Parker, 1010 E. Sprague St., city, have taken the contract for removing all rock and other material from cut.

ROADS STREETS

BIDS ASKED.

California:

Stockton, Cal.—Until March 2, by County Supervisors, for improving about 8 miles of upper Sacramento River Road and about 8 miles of Stockton Mokelumne Road. F. E. Quail, County Surveyor.

San Bernardino, Cal.—Until Feb. 23, according to reports, by County Supervisors, for furnishing 30,000 bbls. crude oil or road oil.

Illinois:

Springfield, Ill.—Until 3 p. m., Feb. 23 (change of date), by State Highway Department, Wm. W. Marr, Chief State Highway Engineer, for furnishing 235,500 bbls. cement for State Aid road construction. Advertisement in this issue.

Springfield, Ill.—Until 11 a. m., Feb. 23, by State Highway Commission, Wm. W. Marr, Chief State Highway Engineer, for 7 state highway contracts, as follows: Cook County, 12,957 ft. concrete; Madison County, 9,000 ft. brick; Winnebago County, 6,200 ft. concrete, 5,280 ft. concrete; Whiteside County, 4,400 ft. concrete, 2,000 ft. concrete; Alexander County, 5,100 ft. gravel. Advertisement in this issue.

Indiana:

Decatur, Ind.—Until 10 a. m., March 2, by T. H. Daltzell, County Auditor, for six macadam roads.

Monticello, Ind.—Until 10 a. m., March 2, by A. G. Fisher, County Auditor, for road in West Point Township.

Princeton, Ind.—Until 11 a. m., March 2, by W. T. Roberts, County Auditor, for stone roads in Jackson and Columbia Townships.

Bloomfield, Ind.—Until 2 p. m., March 2, by Geo. E. Kibb, County Auditor, for six macadam roads.

Petersburg, Ind.—Until 2 p. m., March 2, by J. P. Gray, County Auditor, for road.

Spencer, Ind.—Until 2 p. m., March 2, by County Auditor, for gravel road in Jefferson Township.

Peru, Ind.—Until noon, March 8, by Frank K. McElheny, County Auditor, for gravel roads in Butler, Jefferson and Washington Townships.

Wabash, Ind.—Until 1:30 p. m., March 3, by Dan Showalter, County Auditor, for three roads in Noble Township and one in Waltz Township.

Washington, Ind.—Until 2 p. m., March 2, by L. S. Cove, County Auditor, for pike road in Elmore Township.

Kokomo, Ind.—Until 10 a. m., March 2, by E. B. Swift, County Auditor, for five gravel and stone roads.

Sullivan, Ind.—Until noon, March 2, by W. S. Bicknell, County Auditor, for gravel roads in Turman, Haddon & Gill Townships.

Corydon, Ind.—Until 2 p. m., March 2, by J. L. O'Bannon, County Auditor, for gravel or macadam road.

Kentland, Ind.—Until 2 p. m., March 1, by S. R. Sizelove, County Auditor, for macadam road in Jackson Township.

Fowler, Ind.—Until 1 p. m., March 1, by Warren Mankey, County Auditor, for gravel in Grant Township and stone road in Bolliver Township.

Portland, Ind.—Until 10 a. m., March 1, by County Auditor, for two gravel and two crushed stone roads.

Valparaiso, Ind.—Until 2 p. m., March 1, by C. A. Blackly, County Auditor, for gravel road.

Mt. Vernon, Ind.—Until 2 p. m., March 1, by J. R. Hawes, County Auditor, for gravel roads in Robb, Harmony and Mars Townships.

Greencastle, Ind.—Until 2 p. m., March 1, by C. L. Airhart, County Auditor, for macadam roads in Cloverdale, Greencastle and Washington Townships.

Paoli, Ind.—Until 2 p. m., March 1, by E. A. Palmer, County Auditor, for gravel road in French Lick Township.

Indianapolis, Ind.—Until 10 a. m., Feb. 24, by Board of Public Works, for grading and paving on Rural St. and Caven St.

Shelbyville, Ind.—Until 11 a. m., March 2, by F. W. Fagel, County Auditor, for roads in Shelby and Washington Townships.

Columbus, Ind.—Until 10 a. m., March 8, by W. H. Scott, County Auditor, for crushed stone roads in Haw Creek and Clifty Townships.

Crawfordsville, Ind.—Until 11 a. m., March 2, by B. B. Engle, County Auditor, for road in Brown Township.

Rockville, Ind.—Until 10 a. m., March 2, by Chas. Davis, County Auditor, for gravel road in Liberty Township.

Michigan:

Dundee, Mich.—Until Feb. 23, by Village Trustees, for paving Monroe St. George Champe, Toledo, Ohio, is engineer.

Flint, Mich.—Until Feb. 23, by City for asphalt plant. Ezra C. Shoecraft, City Engineer.

Minnesota:

St. Paul, Minn.—Until 10 a. m., Feb. 22, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Arcade St.

Mississippi:

Clarksdale, Miss.—Until March 3, by county and city, for graveling Fourth St. and other streets to an extent of about three miles. The county will gravel from the end of Fourth St. to Lyons and Big Creek, about 3½ miles; road 24 ft. wide, gravel 16 ft.; $6,000 per mile estimate. G. R. Shidler, Engineer, Clarksdale.

Missouri:

Weston, Mo.—Until noon, Feb. 20, by City Clerk, for 10,000 sq. yds. bituminous macadam paving (penetration method), 1,300 ft. curb and gutter, etc. Chas. E. McCrae, Engineer, Kansas City, Mo.

Montana:

Townsend, Mont.—Until March 1, by Board of County Commissioners, Wm. G. Ragen, Clerk, for grading and ditching county roads; 11 different contracts.

Nebraska:

Omaha, Nebr.—Until 9 a. m., March 2, by City Clerk, for paving and curbing with asphalt, stone asphaltic concrete, creosoted block, etc., portions of eight streets.

Omaha, Nebr.—Until 9 a. m., Feb. 23, by Thomas J. Flynn, City Clerk, for construction

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

Volume XLIII. CHICAGO, ILL., FEBRUARY 24, 1915. Number 8.

Desirability of Independent Audits of Municipal Costs.

Whenever a municipality undertakes to construct or operate plants there usually comes criticism of the economy with which construction or operation is conducted. The criticism is commonly directed by those who are personally biased, and it is answered by those who are personally interested in the outcome. Obviously the full truth is seldom brought out under such conditions.

We have particularly in mind the recent controversy over the municipally operated cement plant that furnished cement for the Los Angeles aqueduct. Cement manufacturers have claimed that not only was the municipal cement of poor quality but that, if proper charges were made for plant depreciation and interest, the cement would be found to have cost the city fully $2.50 a barrel, exclusive of freight. Reply is made by city representatives (Board of Public Works) that in four years 891,648 barrels were manufactured at a cost of $1.89 per barrel, including 10 cts. per barrel for depreciation.

The cost accountant of the Los Angeles Department of Public Service states that when the mill is running at *full capacity* the operating cost has been as low as $1.10 per bbl. exclusive of a depreciation charge. Presumably he includes an interest charge in the "operating cost."

The main point of dispute appears to be the depreciation item, but it may well be added that the "load factor" is quite as important a factor. Doubtless there are other elements upon which there would be disagreements even among cement manufacturing experts and cost analysis engineers. To an outsider it is clear that the municipality, in every such case as this, is entitled to at least one full, detailed report from a disinterested consulting engineer, one who had first weighed all the evidence presented by both sides and had then carefully studied the problem himself.

Such a report was recently made by a commission headed by Mr. Lyman E. Cooley, on the rates that should be charged for hydroelectric energy generated by the Chicago Sanitary District. The report met with severe criticism from Chicago politicians and daily newspapers, because an increase in street lighting rates would result. This rabid criticism is itself sufficient evidence of the need of such a disinterested report. We are glad to note that the Western Society of Engineers has issued a strong, public protest against the criticism of the report merely because the findings did not please some of the public.

Reverting to Los Angeles aqueduct matters, it has been charged that the full cost of the aqueduct will prove far in excess of what the public had been led to expect, and that the estimated costs of developing and distributing hydroelectric power are much too low. Yet, so far as we know, the city has not had a report on the subject made by engineers not interested in the outcome of the report. Certainly the engineers of the aqueduct would welcome such a report from a fair-minded, competent engineering investigator. The public is assuredly entitled to have the results of such a report placed before it.

Some years ago ENGINEERING AND CONTRACTING began the advocacy of a permanent bureau or commission in each large city, the function of such a bureau being that of the critical stockholder in a company. A bureau of that sort should not be affiliated with any other department of the municipality, for it should be free to make "destructive criticism" where necessary, although its main object should be "constructive criticism." Incidentally it may be mentioned that "destructive criticism" often proves most constructive through its exposure of an incompetency that can be remedied.

Where a city does not favor a permanent bureau of this sort, it should at least require a periodic engineering audit of the construction and operating costs of all its important works. To be not only effective but convincing, such an engineering audit should be made by independent consulting engineers of high standing and known fairness.

Because state public service commissions can perform some of the functions of such an independent engineering auditor, we favor the control of public utility company accounting and rate making by a state commission. Such a state commission is more apt to be free from the local politics and petty self interests that have just been made so conspicuous in the Chicago street light case.

In these matters, as in many others, engineers can well lead a public demand for means to secure the full truth.

The Most Effective Means of Raising the Salaries of Engineers.

A chemist in the employ of a large manufacturing establishment was complaining about the small salaries paid by the company to its chemists. Asked for a reason as to this condition he gave an unexpected reply: "American chemists," said he, "can not look for much higher salaries until many chemists become business managers. It takes a chemist to appreciate the worth of a chemist."

Is there not in this last sentence a generalization of great breadth? Does it not, in fact, largely explain why the salaries of all classes of technical men are low in proportion to what such men accomplish? If so, the road to better salaries in general is not restriction in the number of technical graduates but recognition of their economic worth—a recognition that depends largely upon employers who are themselves technically trained.

In electrical industries in America and in chemical industries in Germany there are numerous examples of the rise of technical men to important managerial positions. And with this rise have come better salaries for technical men possessed of ability.

In civil engineering there has been less movement toward the good above indicated, but there has been some progress, particularly in the last decade. Civil engineers are so frequently employed by the public that progress toward better salaries will never be very rapid. It can be accelerated, however, by publicity that will impress the public with the importance of good engineering. It can be accelerated still more by the appointment or election of civil engineers to executive positions. Goethals' prominence as an executive engineer has done much to impress the public with the worth of engineers in general. Should the not improbable happen—the election of such an engineer as Goethals to the presidency of the country—a much greater effect upon public opinion as to engineering competence would follow.

Whenever engineers unite to secure the appointment of an engineer to an important political position, they are unquestionably increasing their own chances to secure better salaries. Whenever an engineer establishes himself as an executive, he is, perhaps unwittingly, doing much to promote the financial welfare of engineers in general.

Engineers Urge Appointment of an Engineer for Idaho Commission.

We are glad to note that engineers are making organized effort to secure the appointment of engineers for positions as public service commissioners. The latest instance of this activity is the action of a committee of engineers of Spokane, Wash. They have written the governor of Idaho asking him to consider the selection of an Idaho engineer to fill a vacancy on the state public service commission.

The committee of engineers that drafted the letter to the governor consisted of members of the four large national engineering societies. In matters of this sort it is wise that such joint action be taken. There is a growing feeling that, while national societies may well retain their independent organizations, local engineering associations should be composed of engineers of all the societies. This is particularly important outside the few large cities, and doubly so wherever it is desired to influence public opinion.

Newspapers state that one member of the Pennsylvania Public Service Commission may resign. Engineering clubs and societies in Pennsylvania should follow the example of the engineers of Spokane. The engineers of sister states may well join the engineers of Pennsylvania in the attempt to secure places for at least two engineers on the Pennsylvania commission of seven men.

Tunneling Speed Records Viewed from a Different Angle.

All comparisons of speed records of driving tunnel, as we have said before, give uncertainties. No one has quite decided what thing measures tunneling speed. Of two accounts of tunnel work very recently published, one is a claim of the American record based on the showing of 596 ft. monthly advance for six months, and one is a claim of the American record based on an advance of 932 ft. in one month. We have not attempted to verify these statements because we have no doubt that both are literally true. Another line of thought occurs and attracts interest, and because it is a variation from the direction taken by most discussions of tunneling records we shall follow it a little distance.

The speed of construction operations has increased. Dam building, steel erection, concreting, trenching, excavation generally are all greatly more rapid now than they were even a few years ago. These greater speeds are due very largely to increased speed and capacity of machines for construction work. Steam shovels, trench excavators, concrete mixers, conveyors, hoists, haulage systems have in many cases doubled and trebled in working speed in recent times. Acceleration of construction has followed. A book just published on masonry dam construction points out that changed methods and appliances have quadrupled speed of dam building. Does tunnel driving in rock show any such leap in achievement? It occurs to us that, broadly, it does not.

At the Sutro tunnel in 1874-8 the maximum month recorded 417 ft. driven; at Tequiquac in 1888 the corresponding record was 656 ft. At Sheep Creek in 1913-14 the monthly maximum was 661 ft., and at Rogers Pass the best record so far is 932 ft. Turning to Europe we quote the following records of average daily progress:

Arlberg, 1880-1883	13.6 ft.
Simplon, 1898-1905	13.7 ft.
[illegible]	[illegible]

These figures do not permit of fine conclusions, but at this time we are not seeking fine conclusions; they show that speed of tunneling is increasing, but that the rate of increase shows no such leaps as it has in other engineering construction. Comparatively, tunneling is far behind the general advance in speed of construction.

Except, perhaps, in mining, tunnel construction is looked upon as a last resort. A tunnel is built only after substitute structures become no longer adequate or economical for service, or where no substitute is practicable. Not long ago a writer on water power asserted that as many such powers had been developed as had economic right to be developed. We presume the same could as truly be said of tunnels. And as there are innumerable water powers awaiting their economic right to be developed, so there are innumerable tunnels waiting. Could some inventive or constructive genius jump the speed of rock tunneling to double its present rate, who would venture to set a narrow limit to tunnel construction in the next decade. The long tunnel has, through electric traction, electric lighting and efficient ventilating systems been relieved of nearly all objections except prohibitive cost and time of construction.

Hysteresis in the Professions.

The eleventh annual council of medical education of the American Medical Association. was held in Chicago last week. Dr. Horace D. Arnold, dean of the graduate school of medicine at Harvard University, in addressing the meeting, suggested the feasibility of regular examinations of finished physicians at intervals to make them keep pace with medical progress. In elaboration of this point Dr. Arnold spoke as follows:

> The aim of the council is to furnish the public with better doctors, but it is difficult to raise the standard of practitioners who have been in the work for many years, and yet they should be required from time to time to undergo examination to ascertain if they have forgotten anything they should know or whether they are keeping up with the times.
>
> When we have approached nearer the millennium perhaps physicians will be examined once in so many years to show that they are still qualified to practice.

The thought back of Dr. Arnold's remarks is the same as that so often brought to the attention of the engineer with reference to the importance of keeping in touch with engineering progress. We think it likely that employers of engineers will some day see to it that their engineers continue the reading and study of engineering books, society proceedings and technical journals even after accumulating much first-hand experience. This will doubtless come first in engineering organizations under civil service. Such organizations are not strangers to examinations and the addition of an occasional examination to determine whether the men are keeping up with the times can readily be made. In other engineering organizations those in charge can readily satisfy themselves, as to whether or not their employes are vegetating, without recourse to a written examination.

It seems that doctors and engineers are much alike. At first only the experience of others is available. With the acquiring of first hand experience, or after putting in several years at work which may or may not yield experience, the practitioner too often grows independent of the experience of others. This tendency toward lagging behind by many men in the professions is well known to the general public. The popular estimate of the value of professional services is often very adversely affected by just this thing.

Dangerous Legislation Affecting Bridge Work.

The fact that engineers and contractors have practically no representation in our state or national legislative bodies makes it desirable that they at least give attention to any proposed legislation affecting their interests. Due to the fact that little co-operative action can at present be expected on the part of our various engineering societies it behooves engineers to exercise vigorously their individual rights in legislative matters. In the past, legislation has been enacted which is detrimental to the interests of engineers and contractors simply because no opposition to such measures has been voiced by those affected. The following quotation illustrates the need of alertness on the part of designers and builders, the quoted paragraph being taken from a proposed act now before the Pennsylvania Legislature, the purpose of which is to amend a section of a law pertaining to bridge work now done under the direction of county commissioners:

> If a bridge is to be constructed or is to be entirely rebuilt the commissioners shall accept any competitive designs and specifications therefor presented which they shall expose to public inspection for at least five days immediately prior to the time set for opening the bids. They shall consider bids or proposals upon such competitive designs and specifications, but it shall not be lawful for them to make any contract based on any such design which does not comply with the general requirements of the survey profile plans and specifications which they have caused to be made or which has not been exposed to public inspection as above required. Any contract shall be unlawful which is based on any plan or specification calling for or making use of any patented process or patented design unless such design and specifications are accompanied by an offer in writing signed by the person owning or controlling the patented design or patented process or by his legal representative setting forth the terms upon which such patented design or process may be obtained or used by any successful bidder in constructing the bridge under such contract.

There is little need for comment on our part as to the intent of the proposed act except to say that it would apparently place the whole concrete bridge business in the counties of Pennsylvania in the hands of certain patentees of structures or processes entering into their construction. The effect of the passage of such an act would be so far-reaching and so detrimental to progress in bridge building, and the possibilities for harm would be so great, that engineers and contractors will do well to exert their influence against its passage. Should such an act be passed no doubt similar legislation would be sought in other states.

ROADS AND STREETS

Surveys and Construction Plans for Trunk Line Road Construction in Michigan.

(Staff Article.)

The location of 3,000 miles of trunk line highway in the state of Michigan was provided for by an act of the legislature of that state passed in 1913. The location of these roads was defined in a general way in the law by naming the cities and towns along the routes but, for the most part, the exact lines to be followed between towns had to be agreed upon by the local authorities and determined by the State Highway Commissioner after making such preliminary examinations and surveys as he deemed necessary.

The law did not compel the construction of the roads at any specified time, or even at all, but simply provided for double rewards. The rewards on trunk lines range from $500 a mile on the sand-clay road, 9. ft. wide, to $3,400 a mile on concrete, macadam or brick road built 16 ft. wide.

A restrictive clause limited the number of miles of trunk line highways that may be rewarded in any county to three miles for each surveyed township. The law further provided that bridges of more than 30 ft. clear span shall be designed and built under the supervision of the state.

PRELIMINARY SURVEYS.

During 1914 preliminary surveys were made of 1,200 miles of road to determine the best location for the trunk lines. In making these surveys the information obtained other than that which was discussed in Engineering and Contracting, Vol. XLI, pp. 387 and 488, was as follows:

(1) Character of country traversed; timber, cut-over lands—character of stumps; clearing; improved farms.

(2) Approximate location of buildings—kind.

(3) Condition of road grade, if any: (a) approximate width; (b) alignments; (c) drainage.

(4) Kind of soil on roadway (a) sand; (b) clay; (c) loam; (d) swamp.

(5) Location, condition and size of ditches, creeks and streams that must serve as outlets for water from the roadway.

(6) Condition of, location of and measure of present culverts and bridges.

(7) Photographs of all truss bridges and others that might need to be repaired or rebuilt.

(8) Bearings of roads traversed with compass.

(9) Intersections with corporate limits of cities and villages.

(10) Slope, length and height of hills where grade exceeds 5 per cent.

(11) On traveled roads, number and kind of vehicles passed so as to form some estimate of public traffic.

(12) Notes as to available road material, gravel, stone, etc.

(13) Approximate estimate of cost of grading per mile.

Prime Meridian Preliminary Survey.—A preliminary survey of 150 miles of the prime meridian through the state of Michigan was made at an average cost of $3.50 a mile. A large portion of the distance was through cut over timber land more or less covered with brush and the cost per mile exceeded the average for other preliminary surveys.

The following running notes made by L. H. Belknap, the reconnoissance engineer, shows the method of recording information:

BETWEEN JONESFIELD TOWNSHIP, SAGINAW COUNTY AND WHEELER TOWNSHIP, GRATIOT COUNTY.

Of this 5 miles of line traversed about 2½ miles are sand and the balance clay.

Passed 16 teams going to or from market, 3 buggies and one auto. Also passed 20 houses and one church.

The lands adjoining are only partly improved.

There is no doubt but that the 5 miles would become a main traveled road, giving much service to the community, were a good road constructed on this line.

ACROSS MIDLAND COUNTY.

In the 25 miles of line traversed across this country 19½ miles have a road built on the line and 5½ miles have not. And of this 19½ miles 14 miles are now a main traveled road. But from the location of improved farms the entire road would be traveled were it improved in sandy and rough places and built where there are now no roads.

Of the 25 miles there are 15 miles of sand land and 10 miles of clay adjoining the line. And of this total there are about 11 miles under some improvements, the good clay being in strips three or four miles wide.

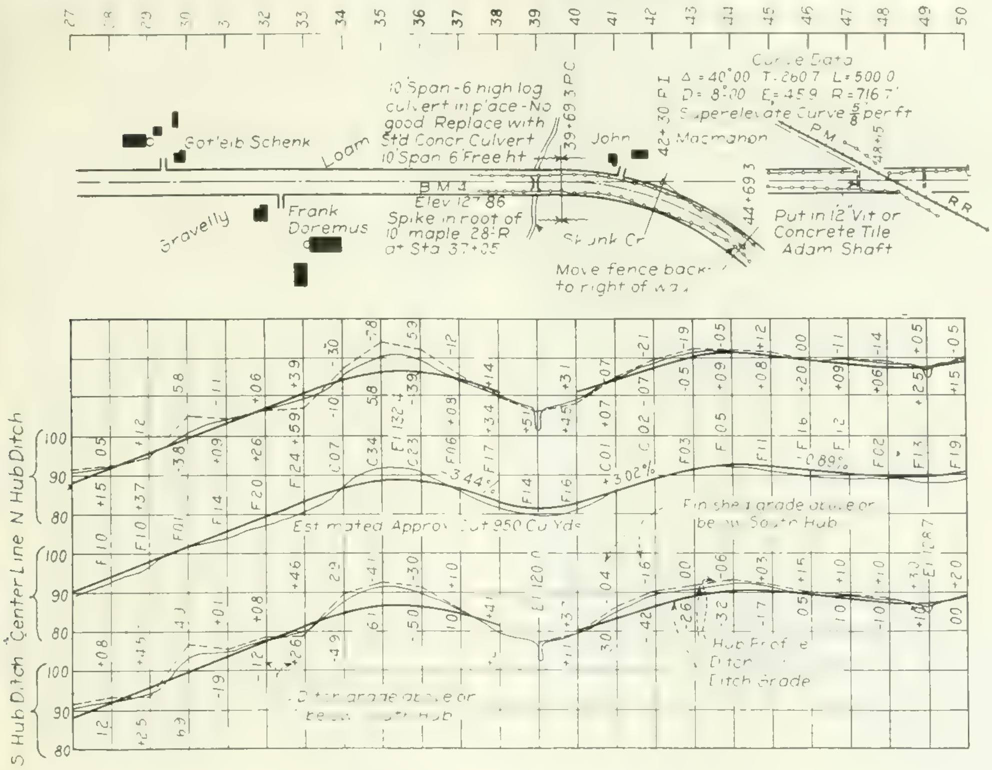
There are 54 houses, 2 schoolhouses and 1 church along the road within a distance of not to exceed 60 rods either side of the meridian.

In traversing the line, 12 farm teams were passed going to or from market and 3 autos.

There will be two new 150 to 170-foot bridges and one new 30-foot bridge to be built.

ACROSS GLADWIN COUNTY.

Of the 25 miles traversed by this line there is now a road extending only 8½ miles and the remaining 16½ miles have not been opened. There are 6½ miles of clay and 18½ miles of sand soils adjoining the line. There are 20 houses along the road. One 60-ft. bridge across Sugar River will have to be constructed. The line from a point two miles north of Winegars to the north county line of Gladwin passes through a very sandy unimproved section. To the east about two miles there are good farms. The road on the meridian north to Winegars would open up some good farming lands and would be a part of a main traveled road.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10' Span - 6 high log culvert in place - No good Replace with Std Concr Culvert 10' Span 6' Free ht
39+69.3 P.C.
42+30 P.I.
Curve Data
Δ = 40°00 T - 260.7 L = 500.0
D = 8°00 E = 45.9 R = 716.7'
Superelevate Curve 5/8 per ft
Gottleib Schenk
Loam
John Macmahon
P.M.
B.M.3
Elev 12.86
Spike in root of 10 maple 28' R at Sta 37+05
Frank Doremus
Gravelly
Skunk Cr
44+69.3
Put in 12" Vit or Concrete Tile
Adam Shaft
Move fence back to right of way
R.R.
N Hub Ditch
Center Line
S Hub Ditch
100
90
80
-3.44%
+3.02%
-0.89%
Estimated Approx Cut 950 Cu Yds
Finished grade above or below South Hub
Hub Profile
Ditch
Ditch Grade

Fig. 1. Portion of a Typical Road Plan for a Trunk Line Highway in Michigan.

On account of the hills in Ogemaw and Roscommon Counties and a bad swamp in the last mile in Gladwin County, a detour had to be made, starting at corner of Sections 9 and 16, T. 20 N., R. 1 E. On this detour there are 10 houses and the line follows a road.

BETWEEN OGEMAW AND ROSCOMMON COUNTIES AND DETOUR ACROSS PORTION OF OGEMAW COUNTY.

Of the 24 miles of line on the principal meridian there are only about 1½ miles of this line that is a road. There are no improvements of any kind except that four miles along the line are fenced off into ranches and there is one farm. The soil is sandy.

From the corner of the Counties Gladwin, Ogemaw and Roscommon to the Michigan Central Railroad in Towns 23 N., Ranges 1 E. and 1 W., the line may be considered impracticable either from a building standpoint or its use to the community.

Considering it from a construction point, it is hard to estimate the cost without making a careful survey of the road, but of the 14 miles (the length of this stretch) it is rolling and quite hilly throughout the whole distance. Of the hilly portions there are the following grades ranging in length from 300 to 3,000 ft., as follows:

4,000 ft. of 3%	500 ft. of 7%	1,100 ft. of 12%
3,800 ft. of 4%	2,100 ft. of 8%	2,600 ft. of 15%
1,100 ft. of 5%	2,700 ft. of 9%	1,800 ft. of 20%
2,600 ft. of 6%	1,700 ft. of 10%	300 ft. of 30%

That would give us 4 miles of the 14 miles on a side hill with grades from 3 to 30 per cent. Three miles of this total length may be considered level, but the balance is rolling, no grades being taken on grades up to 6 per cent unless they were for 500 feet or more in length.

A road on this line would be of absolutely no use to the community who would have it to build.

Because of the above points against a road on the meridian I considered a detour starting in Gladwin county and following main traveled road to West Branch and thence west and north from West Branch as noted. The length of this detour is about 21 miles, of which 13 miles is on a road along which there are improved farms. Also, on two miles of this distance there is now being built two miles of hard head macadam road. Along this detour there are 41 houses and 3 schoolhouses, and the city of West Branch to be benefited directly.

BETWEEN OSCODA AND CRAWFORD COUNTIES.

On 23½ miles of this line there is no road, and along which there are no improvements except about 100 acres of land which is under cultivation and three houses. There are many abandoned farms.

The land is level or slightly rolling, except at Creek Crossings and Elk Hills. The soil is sandy.

There will be bridges to be built by the state. One of about 30-ft span on East Branch of North Branch, and one over main stream of Au Sable River of about 125-ft. span.

BETWEEN OTSEGO AND MONTMORENCY COUNTIES.

On this 24 miles of line there are 6 miles of road on the principal meridian. In three places detours were made. The first detour was made to avoid hills and marshes in Towns 29 and 30 N., Ranges 1 E. and W. This detour passes within a half-mile of Lewiston and goes over a route practically level. Length, 14½ miles. The second detour is north of Hetherton about a mile, and was made to avoid deep pockets. Length is about 1⅛ miles. Third detour was made as noted to avoid four miles of swamp. There are two miles of road on this ⅛ line.

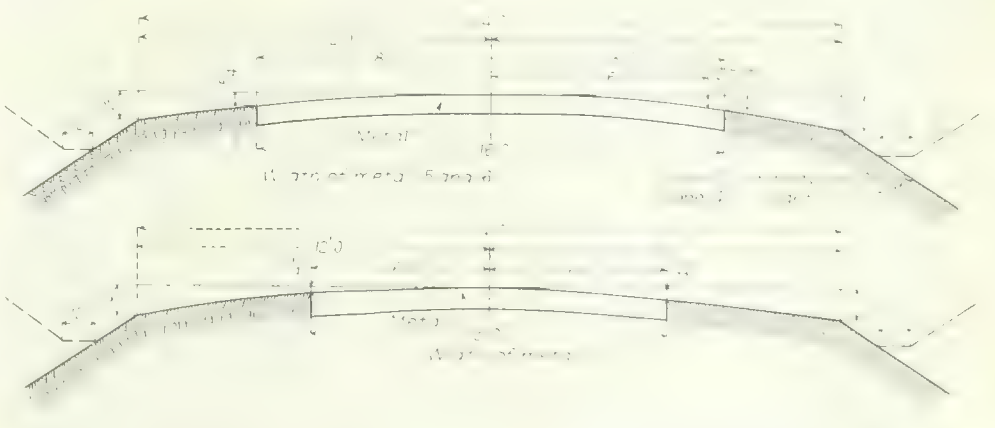


Fig. 2. Standard Cross Sections Used on Class A-B-C State Reward Roads.

Along the principal meridian there are 23 houses, 3 churches, and 1 schoolhouse. From a point a mile south of Vienna to a point a mile north of Hetherton there is good farming lands partly improved.

ACROSS PORTION OF CHEBOYGAN COUNTY.

Of this 11 miles of random there are but two pieces of improvement on the line, but all of the beech and maple lands will make good farms. A detour ought to be investigated to take the place of the last three miles and joint Route 2 west of the principal meridian. The east side of Section 13 is too hilly. There is one 30-foot bridge to be built.

Cost.—The cost of preliminary surveys of 1,200 miles of road was $3,269.40 or $2.72 a mile. As previously mentioned, the cost of surveying the prime meridian increased the average cost.

LOCATION SURVEYS.

Complete location surveys and plans were made for 299.45 miles of road. In making these surveys the following is an abstract of the method used:

(1) In establishing center line permanent monuments of U. S. Government land surveys are followed. If such monuments do not exist section and quarter section corners must be established following the methods of the U. S. Government survey.

(2) Stakes with hubs are set at 100 ft. intervals uniformly 25 ft. from the center line, along both sides of the proposed road.

(3) Readings are taken at each station at the following points: (a) on the center line, (b) on the hub at each side stake, and (c) in the bottom of ditches, if there are any ditches.

(4) The plan must contain a description in sufficient detail so that the road can be plotted on township maps, referring to U. S. Government survey points and give exact location of points of beginning and termination. In the case of angling roads, where the center line crosses section or quarter section lines, the station or place at the intersection must be noted together with the distance to the nearest section or quarter section monument. All angles must be marked with permanent monuments set on the center line. The plan should have upon it a small key map of the township showing the location of the road.

(5) The plan and profile must be placed on the same sheet and the form indicated in Fig. 1 followed as closely as possible under ordinary condition. Scales of 100 ft. to the inch horizontal and 5 to 10 ft. to the inch vertical should be followed. Profile tracing cloth, 10x10 ruling, should be used. Typical cross sections must be shown. A complete working profile should show: (a) center line with cut and fills in figures, (b) side ditches with the depth from the outside hub in figures, (c) the distance of finished center grade above or below each line of hubs, and (d) all other incidental information essential to the construction of the road.

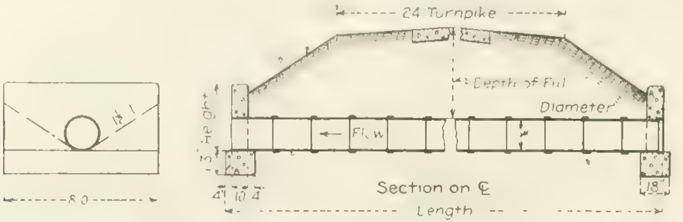
(6) Cuts and fills should balance. Vertical curves should be used. A minimum grade of 6 ins. in 100 ft. is desirable. Elevation of grade at culverts and stream crossings and change points should be referred to located bench marks.

Cost of Location Surveys.—In order to determine the cost of making surveys for trunk line roads in various counties, an accurate card record of cost of each survey was kept and posted weekly from daily reports made by each employe. This cost card shows separately, field cost, wages paid and traveling expenses and office cost, wages paid, materials used.

No allowance is made in the cost keeping for office rent, heat, light, lost time, profit, etc., which would have to be added in order to compare fairly with engineers' cost in private business.

Table I shows the average costs of their work as obtained from these cards. The average cost of surveys throughout the whole state was $41.60 per mile, which includes travel from and to Lansing, stakes used, wages of engineer and all helpers, notebooks, tracing cloth, wages of draftsman, and blue prints sent out in triplicate.

To check these card costs they were compared with the total expenditure for surveys, plans and maps which was $19,824.22. Dividing this by the number of miles surveyed during that period, 300 approximately, a cost of $66.04 per mile is obtained, exceeding the cost shown by the cards by $24.44, which is explained by the fact that during the winter months, draftsmen were employed in drawing county road maps of the whole state, current drawing and filing taking nearly one man's whole time, furniture and surveying instruments amounting to $777.24 are charged out against the survey cost.

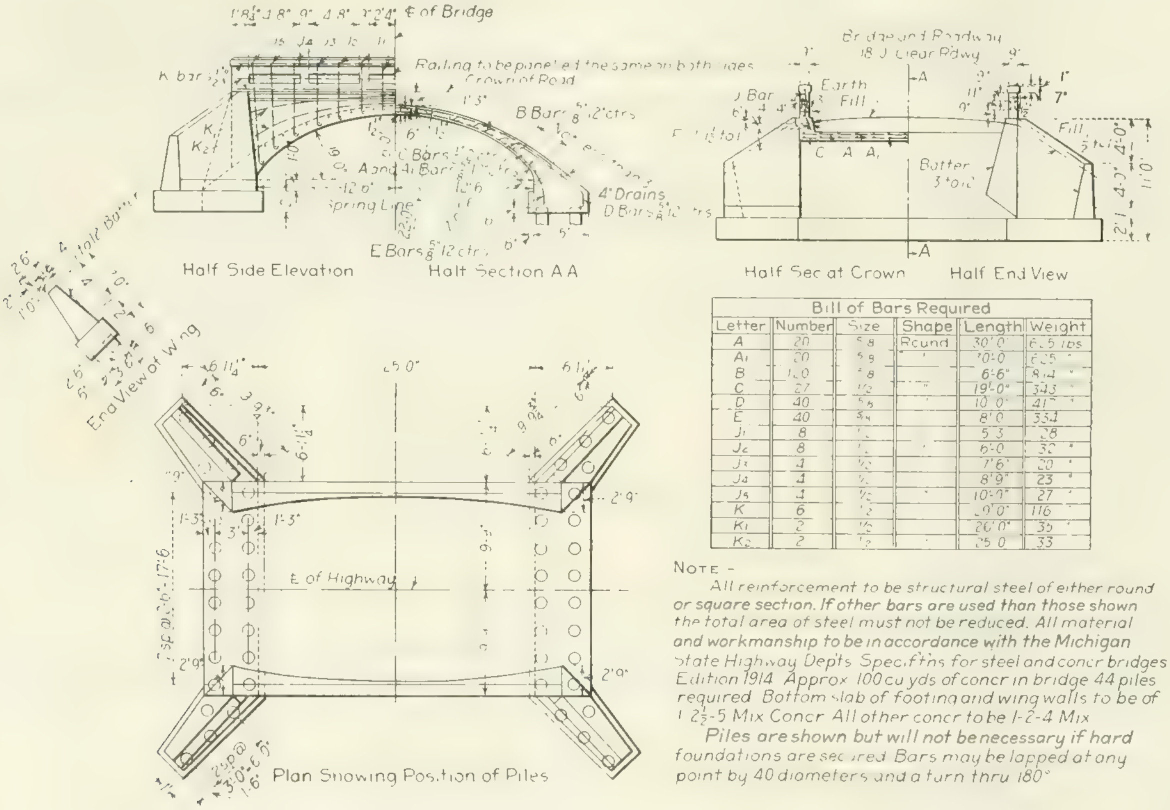


Dimensions of Head Wall		
Diameter of Culvert	Height	Cu Yds in One Head Wall
12"	3'-0"	.26
15"	3'-3"	.31
18"	3'-6"	.38
24"	4'-0"	.43

Length of Culvert for Varying Depth of Fill														
Depth of Fill	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'
Length of Cul	26	28	32	34	38	40	44	46	50	52	56	58	62	64

Note.—Vitrified or concrete tile must be laid in cement mortar. Iron or steel tubes of heavy ga can be used in place of tile as shown. Concrete of 1 3 6 mix, to be in accordance with Michigan State Highway Dept Specifications.

Fig. 3. Vitrified Pipe Culvert Details.



Bill of Bars Required					
Letter	Number	Size	Shape	Length	Weight
A	20	⅝	Round	30'0"	625 lbs
A1	20	⅝	"	30'0"	625 "
B	120	⅝	"	6'6"	814 "
C	27	½	"	19'-0"	343 "
D	40	⅝	"	10'0"	417 "
E	40	⅝	"	8'0	334
J1	8	½	"	5'3	28
J2	8	½	"	6'-0	32 "
J3	4	½	"	7'6"	20 "
J4	4	½	"	8'9"	23 "
J5	4	½	"	10'-0"	27 "
K	6	½	"	29'0"	116 "
K1	2	½	"	26'0"	35 "
K2	2	½	"	25'0	33

NOTE —

All reinforcement to be structural steel of either round or square section. If other bars are used than those shown the total area of steel must not be reduced. All material and workmanship to be in accordance with the Michigan State Highway Dept's Specif'ns for steel and concr bridges Edition 1914. Approx 100 cu yds of concr in bridge 44 piles required. Bottom slab of footing and wing walls to be of 1 2½-5 Mix Concr. All other concr to be 1-2-4 Mix.

Piles are shown but will not be necessary if hard foundations are secured. Bars may be lapped at any point by 40 diameters and a turn thru 180°.

Fig. 4. Design of an Arch Culvert Used on Michigan Trunk Line Roads.

TABLE I.—SHOWING ENGINEERING COSTS FOR SURVEYS AND PLANS FOR TRUNK LINE HIGHWAYS.

Item.	
Miles surveyed	299.45
Total field cost	$ 9,301.78
Total office cost	2,737.91
Total cost	$12,039.69
Field cost per mile	31.59
Office cost per mile	10.01
Total cost per mile	41.60

The average cost of construction of all classes of trunk line road is seldom less than $5,000 per mile, which would make the average cost of surveys less than 1 per cent of the cost of construction.

Bridge plans were prepared and construction supervised on work amounting to $75,000 at a cost of $7,500, or 10 per cent of the total. On this work no standard plans were used and this fact increased the cost of engineering and inspection.

TYPES OF CONSTRUCTION.

No single type of construction is recommended for truck line road construction. An endeavor is made to recommend types of road that will meet the traffic requirements of each locality and at the same time not cost more than the township or county can afford.

Trunk lines reward roads are divided into six classes according to the type of pavement used and designated by the letters A to F: Class A, clay sand or one course gravel; Class B, gravel; Class C, stone-gravel; Class D, gravel or slag-stone; Class E, macadam, and Class F, concrete.

The cross sections used on Class A-B-C roads are shown in Fig. 2. Those for other types are similar except that a crown of 9 ins. is used on Class D-E roads and 7¼ ins. on Class F-G roads.

TYPICAL SPECIFICATIONS.

Specifications for these roads comprise suggestions as to the method, to be followed rather than iron-clad rules for construction. The specification for Class A roads and Class F roads are of special interest and are given here.

CLASS A. LOW TEST GRAVEL, CLAY-SAND OR ONE COURSE GRAVEL.

If good gravel is obtainable within a reasonable haul, say three miles, there is no economy in class A construction, except for the one course gravel road, and at best a clay-sand road does not rank with a gravel road. The construction cost of a clay-sand road varies from $1,000 to as high as $1,800 per mile. The higher cost, it can be seen, does not vary much from the cost of gravel roads. Townships and counties desiring to construct this class of road should place their application in the hands of the State Highway Department early in the season so that an engineer can be sent over the ground where the road is proposed to be built and recommend the quality of clay and sand or the grade of gravel which is to be used.

Grading.—The roadway shall be graded so as to strictly conform to the plans and specifications for the road in question, heretofore submitted to and approved by the State Highway Commissioner. The finished road shall be not less than twenty feet between and exclusive of side ditches or gutters and have a cross-section oval in form, with an average rise of one inch to the foot from the inner edge of such ditch or gutter to the center line of the road. In general, earth for fills should be taken from cuts. In no case shall deep unsightly ditches be cut along the roadside for the purpose of making fills.

Drainage.—The side ditches and gutters shall be of such size as the drainage requirements of the locality demand, and must be formed with true grades, having sufficient incline to cause a free and uniform flow of water to the nearest natural outlets, which outlets must be so improved where necessary as to carry the water quickly away from the highway. The slope of the banks of ditches shall be not steeper than one and one-half horizontal to one vertical.

Tile drains shall be laid where needed, at such places, of such kind and size and on such grades as may be shown on the plans.

In clay soils trenches shall be cut through the shoulders, described in the next paragraph, making outlets into the side ditches for water that may collect in the metal bed during construction and later before the surface becomes hard and water-proof. Such trenches shall be eight inches or more in width and slightly deeper than the metal bed. They shall be placed at all low points in the grade and not farther than 100 ft. apart in retentive soils and must be filled with gravel or other porous material when the first layer of metal is being applied.

Metal Bed and Shoulders.—After the road has been graded as above described the metal bed shall be formed in the central part of the road grade as follows: Shoulders of firm earth, or other suitable material shall be placed on each side of the metal bed not less than nine feet apart or such greater distance as may be required to retain the width of metal specified. The shoulders shall extend to the side ditches or gutters at the same grade and curvature as required for the finished road. Where the road grade is high the shoulders may be formed by moving earth from the center of the present road grade to the sides, or, if the grade is low, by crowning the present road grade by scraping earth from the sides toward the center, or, if sufficient suitable material cannot be had along the roadway, it shall be brought from other places along the line of work.

After the road has been graded, one of the three following forms of construction for metal track must be used. Use the one which will give the best construction with materials which may be had locally.

(1) FORTY PER CENT GRAVEL ROAD.

First Course of Gravel.—After the road has been graded in the manner above described, a layer of gravel shall be spread on the prepared bed to such uniform thickness as to be not less than 5 ins. deep after compacting 6 ins. deep, loose measure. The gravel for this course shall consist of good clean bank gravel, not less than 40 per cent by weight, a larger per cent if possible, of which shall be pebbles that will be retained on a screen of ⅛ in. mesh and pass through a screen of 2½ in. mesh. If the road bed and shoulders are naturally sandy, clay gravel shall be used; if road bed and shoulders are naturally heavy soil, sharp, sandy gravel shall be used. The gravel shall then be harrowed with a spike tooth harrow and rolled until no further compacting is possible. The rolling must be done only when the road has been well wetted by sprinkling or after rains. Any hollows that may develop in the gravel during the process of rolling shall be filled with the same kind of gravel and the rolling continued until the surface is uniformly smooth and hard and everywhere parallel to and three inches below the surface of the finished road. The crown can be preserved during construction by the occasional use of the grader or other suitable floating tools. Ruts formed by hauling over the gravel shall be kept filled by using the harrow twice or more every day, preferably just before quitting time both noon and night.

Second Course of Gravel.—The gravel for the second course shall consist of good, clean bank gravel forty per cent by weight, a larger per cent if possible, of which shall be pebbles that will be retained on a screen of one-eighth inch mesh and will pass through a screen of one and one-half inch mesh. Other requirements for gravel in this course are the same as specified for gravel in the first course. This gravel shall be spread on the road to such uniform thickness as to be not less than three inches deep after compacting, four inches loose measure, after which it shall be harrowed and rolled in the same manner as prescribed for the first course. Any depressions that may be formed during the rolling shall be filled with the kind of gravel prescribed for the second course and the road re-rolled until the surface is uniformly smooth and hard and everywhere conforms to the proposed grade and cross-section of the road.

(2) ONE COURSE SIXTY PER CENT GRAVEL ROAD

Course of Gravel.—After the road has been graded and rolled in the manner above described, a layer of gravel shall be spread on the prepared bed to such uniform thickness as to be not less than five inches deep after compacting, six inches deep, loose measure. The gravel shall consist of good, clean bank gravel, not less than sixty per cent by weight, a larger per cent if possible, of which shall be pebbles that will be retained on a screen of one-eighth inch mesh and pass through a screen of two inch mesh. The gravel course shall then be harrowed with a spike tooth harrow and rolled until no further compacting is possible. The rolling must be done only when the road has been well wetted by sprinkling or after rains. Any hollows that may develop in the gravel during the process of rolling shall be filled with the same kind of gravel and the rolling continued until the surface is uniformly smooth and hard and conforms to grade of the finished road. The crown can be preserved during the construction by the occasional use of the grader or other suitable floating tools. Ruts formed by hauling over the gravel shall be kept filled by using the harrow twice or more every day, preferably just before quitting time both noon and night.

(3) Clay-Sand Road

First Course Clay.—Four inches of clay should be placed between the shoulders which have been previously prepared, taking care to spread it uniformly nine feet wide; over this should be crowded with the grader sufficient sand from the gutters and shoulders to make about three inches. This material should be thoroughly harrowed with a disc harrow until the sand nearly disappears into the clay and the clay works to the top, when it should be

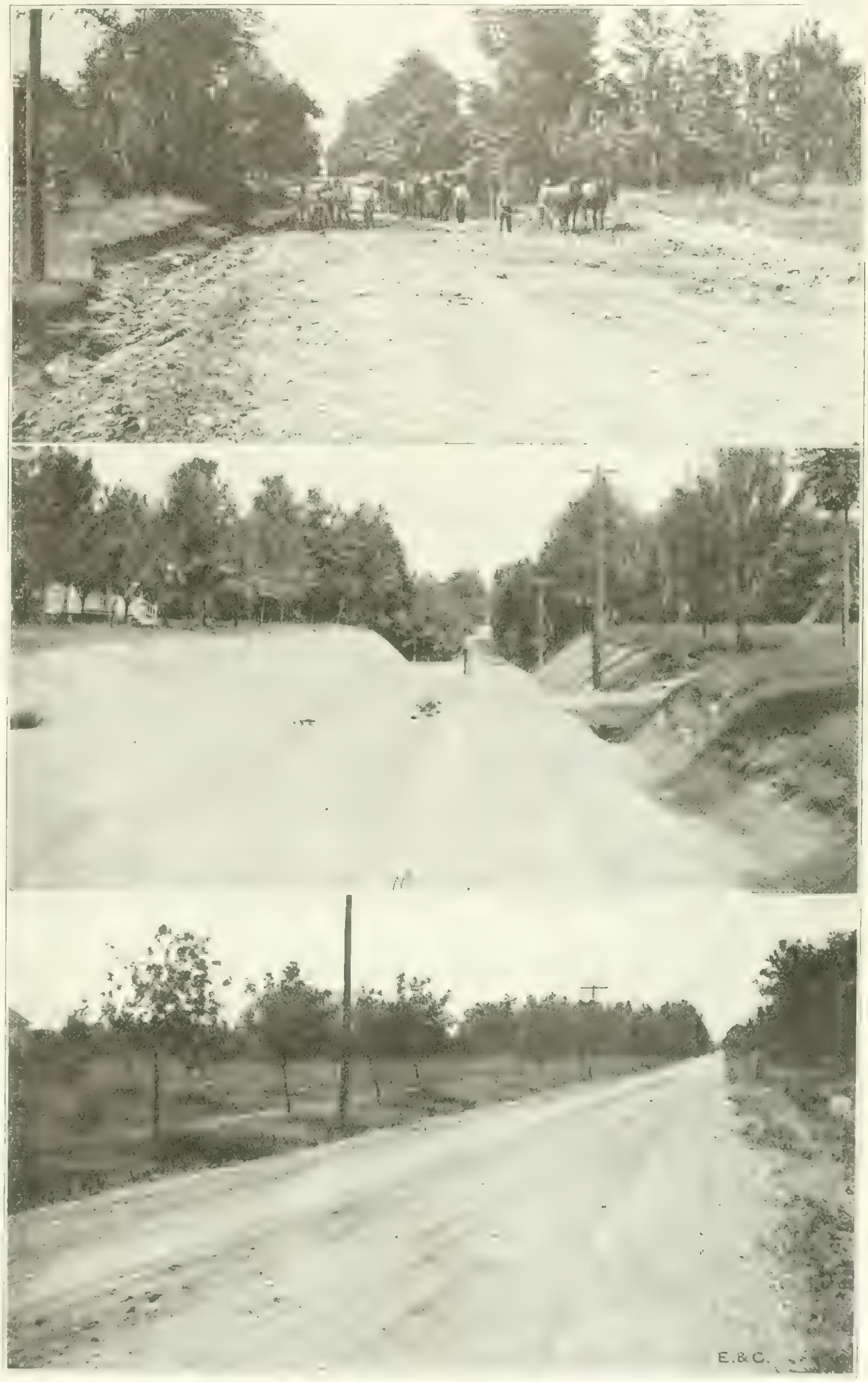


Fig. 5. Typical Trunk Line Macadam Road Construction.

sprinkled or advantage taken of rains before rolling.

Second Course.—After the first course has been completed, another layer of clay shall be spread on the road to nine feet in width, two inches thick. Then sand from the sides should be crowded in with the grader and the whole course thoroughly sprinkled and disc harrowed together until a smooth, even surface is obtained, which will shed water and will not mud under heavy rains, nor disintegrate in dry weather. As the road is worn and rutted with travel, additional sand can be drawn in from the sides, the tendency of the clay on the bottom course being to come to the surface and mud.

Manner of Rolling.—Rolling shall be done only when the gravel has been thoroughly wetted by sprinkling or recent rains, and shall at all times begin at the sides, rolling lengthwise of the road, but gradually working toward the center. In the final rolling the whole surface of the roadway, including the shoulders, shall be rolled from ditch to ditch and the whole road grade left in such perfect condition that water will flow without obstruction to the side ditches. Rolling may be done with a power roller, a heavy horse roller or a traction engine followed by a weighted field roller, if one of suitable strength to bear weighting to three or more tons can be obtained.

With any kind of a roller the spike-tooth harrow, preferably of the lever type, should be used as long as the teeth will penetrate the surface.

CLASS F CEMENT CONCRETE

Grading.—The roadway shall be graded so as to strictly conform to the plans and profiles for the road in question, herewith furnished and approved by the State Highway Commissioner. The finished road shall be not less than 24 ft. between and exclusive of side ditches or gutters, and have a cross-section oval (parabolic) in form with an average rise of ¼ in. to the foot in the concrete roadway and 1¼ ins. per foot in the shoulders. For more details as to the manner of forming grades and ditches see plans and profiles.

Drainage.—The side ditches and gutters shall be of such size as the drainage requirements of the locality demand, and must be formed with true grades having sufficient incline to cause a free and uniform flow of water to the nearest natural outlets, which outlets must be so improved where necessary as to carry the water quickly away from the highway. The slopes of the banks of ditches shall be not steeper than one and one-half horizontal to one vertical.

Tile drains shall be laid where needed at such places, of such kind and size, and on such grades as may be shown on the plans.

In clay soils trenches shall be cut through the shoulders, one on each side, described in the next paragraph, making outlets into the side ditches for water that may collect under the concrete. Such trenches shall be 8 ins. or more in width and slightly deeper than the concrete bed. They shall be placed at all low points in the grade, and not farther than 100 ft. apart in retentive soils, and must be filled with crushed stone or coarse gravel.

Concrete Bed and Shoulders.—After the road has been graded as above described, the concrete bed shall be formed in the central part of the road grade as follows: Shoulders of firm earth, or other suitable material, shall be placed on each side of the concrete bed, such distance as may be required by the plans. The shoulders shall extend to the side ditches or gutters at the same grade and curvature as required for the finished road. Where the road grade is high, the shoulders may be formed by moving earth from the center of the present road grade to the sides, or, if the grade is low, by crowning the present road grade by scraping earth from the sides toward the center, or, if sufficient suitable material cannot be had along the roadway, it shall be brought from other places along the line of work.

Rolling Sub-Grade.—After the shoulders and concrete bed have been formed as above described, the whole roadway shall be rolled until no more compacting is possible. The hollows developed by this rolling shall be filled with suitable material under the direction of the engineer or officers in charge, and the roadway again rolled, and left in solid and firm condition, everywhere parallel to the finished roadway, the concrete bed being six inches below the finished grade and having the same crown.

Forms.—After the preparation of the subbase, forms consisting of 2 in. x 6 in. dressed plank shall be placed on each side of the roadway, at the specified distance from the center line and such distance below the center line grade, as is shown by the plans and profiles of the road. The planks shall be securely staked so that they will hold their true line and grade while the concrete is being placed and while it is hardening.

Concrete Roadway.—Upon the sub-base prepared as hereinbefore specified, shall be laid a one course concrete pavement, not less than 6 ins. thick, mixed in the following proportions, viz.:

American Portland cement, 1 part.
Clean sharp sand, 2 parts.
Broken stone, or gravel, 3½ parts.

Cement.—Only such Portland cement shall be used as conforms to the Standard Specifications for Portland Cement adopted by the American Society for Testing Materials, August 16th, 1909, with the subsequent amendments.

The contractor must notify the officers in charge and the State Highway Commissioner 10 days in advance of the laying of concrete, of the brand of cement he proposes to use, and when it has been examined and approved, that brand or one of equal quality, which must also be approved by the State Highway Commissioner, shall be used throughout the work.

A sack of cement (94 pounds net) shall be considered to have a volume of 1 cu. ft.

The State Highway Commissioner may require that the cement be tested, and each shipment certified to by a reputable testing laboratory.

All cement delivered on the work shall be thoroughly protected from the elements.

Fine Aggregate.—The fine aggregate shall consist of sand, free from clay, loam, vegetable matter and dust, well graded from fine to coarse, all of which shall pass, when dry, a screen of ¼ in. mesh, and so graded that the voids, as determined by saturation, shall not exceed 33 per cent.

Coarse Aggregate.—The coarse aggregate shall consist of clean, hard, durable, crushed stone, or screened, washed gravel, graded in size from material retained on a screen having ¼ in. mesh and passing through a screen having a 2½ in. mesh.

Water.—Water shall be clean, free from oil, acid, alkali or vegetable matter.

Measuring and Proportioning.—All material shall be measured in suitable boxes, or in wheelbarrows, of a measured capacity. Each wheelbarrow load shall be surface struck with a template.

Mixing.—The ingredients of the concrete shall be mixed to the desired consistency in a batch concrete mixer of an approved type, and mixing shall continue until the cement is uniformly distributed and the concrete is homogeneous and uniform in color. The concrete shall be mixed with water above specified, wet enough to produce a concrete that will flush readily under light tamping, but the amount of water used shall not be sufficient to cause a separation of the coarse aggregate from the mortar in handling the concrete.

Retempering or remixing concrete that is partially hardened will not be permitted.

Depositing Concrete.—The concrete, prepared as above specified, shall be deposited in strips extending across the full width of the roadway, and shall be deposited as soon after mixing as practicable, and in no case shall more than 15 minutes elapse between the mixing and depositing of the concrete.

Concrete shall be laid and finished from one transverse expansion joint to another, in one continuous operation, and the stoppage of concrete laying for more than 30 minutes, must be at an expansion joint, and the surface finished to that point.

The sub-base must be kept moist while the concrete is being deposited.

Concrete shall not be laid when the temperature at any time during the day or the night falls below 35° above zero Fahrenheit.

Expansion Joints.—Vertical transverse expansion joints shall be placed across the concrete roadway perpendicular to the center line, not more than 30 ft. apart, extending entirely through the concrete. These joints may consist of heavy 3-ply tar paper carefully placed, or may be formed with a ½ in. dressed board which has been tapered to "draw" and has been shaped so that its edge will fit the specified crown of the roadway. When the concrete has set, this board shall be removed carefully, the rough edges of the concrete smoothed off and the joints filled with an approved paving pitch, which is not soft enough to "bleed" in hot weather nor brittle enough to chip in cold weather. After filling, the joints shall be lightly covered with coarse sand.

Finishing.—After the concrete has been brought to the required grade by means of a suitable template the surface shall be worked with a wood float, in such a manner as to thoroughly compact it and to produce a smooth uniform surface. Before the concrete surface becomes hardened, it shall be slightly roughened by brushing with a stiff fibre broom.

Care must be taken in finishing not to step on the concrete. All work shall be done from a bridge made expressly for the finishers to work from.

Removal of Forms.—Forms shall be removed when concrete has set. Immediately after removing the forms the edges of the concrete roadway shall be beveled to a horizontal width of 3 ins. and a vertical depth of 2 ins. by cutting off the edges with a sharp spade or flat sharp shovel.

Protection.—After finishing, the surface shall be kept well sprinkled with water, and as soon as the concrete has hardened sufficiently, the surface of the pavement shall be covered with a thin layer of dirt, or loam, which shall be kept wet at least 5 days by sprinkling with water.

Under the most favorable conditions for hardening in hot, dry weather, the pavement shall be protected from traffic for at least 10 days, and in cool damp weather, for an additional length of time to be determined by the engineer or officers in charge.

Inspection.—During the laying of the concrete pavement, the local officials shall provide for an experienced and competent inspector, who shall see that the specifications are carried out by the workmen. The qualifications of the inspector shall be such as to meet the approval of the State Highway Commissioner, and he shall be approved by said Commissioner.

INSTRUCTIONS FOR CONSTRUCTION.

The plans and profiles for state reward trunk line roads are, under the law, made by the State Highway Department, the construction work on the road being done in accordance with these plans by the local township or county officials. In explanation of these plans the following suggestions are made to the local authorities:

Survey.—The engineer who surveys the road, stakes it out permanently with two lines of hubs and markers set uniformly 25 ft. back from the center line of the road, marking lines which are parallel to the center line. The hubs are small stakes about 1½ ins. square, while the marker is a larger stake set back of the hub.

Plan.—The drawings are made on cross section cloth in which the large squares measure 1 in. and the small ones 1-10 in. Across the top of the sheet are the numbers representing the hubs or "stations," as they are called, together with any distances noted between hubs which are written +; for instance, 26 + 50 means 50 ft. from hub number 26, measured in the direction of hub number 27. Immediately below this line of numbers is located the plan of the road. On the plan are shown the location of cross roads, curves, culverts, guard rails, telephone poles and trees, United States land corners, buildings, etc., which are found within the boundaries of the road, as shown by the heavy lines or the light lines designating fences. Outside of the road lines are shown the farm buildings, creeks, ponds and other general features of the topography which may affect the grade of the road. Farm entrances of importance are shown.

Profile.—Below the road plan in the center of the sheet is the road profile. The center one of these profiles shows in a light irregular line the surface of the present road before grading. The even heavy line on the same base shows the new center line grade of finished road. The center line cuts and fills are shown directly above these two lines, marked (F) for fill and (C) for cut, which measurements are the actual measurements from the road as surveyed to the top of the finished road. The distance the finished center line is above the hubs, (marked +), or below the hubs, (marked —), on either side, is shown by the figures directly above the actual cuts and fills and directly below the center line profile. One line of figures being references to each hub line. To get the elevation of subgrade one should go the depth of the metal below the point given by these figures. All figures on these plans are given in feet and tenths of feet. This enables the foreman or commissioner to refer his center line cuts and fills to hubs after grading operations have commenced.

Directly above the center line profile is found the ditch and hub profiles for one side. The light dotted line is the hub profile which is 25 ft. back from the center line of the road. The uneven light line shows the present line of ditch or side profile of the road, and the heavy dark line is the proposed new ditch or gutter line. The figures right above these lines are the distances below the hub line, to which the bottom of completed ditch or gutter is to be dug. This also applies to the other ditch or gutter and hub line shown on the lower profile. If any question arises as to what any profile line or figures refer to, see notes on left end of each sheet.

Laying Out Work.—Before starting grading operations the commissioner or foreman should go over the line of the road with the profile in hand, and set side grade stakes for all points where a fill is shown. These stakes should be of correct length to drive in the ground so that the top will be just even with the finished grade. Then, as the work progresses, a sight can be taken across the tops of these stakes to tell how much more fill is necessary.

In cuts it is wise to keep track of plowings and the approximate depth of each, so as to tell when you are within 10 or 12 ins. of subgrade. Then dig a hole in the center of the road and drive a stake so that the top of it will be just flush with the sub-grade elevations. By these two methods, workmen can then be instructed to cut until down even with the top of the stake, and fill until up even with the top of the fill stakes.

For a convenient, cheap instrument for making these measurements we would suggest the use of a 10-ft. pole, marked off in feet and tenths of feet, and a mason's line level. These levels may be procured at hardware stores.

Special Features.—Culvert plans and small bridge plans accompany each set of profiles for the necessary work along the line of that particular road. Wooden guard rails are specified for each unprotected fill which is more than 6 ft. in height. The plans for these guard rails are shown on the road plan, and should be built of good cedar posts with sound, straight grained 2x6 rails. Guard rails should be painted with three coats of good white lead.

CULVERTS.

Figure 3 shows the type of pipe culvert recommended. Details of concrete culverts varying from 7 to 15 ft. in span were given in ENGINEERING AND CONTRACTING, Vol. XLIII, p. 44. The plans for a typical concrete arch are given in Fig. 4.

ACKNOWLEDGEMENT.

We are indebted to the report of F. F. Rodgers, state highway commissioner of Michigan, for the data from which this article was prepared.

Comment on the Cube Method for Determining the Melting Point of Asphalts.

TO THE EDITORS: On pages 87 and 88 of your issue for Jan. 27, 1915, you reprint a paper by J. G. Miller and P. P. Sharples, presented to the American Society for Testing Materials on the "Methods for Determining the Melting Point of Asphalts." The copy furnished you was evidently a preprint of this paper prepared for the meeting of the A. S. T. M., for you repeat in your publication the mistake made in the preprint of crediting the cube method of Hubbard and of stating (in the fourth paragraph of the article) that Hubbard "proposed" the method.

As a matter of fact the cube method described by Hubbard in his book (as referred to) was first proposed in print by the Special Committee on "Bituminous Road Materials" of the American Society of Civil Engineers in 1909 (see report of this committee presented at the annual meeting of the society Jan. 20, 1915, Appendix A, page 3028, of the pamphlet), although Hubbard makes no reference to the previous publication of the method by the committee referred to.

I know that the method had been used to some extent previous to its published description by the committee, but I cannot find that any prior publication of the description exists.

I called the attention of Mr. Sharples to the above facts when the preprint referred to first appeared, and if you will refer to the Proceedings of the American Society for Testing Materials, Vol. 14, 1914, Part II, pages 502, et. seq., you will note that proper corrections of the preprint has there been made.

Very respectfully,
W. W. CROSBY.

Baltimore, Md.
Jan. 28, 1915.

A Judge for County Surveyor.

TO THE EDITORS: I have read with much interest your editorial entitled "A Judge for County Surveyor." Governor Major's late appointment to the office of County Surveyor of Jackson County was a good deal of a surprise and disappointment to the engineers of Kansas City, particularly as engineers of good executive ability were applicants for the position. In particular Mr. Chester Cooke was an applicant, after having served two years as Superintendent of the Department of Road Repairs. The two years' record (1913 and 1914) showed his efficiency and executive capacity in materially reducing the cost of resurfacing and oiling macadam roads, as shown by the following table:

COST PER MILE ROAD REPAIRS OF JACKSON COUNTY, MISSOURI

Year	Resurfacing.	Oiling.
1911.	$1,620.81	$294.18
1912	897.65	365.69
1913	438.27	117.07
1914....................	545.77	82.24

It is unfortunate that an engineer who has succeeded as well as Mr. Cooke did in his work for Jackson County should receive no public recognition of his services, and particularly should be turned down as an applicant for the position of County Surveyor for a man who has had no engineering experience and, therefore, lacks the technical requirements for the proper administration of the affairs of the office. It certainly inspires hope that a change for the better may come through the publicity department of our technical papers. Very respectfully,

W. KIERSTED.

Kansas City, Mo., Feb. 19, 1915.

GENERAL

Appraisal of City Real Estate.

On this subject very little exists in print. "Principles of City Land Values," by R. M. Hurd, is the only modern American book that we know on the subject. In the "Diary and Manual of the Real Estate Board of New York" for 1915 there is an excellent essay by Mr. William E. Davies, entitled "Technical Information for Real Estate Experts." We have abstracted the parts of this essay that seem most likely to be of value to appraisal engineers. Among the data that follow will be found the detailed cubic foot costs of two large buildings in New York.

The particular feature of Mr. Davies' article that will be of most general interest is his formula for calculating the value of city lots, based on the known value of what he calls a "standard lot." He does not approve the old "Hoffman rule," because it does not check with known values in New York City.

It should be noted that for each city there probably can be derived a formula like that of Mr. Davies but not identical with it. A western real estate expert, Mr. Sommers, we believe, has marked out a rather elaborate system of appraising lots, based on the known value of standard lots, but we cannot find that his rule or system has been published.

Bearing to some extent on the problems of real estate appraised are two recent books: "Scientific Building Operation," by Patterson and Lengel, and "The Commercial Problem in Buildings," by C. C. Evers. The first mentioned book contains some excellent cost data on the operation and maintenance of office buildings and apartments. The second book has a chapter on this subject, also a chapter on valuations of real estate.

The following is an abstract of Mr. Davies' essay on city land appraisal. Mr. Davies, it may be added, has had many years' experience as an appraiser in New York City. He was at one time a civil engineer, and attributes much of his success as a real estate appraiser to his engineering training. He suggests that real estate appraisal is a field that more engineers might profitably enter. Tax suits, mortgages, public utility rate cases and the like necessitate the employment of many skilled real estate appraisers in all large cities:

APPRAISAL OF CITY REAL ESTATE.

Hoffman Rule.—From Vol. 2, page 844, of "A Digest of the Charters, Statutes and Ordinances of, and relating to, The Corporation of the City of New York," by Murray Hoffman:

"In several cases in which the author has acted as Commissioner the following table for estimating and apportioning damages and benefits has been used:

		Aggregate per cent.
A lot of ground 25 x 100 feet	$1,000	
10 x 25 feet	160	16
15 x 25 feet	235	23.50
20 x 25 feet	310	31
25 x 25 feet	375	37.50
30 x 25 feet	440	44
35 x 25 feet	500	50
40 x 25 feet	560	56
45 x 25 feet	615	61.50
50 x 25 feet	670	67
55 x 25 feet	715	71.50
60 x 25 feet	760	76
65 x 25 feet	800	80
70 x 25 feet	840	84
75 x 25 feet	875	87.50
80 x 25 feet	910	91
85 x 25 feet	935.......	93.50
90 x 25 feet	960	96
95 x 25 feet	980	98
100 x 25 feet	1,000.......	100

Every 10 ft., if of equal value throughout, would be worth $100. A front 10 ft. is put by this scale at $160; a rear 10 ft. at $40, or one-fourth. This scale was adopted by Mr. McCoun, the late Vice-Chancellor Mr. Boulton, late Master in Chancery, and Mr. John Sidell.

It strikes me that the proportion in favor of the front 10 ft. ought to have been greater. It is taken at between a sixth and a seventh of the whole value, viz.: one-sixth and one-fourth of a sixth.

This rule, though still favored by many who cannot throw aside the shackles of precedent, is practically obsolete, being at least 49 years old, and consequently entirely out of conformity with modern conditions.

It also contains a number of inconsistencies, which were convincingly pointed out in detail by the late Henry Harmon Neill.

Henry Harmon Neill Rule.—Mr. Neill adopted the 50-ft. ratio of the Hoffman Rule and applied same to all depths within the limit of 100 ft., making 2 ft. worth 50 per cent more than 1 ft., 4 ft. 50 per cent more than 2 ft., and so on in the same proportion. This method being pure theory, with no relevant substratum, cannot be safely used where aggressive interrogatories are anticipated.

LUDLAM OR MURPHY SCALE.

(Generally used in Brooklyn.)

Location.		Pct.	Value.	Size.	Pct.	Value.
Front	25 x 25	43	$ 430	25 x 25	43	$ 430
2d	25 x 25	24	240	25 x 50	67	670
3d	25 x 25	19	190	25 x 75	86	860
4th	25 x 25	14	140	25 x 100	100	1,000
Total	25 x 100	100	$1,000			

William E. Davies Rule.—Many years ago, when attending a reference, the counsel for the relator, one of the most able cross-examiners in real estate cases, asked a witness for the respondent if it were not a fact that every square foot of a lot had a different value. The witness replied yes, and further stated that no appraiser could define such value. This question and answer made a great impression on me, and I determined, if possible, to construct a formula which would fill the apparent vacuum in the real estate profession. My first effort in the necessary direction was to obtain at great labor the average of the sales of 10,200 parcels of varying depths, thus fixing numerous points through which a curve could be run, and the resultant parabola stated in a formula, easy to remember, and, moreover, being based on *actual sales,* not subject to attack as having no foundation.

The formula is:

$$Y=\sqrt{1.45\,(X+.0352)}-.226$$

in which Y=the proportion of value of lot in question to value of standard lot, and X=the proportion of depth of lot in question to depth of standard lot, viz., 100 ft.

EXAMPLE.

To find the value of lot 25 ft. by 103 ft. 7½ ins., when standard lot is worth $20,000:

$$Y=\sqrt{1.45\,(1.03625+.0352)}-.226=1.0204$$

Ergo, a lot 25′x103′ 7½″ will be worth $20,000x1.0204, or $20,408.

An appraiser of long and varied experience, to whom I explained this formula, told me I had better place it in the shape of a table if I wished it to come into general use, as few real estate men would take the trouble to work out the formula, although, as seen by the foregoing elucidation, it is but elementary arithmetic, hence the following and various other pertinent calculations.

It should be borne in mind that this formula is applicable to *actual lots or plots only,* and *to any depth,* and that a consideration of the example heretofore given should enable anyone of ordinary intelligence to ascertain the ratio of lots, with fractional depths, between 125 ft. and 200 ft., or deeper than 200 ft.

To key lots should be added the necessary increment, usually 10 per cent, and to corners the Davies Rule ratio of the proper percentage.

To ascertain percentage added to inside lot to obtain value of corner lot, divide difference by value of inside lot.

To find percentage of inside lot of corner lot, divide value of inside lot by value of corner lot.

The percentage deducted from corner lot to fix value of inside lot is the result of difference divided by value of corner lot.

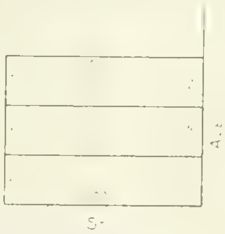
To extract plottage, divide by one plus added percentage.

To analyze sale, if all standard lots, assuming a key lot to be worth 10 per cent and a corner 60 per cent more than an inside lot, multiply the price less plottage by 1 for an inside lot, 1.1 for a key lot and 1.6 for a corner, and divide each result by the sum of the units. When the lots are not of standard depth, the units will be the figures given in Davies' Rule plus the added percentage for key and corner lots, and if more or less than 25 ft. wide, the product of same and the width percentage.

APPLICATION TO CORNERS.

To find the value of corner 20′x60′ if inside standard lot worth $10,000 and standard corner lot 70 per cent in addition:

60 feet ratio (10,000 X)	$7,337.10
Add 73.371 per cent of 70 per cent or 51.3597 per cent	3,768.31
	$11,105.41
Multiply by .8 (width percentage of 20 ft.)	.8
Value of corner 20 x 60 ft	$8,884.328



To analyze the sale of three standard lots as per diagram, selling for $110,000, key lot being worth 10 per cent and corner 65 per cent more than inside lot:

Divide the consideration by 1.10 to extract plottage, leaving $100,000; multiply this quotient by each ratio successively and divide products by the sum of the ratios.

	Ratios.		Values.
Lot No. 1	1.65	$\frac{(100,000 \times 1.65)}{3.75}$	$44,000
Lot No. 2	1.1	$\frac{(100,000 \times 1.1)}{3.75}$	29,333
Lot No. 3	1	$\frac{(100,000)}{3.75}$	26,667
			$100,000
Plottage, 10 per cent			10,000
			$110,000

Copy of one of rorty-two analyses made in a certiorari proceeding to review a real estate assessment.

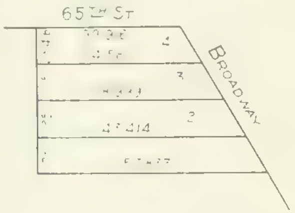
From Record & Guide Annual, 1900, page 137:

"Broadway, s. w. cor. 65 St., 116.1 x 157.10 x 99.11 x 100.5, vacant. Nellie Flake wife of and Albert Flake as atty. to Robt. E. Dowling. Mort, $123,900. March 28, March 29, 1900. R. S. $54. 4:1136. $177,000."

Flake (since deceased) & Dowling were partners.

Now Miller Building, four stories.

Diagram with inches expressed in decimals of a foot.



ANALYSIS.

	Ratios.	Values.
Lot 1	1.269	$37,181
Lot 2	1.197	35,070
Lot 3	1.234	36,155
Lot 4	1.792	52,503
	5.492	
		$160,909
Plottage, 10 per cent		16,091
		$177,000

The ratios are obtained by ascertaining the ratio of the average depths by Davies Rule, adding 10 per cent for key lot, ratio of 66⅔ per cent to corner, and as the latter is 25 ft. 5 ins. wide, multiplying result by the width percentage of the latter figure, and the values by multiplying the price, $177,000, less 10 per cent plottage, $160,909, by the single ratios and dividing by the sum of the ratios, 5.492.

Inside standard lot value $37,181÷1.269=$29,298.

Copy of analysis made in May, 1912, in connection with the appraisal of property on west side of Broadway between Exchange Alley and Rector Street.

From Record and Guide Annual, 1911, page 229:

"Broadway, No. 57 New Church st No 95 or Trinity Place No. 33 } n w cor Exchange Alley, 28.6 x 203.7 to e s New Church st or Trinity pl x 28.5 x 202.4, 5-sty stn office and store building. Wm. A. Pinkerton of Chicago, Ill., to Wm. M. Barrett, 272 West 85th st, as Pres. of the Adams Express Co., 59 Broadway. ½ part. All liens. May 12. May 23, 1911. 1:21. A $400,000-$460,000..............O C & 100. Same property. Anna E. Pinkerton of Bklyn as TRUSTEE Robert A. Pinkerton to same. ½ part. All liens. May 12. May 23, 1911. 1:21 .... $500,000."

Indicated consideration $1,000,000.

The building thereon has been demolished and a 32-story office building erected on the site and adjoining land.

Following my division between Broadway and New Church Street or Trinity Place, which was adopted as the most logical by Justice Lehman in his decision in the proceeding, Fargo vs. Tax Commissioners, taxes of 1905-1910, inclusive, reported in the New York Law Journal of July 19, 1911, on pages 1749 and 1750, then an accurate analysis of this sale, Broadway lots being considered as two and a half times more valuable than Trinity place lots will be, as viz.:

3,000 square feet on Broadway at $225.04482 per square foot	$ 675,135
2,599 square feet on Trinity place at $90.0179 per square foot	233,956
	$ 909,091
Plottage, 10 per cent	90,909
	$1,000,000

Copies of three of a number of analyses made in a certiorari proceeding to review a real estate assessment.

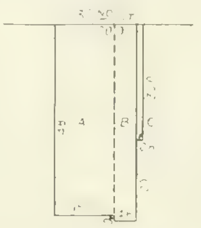
From Record and Guide Annual, 1906, page 142:

"32d st, No 138, s s, abt 380 e 7th av, 3-sty brk tenement. CONTRACT. Josephine Halbach with Wm. L. Sutphin. Mort $........ Nov. 12. Nov. 13, 1906. 3:807—62. A $16,500-$18,000........................$47,000."

From Record and Guide Annual, 1907, page 252:

"32d st, No. 138, s s, 395 w 6th av, runs s 30 x w .06 x s 20 x w 4.6 x n 1 x w 15 x n 48.11 to point x e 20 to beginning 3-sty brk tenement. Josephine Halbach to Investors and Traders Realty Co. Jan 28. Feb 4, 1907. 3:807—62. A $16,500—$18,000........................100."

170 Broadway, Room 1107."



Analysis.

A. 15′ x $\frac{48'\ .11'' + 49'}{2}$	Ratio	.6x.646	.3876	$35,811
B. 4′ .6″ x 50′	Ratio	.18x.654	.1117	10,320
C. 0′ .6″ x 30′	Ratio	.02x.471	.0094	869
			.5087	$47,000

Standard lot, disregarding building = $\frac{35,811}{.3876}$ = $92,391.

From Record and Guide Annual, 1906, page 475:

"Broadway Nos 1270 to 1280 33rd st, Nos 60 and 62 } s e cor 33rd st, runs s 118.6 x e 87 x n 17 x w 30 x n 75 to st x w 97.4 to beginning. Lease and option to purchase above for $1,525,000 and agreement as to erection of new buildings. Mary E. Hanley to Felix Isman and George B. Wilson of Philadelphia, Pa.; 21 years from Jan 4, 1906, with privilege four renewals of 21 years each. Feb 3, 1906. 3:834............taxes, etc., and 50,000 and 60,000"

"Broadway Nos 1270 to 1280 33rd st, Nos 60 and 62 } s e cor 33rd st, runs s 118.6 x e 87 x 17 x w 30 x n 75 to 33d st, x w 97.4. Assign lease. Felix Isman, Philadelphia, Pa. to Geo. B. Wilson. All title. April 2. April 3, 1906. 3:834..........nom.”

From Record and Guide Annual, 1910, page 439:

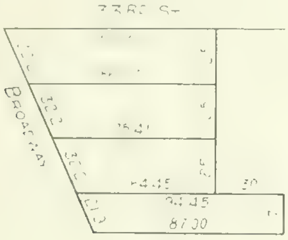
“Broadway Nos 1270 to 1280 33rd st, Nos 60 and 62 | s e cor 33rd st, runs s 118.6 x e 87 x 17 x w 30 x n 75 to s s 33d st x w 97.4 to beg. Assign lease. Felix Isman, Phila, Pa, to Geo B Wilson, of Phila, Pa. All title. Apr 2, 1906. (Rerecorded from Apr 3, 1906.) Dec 28, 1910. 3:834..............nom.”

“Broadway Nos 1270 to 1280 33d st, Nos 60 and 62, on map Nos 60 to 66 | s e cor 33d st runs s 118.7 x e 85.9 x n 17.6 x w 27.7 x n 75.9 to s s 33d st x w 98 to beg, seven 4 and one 3-sty brk loft, str & office bldgs. Daniel A Loring to Geo B Wilson, 4228 Walnut st, Phila, Pa. Dec 27. Dec 28, 1910. 3:834—80. A $765,000—$790,000..........nom.”
“99 Nassau st, r 904.”

“BROADWAY, Nos 1270 to 1280.
Wilson, Geo B, 4228 Walnut st, Phila, Pa, to METROPOLITAN LIFE INS CO, 1 Mad Av.
Bway, Nos 1270 to 1280, s e cor 33d str, Nos 60 and 62, on map Nos 60 to 66, runs s 118.7 x e 85.9 x n 17.6 x w 27.7 x n 75.9 to s s 33d st, x w 98 to beginning. P.M. Dec 28, 1910, due Apr 1, 1921, 5½% until Apr 1, 1916, 5% thereafter. 3:834..........................1,150,000
Woodford, Bovee & Butcher, 1 Mad av.”

Old buildings demolished, 12-story “Wilson Building” erected on site.

Diagram with dimensions from lease and option and inches expressed in decimals of a foot:



Analysis.

Southerly lot, 17′x87′ + 94′ .45 / 2 = average depth of 90.725′.		
Ratio .943x.60 (width percentage)	.551	$ 197,183
Next adjoining lot on north, 25′x64′ .45 + 75′ .41 / 2 = average depth of 69.93′.		
Ratio	.806	288,138
Key lot, 25′x75′ .41 + 86′ .37 / 2 = average depth of 80′ .89.		
Ratio .88 plus 10%	.968	346,412
Corner lot, 25′x86′ .37 + 97′ .33 / 2 =average depth of 91′ .85.		
Ratio .949 + .949 of 62.2/3% or 63.26%	1.549	554,381
	3.874	$1,386,361
Plottage 10%		138,636
		$1,525,000

Standard lot 197,183 / .551 = $357,863

From Record and Guide Annual, 1907, page 612:

“Broadway Nos 1279 and 1281 6th av | w s, 33.4 n 32nd st, runs w 68 x n 16 x w 32 x n 24.8 x e 100 to Broadway or 6th av x s 40.8 to beginning, two 3-sty brk tenements and stores.
6th av w s, 74 n 32nd st, runs n 26 x w 102.11 x s 1.6 x e 100 to beginning. Interior gore, at c l blk bet 6th and 7th avs, and 32nd and 33rd sts, 6.6 w 6th av, runs w 93.6 x s 23.3 x e 96.3 to beginning, together known as Nos 1283—1283½ Broadway, two 3-sty brk tenements and stores.
Edward A Morrison to Hudson Co. All liens. Apr 17. May 1st, 1907. 3:808—12, 13, 14. A $301,000—$314,000. 111 Broadway, r 914............................other consid and 100.”

From Record and Guide Annual, 1908, page 178:

“Broadway Nos 1289 and 1291 6th av | begins 6th av [illegible] cor 33rd st, 49.1 x 100 x 50.4 x 100.
33rd st, No 100 w 33d st, No 102 | s s, 100 w 6th av or Broadway, 16.8 x [illegible] x 17.3 x 21.9.
3 and 4-sty brk hotel. Edward A Morrison to Hudson Companies, a corp'n. All liens. Mar 30. Apr 1, 1908. 3:808—47 to 50. A $381,000—406,000. 111 Broadway, r 914
........................other consid. and 100.”
Actual consideration for the two parcels, $2,100,000.

Old buildings town down. Now part of site of Gimbel Brothers' 10-story Department Store.

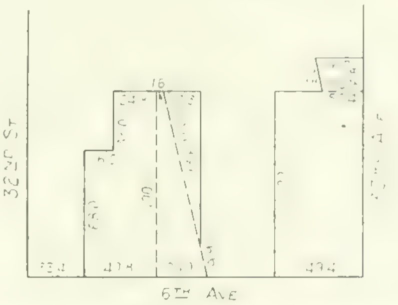
ROUGH ANALYSIS.
BROADWAY OR SIXTH AVENUE.
Inside Parcel.

Portion of key lot, 16′x68′. ratio.	.5069	$ 180,272
Balance, 50′ .8″ + 49′ .5″ / 2 x 100 ratio	2.0017	711,882
Corner Parcel.		
Portion of key lot, 24′ .4″ / 2 + 25′ .4″ / 2 x 100 ratio	1.0926	388,570
Corner, 25′ x 100′, ratio..	1.666	592,713
Carried forward	5.2678	$1,873,437

33rd street key lot, 16′ .8″ x 21′ .9″ x 17′ .3″ x 26′ .2″.
Average depth, 21′ .9″ + 26′ .2″ / 2 = 23′ .11½″.
Y[illegible] .4052

Brought forward	$1,873,437
Ergo, this lot is valued at .4052 of $132,000 x .6666 (width percentage) or....	35,654
	$1,909,091
Plottage, 10%	190,909
	$2,100,000

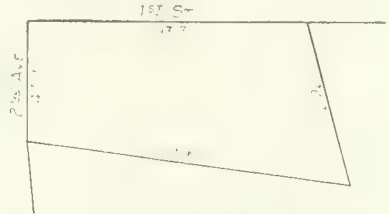
Standard Broadway lot 592,713 / 1.6666 = $355,642.



Copy of analysis made in a condemnation proceeding.

From Record and Guide Annual, 1900, page 159:

“2d av, No 14½ :s e cor 1st st, 47.11 x 105.6
1st st, Nos 25 to 31 :x 72.7 x 93.3 Nos 25 to 29½.
Four 2-sty frame, brk front bldgs; No 31, 5-sty brk tenem't, 1-sty frame store on av, Susan A Tier extrx Daniel Tier to Leopold Kaufman, May 10, 1900.
R S $77.50. 2:442. 77,500.
See projected buildings.”
Old buildings demolished, new 7-story building erected.



ROUGH ANALYSIS.

25′ x 93′ .3″ on corner, ratio......	1.571	$36,207
Balance of plot, ratio.............	1.486	34,248
	3.057	$70,455
Plottage, 10%		7,045
		$77,500

Standard lot $70,455 / 3.057 = $23,046

Foreclosure Sales.—Foreclosure sales are no criterion of values, for the following reasons:

First—Prospective bidders are well aware of the fact that the auction is not really an open one to the highest bona fide bidder, as the mortgagees and other lienors will in all probability bid up to the amount of their respective claims, which are only publicly advertised in the case of liens prior to that under which the sale is authorized, subsequent liens not being disclosed, whereas other judicial sales are almost invariably absolute, positive, peremptory and without reserve or upset price, thus encouraging buyers to bid against each other.

Second—In foreclosure sales the referee has to require payment in cash, while in partition, executors' and trustees' sales it is very common to state in the advertisement that a large percentage can remain on bond and mortgage at a low rate of interest, if desired, and also to furnish title insurance policies free of cost.

Third—It is the general impression of the real estate fraternity that it is much easier to deal with a mortgagee after he has bid in the property, as time is allowed for negotiations, and easy terms can probably be arranged.

General.—Whenever land increases rapidly in value, although it may seem somewhat anomalous, the rental value of the buildings several years old decreases materially, on account of the necessary demolition of older buildings and the construction of adequate improvements with which the first mentioned cannot successfully compete.

It is generally recognized in real estate circles, and could not well be otherwise, that when land and buildings are purchased and the latter torn down in order to make way for a more adequate improvement, that the value, if any, of the structures so demolished is merged in the cost of the land.

Plottage.—Plottage is an added percentage to the aggregate value of two or more contiguous lots held in one ownership and attaches when vacant or covered by a single structure. Where there are separate buildings on the lots and plottage is claimed, full value cannot be allowed for the buildings. (73 App. Div., 152.)

Antiquity of Plottage.—As illustrating the difficulty and expense of securing a moderately sized plot downtown, even as early as 1830, the circumstances under which the first John Jacob Astor purchased the site of the Astor House are here set forth:

“It was in 1830 that John Jacob Astor put into execution a resolve he had long cherished to rear at the junction of two of the most crowded thoroughfares of the city a hotel which should bear his name. Keeping his own counsel, he gradually acquired possession of all the houses save one on the block designed for a site. John G. Coster, the wealthy owner of this, did not wish to sell it, nor was there prospect of his ever falling into financial difficulties that would force him to part with it at the buyer's price. So Astor one day said to him: ‘Coster, I want to build a hotel on this block, and have bought all the houses except yours. It is of no particular use to you, and you can buy another lot and build a palace with the money I will pay you. Now, you name two friends and I will name one to value your property. When they have done so, add twenty thousand dollars to the sum upon which they agree, and I will give you a check for the total amount in exchange for a deed.’ This liberal offer was at once accepted, and a site thus secured for the Astor House, which, opened in 1836, has stood for more than sixty years the most famous tavern in America.” (New York, Old and New, Wilson.)

Leaseholds.—As far as I know, I was the first to introduce the use of “Inwood's Tables,” the standard English work on the subject, but a practically similar method, though in cruder form, appeared to prevail before 1835, as per following extract from Hoffman's “A Digest of the Charters,” etc., before referred to:

For example: “John C. Morrison is the lessee of No. 6 on our Damage Map, consisting of four lots corresponding with lots Nos. 78 and 79, 133 and 134, of the map of the Sailor's Snug Harbor. His leases are to run seventeen years from the first of November, eighteen hundred and thirty-five, for the first two lots, eighteen years from the same time for the two last. The ground rent of the two first is $70 each, and of the two last $75 each, averaging $72.50 a lot, and upon the four lots equal to $290.

Th[illegible] allowed [illegible] on the four lots is $20,000; the interest at 5 per cent is............................	$1,000
From th[illegible] M[illegible] .000	[illegible]
Income to l[illegible]	[illegible]
The [illegible]	[illegible]
The value [illegible]	[illegible]
	2,022.964
[illegible]	[illegible]
	710
	[illegible]
	8,037.4

Morrison's proportion	$ 8,152.22
Sailor's Snug Harbor, the residue	11,847.78
	$20,000.00

"The whole lease is in this case annulled; the lessee discharged. He gets his satisfaction in the proportion awarded, and the lessors get in the amount now awarded their proportion, including the value of the $290 ground rent (in the amount given to them)."

[Inwood's "Tables" are merely tables giving the present worth of an annuity, so arranged as to provide for monthly payments.—Editors.]

The chief distinction between a leasehold and a reversionary interest, each of which has its own determinable value, the sum of the two being always equal to the total value of the fee in perpetuity, is that the former is fluctuating and insecure, while the latter is fixed and permanent.

It being customary to make leases of the fee on a 5 per cent basis, it would therefore appear that the lessee must provide for a larger return, which, in my judgment, should be at least 7 per cent.

Example: To ascertain the value of a leasehold of 21 years, of which 10 years has expired, the net annual rental, after deducting all possible disbursements, including ground rent, taxes, allowances for vacancies and repairs, being $1,133, and the rent payable monthly in advance:

Net annual rental	$1,133.00
Present value of $1 per annum for 11 years at 7 per cent (Inwood's table)	7.499
Product	$8,496.367
Seven per cent constant monthly factor (table)	1.03169
Product	$8,765.62

Therefore the value of this leasehold will be $8,765.

Renewals of leases where the ground rent remains the same constitute a simple problem, but where provision is made for a reappraisal at the end of the first or subsequent terms, a condition arises which it is almost impossible to solve, as no one can anticipate the future.

Buildings.—Experience in the cost of various structures, material and labor is a very necessary element in determining the sum buildings add to the value of the land, although naturally such is far from being a definite figure, as besides physical deterioration a shift of neighborhood may render expensive improvements simply taxpayers. It can, however, be confidently stated that in high-class fireproof buildings, if kept in repair, there is practically no sensible impairment except from change of fashion.

I have always considered that the cubic foot system, combined, of course, with a thorough scrutiny of the premises, is the most accurate in nearly all contingencies, as you thus obtain the volume, and can more precisely decide upon a unit than ascertain the value of an unknown quantity.

It is obvious that an examination of the exterior only, quite a common occurrence, or even a careful survey of the interior, unless informed of the solid contents, cannot enable anyone to establish a reliable figure.

The capitalization of the gross or net rental is likely to lead to flagrant error, as very often the rents are decidedly inadequate, and otherwise, for special reasons, entirely too high.

In numerous instances where the value of large fireproof buildings was in litigation, the opposing counsel frequently demanding such items, I have divided the cubic foot value into the several components, of which the following are two concrete examples:

From appraisal of No. 42 Broadway (20 stories, 5,215,000 cu. ft.), as of the second Monday of January, 1906:

DISTRIBUTION OF CUBIC FOOT VALUES.

	Cents.
Architects' fees	2.1
Interest	1.0
Increased cost of material, labor, etc., since contract	1.9
Excavation	1.2
Foundation	5.0
Brick work (face brick on two streets)	4.3
Structural steel	6.2
Granite and limestone and terra cotta	3.4
Fireproof floor construction	1.8
Fireproof partitions	0.85
Plastering and furring	2.5
Ornamental and bronze work, stairs and elevator enclosures	4.0
Hydraulic elevators	2.55
Plumbing	1.5
Heating and ventilating	1.2
Electric light plant and wiring	0.8
Carpenter and joiner work	2.2
Interior marble mosaic and finished flooring	2.8
Skylights and copper work	0.2
Hardware	0.05
Roofing, tanks, ash lifts and miscellaneous	1.0
Glass	0.97
Total	47.50

From appraisal of Astoria (part of hotel Waldorf-Astoria, 7,987,000 cu. ft.), as of the second Monday of January, 1910:

DISTRIBUTION OF CUBIC FOOT VALUES.

	Cents.
Excavation, shoring and sheath piling	3.18
Mason work, rough and face brick	2.31
Fireproof floors	1.47
Cut and carved stone	1.55
Structural steel	5.26
Ornamental iron work and bronze	1.69
Fireproof partitions	1.53
Plain and ornamental plastering	1.61
Carpenter and joiner work, includes both rough and finish	4.92
Glass, glazing and skylights	0.54
Concrete work	0.39
Heating, including steam fitting	2.21
Terra cotta	2.13
Sheet metal work	1.06
Waterproofing	0.28
Metal doors	0.12
Marble, marble mosaic, etc.	3.52
Painting, staining and varnishing, includes no decorations	1.86
Plumbing	2.33
Hardware	0.15
Electric wiring	1.41
Electric fixtures	1.24
Passenger and service elevators, dumb waiters and sidewalk lifts	1.68
Ventilation	0.99
Decorations	2.19
Revolving doors	0.12
Refrigeration	0.51
Vacuum cleaning system	0.17
Pneumatic system	0.08
Kitchen fixtures	0.38
Builders' profit	5.36
Architect's commission	3.34
Carrying charges	1.69
Miscellaneous, mail chute, etc., etc.	1.43
Total	59.00

Some Court Decisions.—In ascertaining the respective interests of a landlord and tenant in real property taken by eminent domain the following methods should be adopted:

The fair market value of the whole premises should first be ascertained, which amount is the sum total to be awarded. The actual market value of the leasehold as a whole should then be determined and awarded to the tenant, the difference between that value and total measuring the award of the landlord.

In ascertaining the value of a leasehold the same rule should be applied as in ascertaining the market value of the property as a whole. The tenant's interest in the lease as a whole should be determined in the light of the rent he has paid and his rights and obligations under the lease.

The value of buildings erected by the tenant and which become a part of the freehold should not be treated as a separate entity to the value of which he is entitled in addition to the value of his lease apart from the buildings. (120 App. Div., 700.)

When part of a parcel of private lands is taken by eminent domain for dock improvements by the city of New York, the cost of which improvements is to be paid not by assessment but by the city at large, the commissioners in estimating the just compensation to be made may take into consideration the special benefit accruing by reason of the improvement to the portion of the parcel not taken.

Section 822 of the charter of the city of New York (Laws of 1901, Chap. 466), providing that if a portion of the property of riparian proprietors which has been "built upon or improved" and is contiguous to lands under water or which were originally under water and used in connection therewith, be taken by the city for the improvement of the water front, the owner shall be awarded the fair value of the entire premises less the value of the premises in the condition in which they will be after a part thereof is taken, is constitutional and applies where lands are taken for a water front by the city at its own expense without assessment.

Lands which were originally under water and have been filled in to the grade of an established street have been "improved" within the meaning of said section. (120 App. Div., 849.)

Where a railroad has acquired the bed of a closed street which is part of an area upon which it is erecting a large terminal station, the valuation of lots owned by the railroad abutting upon the closed street and included within the boundaries of the proposed station should be assessed as interior lots, not as lots having a frontage on the closed street.

"Plottage" is a percentage added to the aggregate value of two or more contiguous lots when held in one ownership as representing an increased value pertaining to a group of lots by reason of the fact that they admit of more advantageous disposition and improvement than a single lot.

In making an assessment upon a whole city block upon which a railroad is constructing a terminal station, it is proper to add a "plottage" value, as the land could be cut up into parcels of convenient size and sold with plottage advantages. (130 App. Div., 734.)

When the state compels a man to give up his land for public use, and permits him to recover, not what he thinks it is worth, but only its fair market value, he should have the right to prove every element that can fairly enter into the question of market value.

When structures are well adapted to the character of the land upon which they are erected, the value of the land is enhanced to the extent of the value of the buildings. In such cases the value of each enters into the total value which must be the measure of the owner's just compensation when his property is condemned for public use.

When buildings have an intrinsic value which must be added to the value of the land in order to ascertain the value of the whole, the owner may prove the value of his land and the value of his buildings separately, and the latter may be established by the cost of reproduction after making proper deductions for wear and tear.' The result of adding these two quantities is nothing more nor less than the value of the land as enhanced by the buildings thereon. This is not a conclusive test of market value applicable to all cases, but it is always competent evidence where buildings are well adapted to the land upon which they stand. (198 N. Y., 84.)

The Auto Truck on Geodetic Work.—An unusual feature of the work of the U. S. Coast and Geodetic Survey during the past summer was the successful use of a 1½-ton automobile truck in transporting an astronomical party and outfit through a portion of the southwest which is generally dreaded by the transcontinental tourist. The party was in charge of Mr. C. V. Hodgson and was in the field from May to October.

During the season the truck, carrying a capacity load, was run more than 5,000 miles under road conditions varying from the deep mud encountered in New Mexico and Texas, and the heavy sands of the Colorado River and Nevada desert regions, to the splendid roads of southern and central California.

The cost sheets of the season show that the work was done at a saving of at least 35 per cent from the cost had teams been used. The cost per mile for oil and gas varied from 2.7 cents to 6.6 cents in different sections of the country, and averaged 3.9 cents for the entire season.

A remarkable feature of the performance of the truck and a tribute to the good work of the driver was the fact that, from the time of leaving Colorado Springs to the end of the season, about six months, during which the truck was run over 5,000 miles, only two hours were lost on the road on account of engine troubles.

WATER WORKS

Choice of Pumps for City Water Works.

Perhaps in no other part of a modern water system have so many economic mistakes been made as in the selection of pumping machinery. This is due largely to two causes; first, in the past many civil engineers who have designed water works and recommended the purchase of equipment have not been competent judges of the relative worth of different pumps for a given set of conditions. Second, city boards often consider their judgment on pumps as good as an engineer's and override the latter's recommendations. Thus pumps have often been bought because of low first cost without regard to other and equally important considerations. The present article discusses the choice of pumps for water works service, and is taken from an article by Mr. J. E. Craig, engineer of the Board of Port Commissioners of Jacksonville, Fla., in the Cornell Civil Engineer for February.

For pumping service in villages and small towns where the regular domestic supply is from an elevated tank, the demand is for a pump to fill the tank at intervals and to furnish direct pressure for fire-fighting purposes. If there is available a reliable source of cheap electric power, motor-driven turbine pumps, or triplex plunger pumps are desirable, the latter driven through gears by electric motors. If such electric power is not available, triplex plunger pumps driven by gasoline or kerosene engines should be given careful consideration. These machines are highly desirable for intermittent service, as they deliver their full output at once when started, instead of requiring such time as is necessary to raise steam in a boiler for a steam driven pump. In addition to the great loss of heat from the boiler while the pump is not in actual operation, the inefficiency of all small direct acting steam pumps almost eliminate this type, except when operated in connection with an electric lighting system which requires that steam be kept up most of the time, anyway.

In considering the service for towns which use from 1,000,000 gals. to 5,000,000 gals. a day, there is a broader field for careful consideration as to the actual conditions to be met. When the supply is taken from a river and first delivered to filter beds, there is nothing better than the turbine pump for this service as a low and practically constant head is to be operated against. The turbine pump may be driven either by an electric motor or steam engine, as the local conditions demand. Where the source of supply is wells in which the water does not rise to the surface, the engineer may consider several methods. One is the direct acting deep well pump with the steam cylinder at the surface and the water piston near the elevation of the source of water, actuated through a long vertical piston rod. One of the best examples of this system is at Memphis, Tenn. The Memphis supply is interesting because such a large city is supplied from a great many wells scattered for a considerable distance and flowing into a masonry tunnel which is nearly 100 ft. below the surface of the ground and which discharges by gravity into a sump at the pumping station. The steam cylinders of the vertical pumping engines are in the engine room at the surface of the ground while the water cylinders are far below near the surface of the water. These engines have given excellent service.

Small pumps of the usual deep well type are liable to give considerable trouble with the water piston and valves far below the surface of the floor and where they cannot be inspected, as the ordinary deep well pump has its piston rod and water cylinder in a well usually less than 1 ft. in diameter. The pumps at Memphis are in a sump large enough to give ample access even at the bottom for attention and repairs to the water cylinders.

In parts of the country where the source of ground water is not more than 30 or 40 ft. below the surface the ordinary duplex steam pressure pumps are put in a sump, far enough below the surface so that water can be drawn from the natural source with a suction lift of not more than 15 ft. This arrangement, which subjects the pumps to possible submergence if the level of the ground water should rise, and from the usual dampness and inacessibility of such places, is in small favor. In the rice fields of Louisiana and Texas a submerged vertical turbine pump in the bottom of the well, driven through a vertical shaft either with a belt or electric motor, has found considerable favor.

For a reliable method of raising water from a considerable depth probably there is nothing better than compressed air. The air lift leaves much to be desired in the matter of total efficiency, but its reliability of operation and durability offset this objection. The entire engine is in the pumping station. One compressor can raise water from one well or many and they may be scattered widely. When the available funds will provide a compressor with Corliss valve, steam cylinders, and condensors, and two stage compression, if the required pressure warrants this, very satisfactory operating efficiency is obtained.

In the choice of pumping engines for the smaller cities, which require between 1,000,000 and 5,000,000 gals. daily, there is a slightly wider range of equipment from which to make a choice to meet the conditions of the individual installation. In this class of pumping station 24-hour attention is usual. Most such cities operate an electric lighting system in connection with the pumping station, which requires that boilers be kept in operation constantly. Under this condition the choice lies between several arrangements with steam as the motive power. When the engines operating the generators are of high efficiency, ample capacity, and in duplicate, electric motor driven pumps give excellent total efficiency. The higher steam efficiency obtainable from the steam engine often more than balances the loss in electrical equipment. Either turbine pumps, direct connected to electric motors, or triplex plunger pumps, motor driven through gears, are available.

It is usually demanded of pumping engines that they deliver the normal domestic consumption, against about 50 lbs. to the square inch, for more than 95 per cent of the time in operation, and yet be capable of furnishing this same output and considerably more for fire streams, at 125 lbs. to the square inch, or more. This condition means the engine must operate 95 per cent of the time, at about 40 per cent load, or at times of fire at more than 100 per cent over-load, depending on whether the engine is designed for its rated service at domestic or at fire pressure. To meet these requirements two turbine pumps can be operated in series for fire pressure and either operated singly for domestic service.

To have duplicate equipment, either set of which is capable of meeting any reasonable daily demand for both domestic and fire service, is absolutely essential for a first-class water works pumping station. To meet this condition will require much idle equipment, or operation at small load factor, with turbine pumps. Triplex plunger pumps, motor driven, give good efficiency under domestic service pressure, and will deliver the same volume at double the pressure when required. They are reliable and worthy of careful consideration in this connection. For service of this character, duplex directing acting, tandem compound, or triple expansion, condensing pumping engines are probably the most used. Under favorable operating conditions a duty of 70,000,000 ft.-lbs. per 1,000 lbs. of steam may be approached. In the smaller stations of this class, one more expensive compound engine may be installed, which will do most of the work with reasonable efficiency, and one Standard Underwriters' Steam Fire Pump, which will serve to aid in giving fire service and can furnish the domestic supply also when the more efficient engine must be stopped for repairs.

In many of the stations delivering 5,000,000 gals. a day or more, vast sums of money are wasted, either through the operation of equipment unsuited to the conditions, or that would be inefficient under any conditions. Here it becomes possible to make interesting comparisons between present and final economy. Large pumping engines may be obtained that will give a very high operating efficiency. Some in daily operation are giving a duty of about 200,000,000 ft.-lbs. per 1,000 lbs. of steam. These engines, of course, represent considerable capital, and the problem before the engineer is to determine how large an investment the proposition will warrant. It is possible to purchase costly, high-duty engines and operate them under such conditions that the interest on the first cost of the engine is more than the saving effected by their higher efficiency in operation.

For the smaller stations in this class the horizontal cross compound crank and fly-wheel type of condensing engine offers a satisfactory total efficiency; its first cost is much less than the vertical triple expansion, crank and fly-wheel type, and a duty of 125,000,000 to 150,000,000 ft.-lbs. can be obtained.

In the larger stations using only engines of a daily capacity of 12,000,000 gals. or more, every factor before any but the vertical triple expansion type of engine is chosen should be considered, if the necessary money can be secured to install the more costly type. Data should be obtained as to the actual daily probable output during the term of service of the engine and the cost and efficiency of the two general types of machines. In the larger pumping stations, when the city also owns its electric lighting system, there is a possibility of securing considerable saving in the joint operation of the two stations by having a turbine pump designed to deliver at best efficiency the average domestic consumption so that it will be running practically constantly; this pump to be driven by a synchronous motor so designed and operated as to improve the power factor on the electric circuit.

The Faulty Operation of the Average Public Utility with Special Reference to Water Works—Suggested Betterments.

The average small water works system represents the largest single investment in the city in which it is situated, but less attention is given to its care, operation and the handling of its business than to any other business enterprise in the city. This is particularly true in the case of municipally owned plants. The same thing is true of many unregulated privately owned plants in the smaller cities where slipshop management is made possible by high rates and cheap service. The need of more expert knowledge in connection with utility operation has long been indicated. In a paper before the recent annual meeting of the Kansas Engineering Society Mr. N. T. Veatch, Jr., Associate Engineer with Worley & Black of Kansas City, Mo., read a paper along these lines from which the following matter is taken.

The majority of utility plants in Kansas were designed and constructed under the advise of competent engineers. If properly operated they should be satisfactory. Mr. Veatch mentions a few interesting examples of plants, however, so poorly designed or constructed as to make successful operation difficult if not impossible.

Thus the city of Caney at present pumps its water supply from the Caney River, directly into the city standpipe, which is connected to the city's distribution system. Some few years ago a self-styled engineer designed what the people considered a filter plant. This consisted of nothing but a concrete pit on the river bank, which was filled with broken stone. The idea was that in allowing the water to flow to the pumps through the broken stone, it would be purified. As would be expected, the bed of broken stone soon became clogged, and as there was no way of cleaning it, it was necessary to pump direct from the river. This plan has been followed almost since the installation. Since the raw water is pumped direct into the city, is not used when it can be avoided. As a striking example of the effect of this bad water the city has 668 services, but only 375 are being used. The plant costs about $9,000 per year to operate, and the revenue is between $4,000 and $5,000.

On top of all this the City Council, when they found that the plant was losing money, in an attempt at economy, decided that it would be wise to carry the discharge line from the pump up the outside of a 70-ft. standpipe and discharge into it from the top. The idea was to overcome the extra pressure due to pumping into the bottom of the tank, as it would in their opinion be easier to pump the entire amount the entire height of the tank through a 10-in. pipe than to pump into the bottom of the tank against a body of water 30 ft. in diameter regardless of height. This of course helps to make the plant a losing proposition, especially as the pressure from the standpipe was considerably more than the city needed for domestic use. The city expects to let a contract shortly for a modern purification plant, which will enable the city to sell the water for domestic use. The plans include arrangements for using the standpipe for emergency only, which will save perhaps 30 per cent of the cost of pumping. This is possible as the standpipe is located on a hill, which is considerably higher than the city. By placing the filter plant on this hill enough pressure can be obtained by allowing the water to flow by gravity into the city from the filters.

At Osawatomie, a direct pumping system was installed, with steam pumps. Osawatomie has a population of about 4,000 people. The fact that it is necessary to run the pumps 24 hours each day, and as their capacity is based on the maximum demand that might be made upon them for fires, etc., it makes the pumping cost much higher than necessary. Also the city later on installed an electric lighting plant with oil engines. At present the city is operating their steam plant and their oil plant side by side, each operating 24 hours per day. One can readily see what a problem the operator of such a plant has to make it pay, even though he is capable, as is the case. Osawatomie also has a filter plant which has never been satisfactory. Plans are being drawn at present for a complete purification plant, and the changing over of the two separate plants to operate with the same power. The pumping will be done by electricity.

Garnett is another city that has been operating under adverse conditions. For a large share of the year it has been necessary to pump the water three times. The supply is ordinarily taken from a small impounding reservoir which is replenished regularly by pumping water from a small stream about three miles away. The water was pumped by an old steam-driven mine pump through an 8-in. cast iron pipe line for part of the distance, and then flowed by gravity through a 10-in. vitrified clay pipe to a point several hundred feet from the edge of the reservoir, where it was discharged upon the surface of the ground. The pipe line leaked badly, in fact every joint had to be re-poured and calked. Most of the water which got to the end of the pipe line was lost in seepage and evaporation. The excessive cost of pumping and the fact that the filter plant was unsatisfactory and poorly designed, causing the quality of water to be bad, has made the successful operation of the utility impossible. The city has repaired the pipe line, and made arrangements to pump directly into a new basin at the filter plant which will avoid the loss of water as heretofore. The filters were repaired, and as soon as the city gets straightened out on their light plant, which they have just purchased, motor-driven pumps will be installed at the auxiliary station, and the city will be in shape to make their utilities profitable.

There are several other instances that could be mentioned where the physical condition, the design and other features make it next to impossible to operate economically, but as a whole the plants in Kansas have been well designed and constructed where competent advice has been followed. The supervision of the State Board of Health has been of great value in getting good plants installed. The object of this paper, however, is to deal more with operation than the general features of design.

Assume that a city has voted bonds for one or more utilities, and that these have been designed and constructed in accordance with best engineering practice to meet the local conditions. In all probability the first thing that is done after the construction work is completed is to engage some one to run the plant or plants, and quite often, although there are quite a number of exceptions, the only qualifications the chosen man has are that he may have worked in an automobile repair shop, or perhaps has run a threshing machine engine. And it is safe to say that the cheapest man the city can get is the man chosen. The idea generally seems to be that if some one can be engaged who can make the plant run, regardless of how it is run, that everything will go along nicely. Little if any thought is given to the business end of the operating. This part is sometimes turned over to the city cuerk and sometimes almost turned loose to shift for itself. It is nothing unusual to go into a city and find that there is absolutely no idea on the part of the city, and particularly the man in charge, as to the amount it is costing to produce the product of his utility, whether water or light. It is also nothing strange to find that the number and location of services are not known; and where meters have been installed no record is kept of the time of placing or the condition when installed. There is also practically no attention paid in selecting a superintendent or manager as to whether or not he will create a favorable impression with the customers and be able to handle the controversies that invariably arise between manager and customer in a proper and politic way.

There are many chances for the proper man to make a favorable showing at any of the cities owning and operating utilities. Quite a few cities in Kansas are realizing this and placing plants in charge of trained men. Washington, Abilene, Coldwater, McPherson, Osage City, Garden City and several others have placed graduate engineers in charge of their utilities. There are several other cities in the state that have perhaps the best operating records of any, and whose utilities are in charge of men who have made a very careful study of the business. Of these cities, Coffeyville, Cherryvale, Topeka, Fredonia and Emporia have perhaps secured the best results.

A good example of what a wide awake, capable water works superintendent can do is at Washington. The city recently hired a university engineer graduate, who has had four or five years' experience in the design and construction of water works. He found absolutely no records whatever, and found that a large number of meters had apparently never been read. Other meters and services were not even being charged the minimum rate, which was the customary charge regardless of what the meter read. He will perhaps double the city's revenue by getting their present business straightened out and will then be able to build up a larger business. It is evident that such a plan on the city's part will more than make up for the difference in salaries of competent and incompetent superintendents. There are other similar instances, which prove beyond any doubt that it is false economy to hire cheap men to handle a city's utilities.

SUGGESTED BETTERMENTS IN OPERATION METHODS.

The following are some suggestions which it is believed would be of value if followed.

Management.—The public utilities in every city, regardless of size, should have a well trained, energetic man in charge. He should be given such help as the size of the plant would require, and should be allowed to select his own help, also to discharge it if necessary. He should be given to understand that politics will not enter into his work in any way, and that his position depends on just one thing, and that is "results."

The manager should keep his records, accounts, etc., in such shape that they can be made public at any time. He should attempt to take the people into his confidence at all times, for in fact they are his stockholders, and the city officials his board of directors.

He should be given power to spend such money as may be needed to advertise for new business. There is no reason why a city should not advertise its product the same as any other concern. The fact that they have a monopoly is no argument for not advertising. The people need to know what is going on and to feel that by patronizing the city's utility they in turn reduce their taxes. The manager should also feel free to call in expert advice.

Coldwater, Kans., a city of perhaps 1,000 people, has had for several years a manager for its utilities who is a graduate of the engineering department of Kansas University. The utilities even in this small place, located almost at the southwestern corner of the state where freight rates are high, have been paying investments from the start. This is another strong argument for efficient management.

The idea of "city management" is working for the same efficiency in the entire city government, as is desired and essential in the utilities. The commission form of government is a step forward, but it is evident that it is far from being a cure-all, as some of the greatest drawbacks to efficient government are not eliminated. To be more explicit, politics still play an important part in selecting employes and labor, and the average superintendent is handicapped continually by such interference.

There are several examples in the state where the commission form of government has shown its advantages over the council form. At Holton, the commission took charge of the city when the utilities were in bad shape and in less than three years' time have placed things in tangible shape and the plants are now operating successfully.

Kingman is another city that has had a similar experience. The street department and water works at Emporia furnish a striking example of what the proper men can do when put in charge. Manhattan, Garnett, Wichita and a number of other cities have shown the advantage of the commission form of government.

To furnish the best service at the lowest possible cost and to sell all of his output possible should be the ambition and persistent effort of every water works manager.

Accounts.—Next to having a good manager, the most important item connected with public utilities is the system of accounting. Too much stress cannot be laid on this. Accurate records should be kept of each consumer, giving his name, address, list of house fixtures, size, number and make of meter, and each monthly or quarterly meter reading should be shown on the books. Records of meter readings should not be kept as a permanent record by simply filing the meter reader's cards or book.

Accurate account should be kept of all expenditures, showing articles purchased, to whom salaries are paid, etc. Record should also be kept showing by whom each purchase is made, and by whom authorized. The system of issuing orders for all material which are to be honored only when signed by the superintendent, is perhaps the best system of handling expenditures for material. The order should be made in duplicate, and should show on its face the purpose for which the material is being purchased. It is then an easy matter to distribute accounts properly by simply checking invoices against these orders.

All office records should be complete, reliable, and as simple as possible to allow of immediate access.

There are very few cities that carry a charge on the books of either their water or light departments, for rental of hydrants, or street lights. It is argued by some that such charges are of no value, as it is simply a matter of shifting accounts. Granting that it is merely a shifting of accounts, is it not a proper one? In cities of 10,000 population or less the entire system, including mains and pumps, electric distribution lines, engines and generators are from 25 to 75 per cent larger than would be needed for serving water and light to the city for domestic use only. Why then should the people who become consumersfurnish 100 per cent of the revenue. The city as a whole is benefited by the fire hydrants and street lights, and the city as a whole should be taxed for this benefit. The revenue from the city at large covering hydrants and street lights, plus the revenue from the sale of water, should make any properly managed utility pay unless there are some special features to make the plant lose money.

Records.—Accurate records should be kept of all operating items, such as plant costs, hydrant flushing, repairs, extensions, new services, etc. The records of plant operation should be daily, and should enable the manager to tell each day what it cost to produce his product the day before. This gives him a means of determining what sort of an engineer or engineers he has at the plant. This is especially true when coal is used for fuel, as the personal qualifications of the fireman show up in the coal consumption. There are few firemen who can, without advice and continual watching, carry the right amount of draft, or proper thickness of fire.

Records of all hydrants, giving location, make, date of installation and repairs, and date of last inspection, should be kept. Quite often the hydrants are not thought of until the fire department wishes to connect quickly and sometimes finds it out of repair.

Accurate records should be kept of all extensions to mains, new services, and all improvements which are covered up. This is particularly true of all valves.

The fact that careful management is essential cannot be disputed by any one, and the idea is growing even though it is as yet in its infancy. If cities can give assurance that there will be no political harrassing and remove the continual worry about the keeping of one's position, they will attract a large number of able men, and especially engineers, into their service. From the engineer's standpoint the work is full of possibilities, and at present has only the objectionable features indicated.

Data and Discussion on Relative Efficiency of Liquid Chlorine and Hypochlorite of Lime.

The accurate determination of the ratio between amounts of liquid chlorine and hypochlorite of lime which will perform equivalent disinfection of water is not a simple matter. Such ratios have usually been based upon approximate bacterial efficiency. Many factors must be considered in arriving at a conclusion as to this ratio. These factors were discussed by Mr. Frank E. Hale, Director of Laboratories, New York Department of Water Supply, Gas and Electricity, in a paper before the latest annual meeting of the New Jersey Sanitary Association. The paper is here given in part:

FACTORS INFLUENCING RATIO.

1. Overdosing will influence the results. If the dose applied is greater than required the average figure for chlorine applied will appear too large and the bacterial removal proportionately too low. Again overdosing, in my experience, frequently results in poor efficiency and should be avoided. It is my belief that it eats into sediment and sets free clumps of material containing B. coli, thus sometimes apparently increasing the B. coli and the bacteria in the treated water. From the first I have felt that the setting free of sediment was responsible for so-called aftergrowths. In fact such seems to be the consensus of opinion at the present time. 2. Underdosing also tends to throw error upon an average, since if the available chlorine applied is too small it produces little or no bacterial removal. 3. The quality of the water treated affects the results also. Turbidity and color influence the amount of needed chlorine greatly, the latter rising or falling with increase or decrease respectively. Presence or absence of miscroscopic organisms, hardness or softness, all have their influence. 4. Apart from these influences the goodness or badness of the water, considered from a bacteriological standpoint, decreases or increases respectively the apparent efficiency. It is well that greater percentage removal is shown by a sand filter when the bacteria in the raw water are high, that with less than 100 bacteria in the raw water a high percentage removal is rare. 5. A certain number of tests of treated water in my experience will show no removal or even an increase in bacteria though the dose applied is correct and sufficient. These may be due to accidental variation in the application of the chemical, the slipping by of untreated water, disturbance of sediment, etc., but they influence the average and the ratio. They occur with both liquid chlorine and hypochlorite of lime. 6. Attenuation only of B. coli instead of destruction is frequent. 7. The limits of analysis offer another difficulty. Ordinarily tests are made in 0.1 c.c., 1 c.c. and 10 c.c. of water. If all three dilutions are positive on the raw sample the limit may not have been reached and a test in 1 c.c. in the treated sample may indicate a purification of 90 per cent when it may really be 99 per cent. Again a negative test in 10 c.c. in both raw and treated water may be a 90 per cent removal although it appears to be 0 per cent because of the lack of 100 c.c. tests. 8. Lastly the amount of chlorine actually getting into the water in hypochlorite of lime application is very irregular and uncertain, resulting in tremendous errors.

TABLE I. COMPARISON OF BACTERIAL REMOVAL AT VALHALLA, N. Y., BY LIQUID CHLORINE AND BY HYPOCHLORITE OF LIME.

	Raw water					Treated water						% removal.	
			B. coli					B. coli					
Treatment.	No. of analyses.	Bacteria per cc. 37° C.	0.1 cc.	1.0 cc.	10 cc.	No. of analyses.	Bacteria per cc. 37° C.	0.1 cc.	1.0 cc.	10 cc.	Chlorine ppm.	Bact.	B. coli.
CaOCl₂	262	171	19%	53%	88%	260	38	3%	10%	37%	.634	78%	83%
Liq Cl	121	185	30%	58%	83%	155	49	1%	16%	52%	.277	71%	91%

RESULTS AT VALHALLA, N. Y.

Although the City of New York has used hypochlorite of lime and liquid chlorine at many points it has been difficult to choose a point at which the data were sufficiently exact to be reliable. For example, in the case of brooks the exact amount of water treated is not sufficiently well determined. Excess of hypochlorite of lime is fed in order to insure good bacterial results.

At Smith's Pond, Brooklyn, two sources of supply admixed, a few feet from the point of chlorination, so that mathematical combination according to volumes was necessary of the analyses of the two raw samples. At Watt's Pond, the treated sample is mixed with well water. In the case of Croton water, treated at Dunwoodie, the treated sample taken for analysis has passed through a large reservoir so that the time element is uncertain and the daily results could hardly be studied.

Only at one point did the data seem complete and sufficiently exact to compare, and even there the available chlorine is based upon the hypochlorite of lime, amount of dry powder, used. The results at this point, Valhalla, New York, with liquid chlorine and hypochlorite of lime have been carefully studied. The results with hypochlorite of lime cover February, 1912, to November, 1913, inclusive, and with liquid chlorine December, 1913, to September, 1914, inclusive. The liquid chlorine results are based on weight of chlorine delivered. The machine is an Electro Bleaching Gas Company's with absorbing tower. Analyses have been made three times a week. The analyses for B. coli are made upon 0.1 c.c., 1 c.c. and 10 c.c. quantities. If all three tests are positive in the raw sample and 0 in the treated the result is considered to be 100 per cent removal. If three positive tests are reduced to one, or two positive tests to none, the removal is considered to be 99 per cent. If three positive tests are reduced to two, two to one, or one to none, the removal is considered to be 90 per cent. In averaging several B. coli results to find percentage reduction 0.1 c.c. results are multiplied by 100, 1 c.c. results by 10, and added to the 10 c.c. results. The resulting sums are then compared. The averaging analyses at Valhalla are given in Table I.

In order to study the results more closely, the analyses were grouped by amounts of chlorine applied and separately averaged. The results obtained by liquid chlorine between 0.14 to 0.36 p.p.m. appeared to be justly comparable to those obtained with hypochlorite of lime between 0.41 to 0.63 p.p.m.

That a large amount of the available chlorine of hypochlorite of lime may be wasted has been demonstrated this year at our Dunwoodie plant. West states that, owing to variation in strength (21 per cent—43 per cent of available chlorine in the powder), lumpy condition, difficulties of admixture, and variations in feed, under best conditions only 87 per cent of added available chlorine is obtained at the Torresdale filter in Philadelphia. At Dunwoodie there are two 5,000-gal. concrete tanks into which alternately a drum of hypochlorite of lime (700-800 lbs.) is washed by water delivered with force from hose. The emulsion passes through a coarse screen where lumps are crushed with a hoe by hand, and the solution is then agitated with compressed air. Improper bacterial results were obtained in June which led to a thorough investigation by the laboratory force. Analyses were made every one-half hour of the hypochlorite of lime solution and it was found to be very irregular in strength and to contain not nearly what it should of the hypochlorite of lime added. As low as 10 per cent of the available chlorine added was delivered at times toward the end of a run, and the average loss was altogether too high. Instructions were given the laborers to crush more thoroughly all lumps, to blow the solution several times during the rest period and finally settle two hours. The air blast is applied three to five minutes at a time. Later the system was adopted of blowing the sludge in a half tank of fresh water before adding fresh hypochlorite of lime. When heavier dosing is necessary, because of a large amount of B. coli in the raw water, two drums are successively added to each tank, making over 1 per cent solution of available chlorine. This seems preferable in order to give sufficient time for solution and settling, a tank being emptied in six hours instead of three hours when feeding eight drums a day. The sludge is washed out after an accumulation of about 10 drums when there is an unavoidable loss of some of the solution. Samples at the beginning, middle and end of each run have been analyzed since the middle of July, 1914, and serve as a good check on the laborers who make up the solution. The first week about 95 per cent of the chlorine added was actually applied, the second week it dropped to 85 per cent, and the third week to 75 per cent. Whenever a poor run is called to the attention of the laborers results improve. When the three analyses for a single run vary there has been insufficient blowing. Thus the poor results at midnight of July 17, for example, were due to a heavy thunder storm during which, the men afterward admitted, they had failed to use the electric pump which drives the air. Absolute changes of the value between tanks is due to carelessness in breaking up lumps, variation in solubility of the hypochlorite of lime, differences in weight of the powder in different drums, and variation in percentage of available chlorine. To equalize these fluctuations the water of the new aqueduct (seven-eighths of the supply) is passed through Jerome Park Reservoir entering at the lower end and leaving at the upper middle side so as to create circulation, admixture and storage. The storage capacity of the reservoir is about three days' supply. The most interesting feature of this work, apart from economy, is the reduced amounts of hypochlorite of lime used to produce such good results. Some of the individual figures were as low as 0.10 to 0.14 p.p.m. chlorine and at present daily averages are between 0.25 and 0.40 p.p.m. This is about the quantity at which the liquid chlorine figures have been maintained in treating Bronx Water at Valhalla, of quite similar character.

There have been published figures for available chlorine of hypochlorite of lime treatment effective at 0.1 p.p.m. chlorine. If based upon sufficiently accurate data, they tend to support the above remarks and show that hypochlorite of lime may be active in as small amount as liquid chlorine. Cincinnati, Ohio, has used liquid chlorine on filtered water as low as 0.12 p.p.m. Pittsburgh, Pa., has utilized hypochlorite of lime, introduced directly into the water so that it was completely available, on filtered water as low as 0.12 p.p.m. available chlorine.

During the spring of 1914 an extended series of experiments were made comparing the application of liquid chlorine to water by direct application and by previous solution in running water. Two machines were used, the Leavitt-Jackson with corundum distributors and the Electro-Bleaching Gas Company's with an absorption tower. The experiments were made at Smith's Pond, Brooklyn, on a mixture of water from Smith's Pond with conduit water, the latter a mixture of surface and well water. The two raw waters were analyzed separately and results were combined proportionately to the amounts of each. Each machine was run 24 hours alternately and three samples for analysis, one-half hour apart taken during the last hour and second hour of each run, so as to bring the character of the water compared as near alike as possible.

It appears from the results obtained that the chlorine yields the same results bacteriologically whether introduced directly to the water or put into solution first. Bacteria counts were made on both gelatin and agar. An interesting feature was indicated in the fact that the absolute number of bacteria growing upon gelatin at 20° C., and upon agar at 37° C. were practically the same in the treated water, tending to indicate that the residual bacteria were of a type that grew either at 20° C. or 37° C. and were probably identical. Tests were made for B. coli in the 100 c.c. quantity also. With one exception this test was always positive in the treated water, possibly due to the fact that cold weather prevailed.

In order to study the rapidity of the action of the chlorine a series of square holes were made into the aqueduct, lined with boards, and fitted with a cover in order to avoid contamination in sampling. There were six holes, the last several hundred feet from the machines. Samples were taken, tested with orthotolidin and compared with standards. About 0.2 p.p.m. chlorine was immediately consumed. Hole No. 2 was only a few feet away from the point of treatment. Such immediate consumption of chlorine probably varies with the character of the water treated. The water in these tests was moving at the rate of about 3 ft. per second. That the action of the chlorine is practically instantaneous is also shown by the fact that the bacterial results at an intermediate point of sampling within a few feet of the point of treatment averaged practically the same as at the furthest point of sampling.

Both machines showed fluctuations in amount of chlorine fed as related to that indicated. The Leavitt-Jackson machine varied about + 5 per cent, but fed a total amount practically as indicated. This machine delivers a definite weight of chlorine, consequently pressure and temperature has no effect except as regards lag in adjustment automatically made by the machine when conditions are fluctuating. The Electro-Bleaching Gas Company's machine yielded less weight of chlorine than indicated, sometimes as low as 72 per cent. This is in keeping with results at Somersworth, N. H. In a run from March 31 to June 26, 1914, feeding 0.34 p.p.m. chlorine, the actual feed was 73 per cent of the indicated amount. In another run from June 26 to August 28, feeding 0.38 p.p.m., the actual feed was 83 per cent of that indicated. In testing the machine at Smith's Pond, the water flowing through the tower was measured by means of a ⅛-in. orifice and a mercury "U" tube. The solution was analyzed for available chlorine.

SUMMARY.

1. Intensive study of the application of liquid chlorine and of hypochlorite of lime during the course of three years at Valhalla, N. Y., points to a ratio of 1:7, chlorine to hypochlorite of lime, as productive of equal bacterial purification when hypochlorite of lime is applied under usual conditions. 2. Insufficient attention to details, causing serious loss of available chlorine, is a large factor in the use of hypochlorite of lime, and greatly affects the above ratio. When efficiently used the ratio approaches 1:3. 3. Liquid chlorine is equally efficient whether applied to the water as a gas or in solution. 4. A certain immediate consumption of chlorine takes place, probably dependent on the character of the water treated. This is true with both liquid chlorine and hypochlorite of lime. Liquid chlorine soon disappears entirely from the water whereas residual hypochlorite of lime may persist for weeks. 5. The bactericidal action of chlorine is practically instantaneous. 6. The amount of chlorine treatment should always be based on analysis of the solution with hypochlorite of lime and upon loss in weight of chlorine with liquid chlorine.

I may perhaps in closing best add in concise form the important advantages liquid chlorine has over hypochlorite of lime. 1. Compact installation. 2. Ninety per cent less storage space required for chemical. 3. No loss of strength of chemical during storage. 4. No sludge problem. 5. No residual hypochlorite in water, hence less corrosive effect, no complaint of odor, and less danger from overdosing. 6. More effective per unit applied. 7. More uniform application. 8. Better and easier regulation. 9. Easier to handle generally and less obnoxious. 10. No increase of hardness in water. 11. Labor cost less and chemical more efficient making total cost about equal.

The Development Plan for the Water Distribution System of the City of San Diego, Cal.

The function of a distributing system naturally divides into two parts: first, the ordinary consumption for domestic, commercial and public uses, and second, the use for fire extinguishment. In the first case the demand is relatively uniform over the entire city and distributed over many hours of the day, while in the second case the demand is extremely high for a short time and is usually confined to a small area. Also this second case must be cared for without interruption to the first. Both considerations must be kept in mind in developing the system. How this is done at San Diego, Cal., is here described from information given by P. H. Thearle, chief draftsman of the Department of Water, in his paper before the January meeting of the employes of the department.

In considering an ideal water distributing system for the entire city of San Diego, it is immediately seen that the area covered is very naturally divided into four separate divisions, as the main portion of the city south of the San Diego River, including Old Town, all of Point Loma and Ocean Beach, Pacific Beach, and last, La Jolla.

Each of these, under the present arrangement of bringing the water into the city, must be supplied by a main feeder from the central distributing point, the University Heights Reservoir. These feeders should be capable of supplying during any period the maximum probable use, bearing in mind always the probable future growth of the section, considering and balancing against this the probable useful life of the pipe and the cost of it. Each of these natural divisions is, or should be, provided with a storage reservoir capable of caring for any fluctuation in rate of consumption, including any sudden fire demand.

Also in considering these large main feeders it should be borne in mind that they will be subject to more or less draught from other districts they pass through other than the one they finally serve.

Having the main and primary feeders cared for, attention is given to the separate natural divisions. Each of these fed by a large main feeder is divided into smaller secondary areas, each of which is surrounded by a system of pipes sufficient in size to supply any demand up to the maximum for fire extinguishment in any two adjacent areas.

In portions of the city where the blocks are even and the streets straight this secondary division and also the next consideration, the spacing of the fire hydrants, is relatively simple, but in a district where the contour of the country is rough and the streets are laid out accordingly, this secondary division sometimes requires considerable study both as to the location of pipes and the spacing of hydrants.

While on the subject of hydrant spacing which should be the next consideration I will not attempt to go into the matter of pressures, quantities of water, hose lengths, etc., but will base hydrant spacing upon the recommendations of the National Board of Fire Underwriters, Committee on Fire Prevention, made in May, 1910. Their recommendations were:

> That......hydrants.......be installed so that there shall be: (1) in the principal mercantile and other important districts, two hydrants at each street intersection; (2) in other districts one hydrant at each street intersection and intermediate hydrants.....so that the distance between adjacent hydrants in no instance will exceed 350 ft.

It is obvious that such a recommendation, if carried out, all over the city, would be very expensive, so that San Diego will space its hydrants with a view to the present conditions and future growth, trying to approach as near as possible to the above mentioned recommendation.

To go back to the secondary division in the distributing system a great deal of study should be given to the hydrant spacings. Many different arrangements can be laid out but the main idea should be to arrive at the most efficient spacing, in other words, the least number of hydrants (and lowest cost) which would be consistent with safety and a minimum hose length in case of fire.

The final division of the system is the smaller pipe that feeds the separate hydrants and cares for the domestic and commercial consumption. These pipes feed and cover the areas surrounded by the larger secondary mains. These should be laid as much as possible in the cross streets, or those which cross the short sides of the blocks.

Since the primary consideration is fire protection there would be no object in entailing the extra expense of laying these pipes in the longer streets.

The consumption which occurs on the long sides of the blocks can be cared for by small pipes, say by 4-in. or even by 2-in. where a minimum consumption would not warrant larger sizes.

The sizes of these smaller pipes which feed the hydrants must, of course, be proportioned so that larger ones feed the center of the secondary areas and smaller ones support the larger toward the edge of the area. It is, of course, apparent that if a fire occurs, the consumption necessitated thereby is confined to a very small area which is fed from all directions. This consumption in the case of an average fire would probably be confined to two or three hydrants at the most and the pipes should be so proportioned that at least this demand can be cared for without any material lessening of pressure or lack of water.

GENERAL CONSIDERATION.

While a development may appear to be right at the time of its inception, if at a later time when the question comes up of installing the pipe, due to a more detailed study of any separate portion or to a location very remote from a large supply main, it may be deemed inadvisable to install mains of a size developed for that particular locality, there certainly can be no harm done to the remainder of the system by changing the development in this case to conform to present rates of growth or local development.

The ever present real estate promoter with his acreage property subdivided into small lots which he wishes to sell for a dollar down and a dollar a week is the greatest enemy to a properly developed water system. However, the Department of Water, as the servant of the people, should listen to his demands and in nine cases out of ten it can work in harmony with him. After a due consideration of his needs and of the location of the land it is possible to lay out a water system that will not bankrupt him and will care for all ordinary consumption and any probable fire demand.

In the first steps of laying out a development due consideration should be given to pipes which are already installed. In nearly all cases a development can be devised that will make use of these pipes and still retain its efficiency. It should also be borne in mind that the greatest cost of a water system is in the distributing pipes.

SEWERAGE AND SANITATION

Some Considerations Affecting the Collection and Disposal of Sewage at Seaside Resorts.

For a distance of approximately 125 miles the coast of New Jersey has an almost continuous line of summer resorts, some large and some small. These resorts are receiving a constantly increasing number of visitors, excursionists and cottagers, and are growing rapidly. This same condition prevails elsewhere in states lying adjacent to the Atlantic and Pacific Oceans and to the Gulf of Mexico.

The sewage problem at these pleasure colonies is identical with the same problem as met with elsewhere, in that it consists in removing the sewage, or used and dirty water, and decomposing wastes as rapidly and completely as possible from the dwellings, and disposing of them in a safe, inoffensive and economical manner.

A number of exceptional conditions exist, however, some obvious and some not so evident, which must be taken into account if satisfactory results are to be obtained. These conditions were fully considered in a paper before the latest annual meeting of Section D of the American Association for the Advancement of Science, held at Philadelphia on Dec. 30-31, 1914, by Mr. Marshall A. Pugh, Civil Engineer, Philadelphia, Pa. The paper in full follows.

It is the purpose of this paper to call attention to some of the considerations affecting the design and construction of collecting systems and sewage disposal plants at such resorts, more particularly where a departure from ordinary current practice is involved. While nothing particularly new or novel will be presented, it is probable that certain details may be helpful to engineers encountering somewhat similar conditions elsewhere.

In a brief enumeration of salient points wherein these seashore colonies differ from ordinary inland communities, one of the first and most striking is the enormous seasonal change in population. One such place for which a plant is at present being designed has in winter, about 700 inhabitants, while in summer the number rises to 10,000.

In the second place, they are situated on a body of water of vast extent, capable of caring for an unlimited amount of sewage. The beach front of this body of water, however, is one of the main assets of the resort, and is used for bathing purposes. These communities also frequently adjoin an inlet, bay or river, which may or may not be salt, but which is ordinarily very popular for boating and fishing, and in some instances is an important source of oysters and other shell-fish. Often the water in such bays and inlets is very shallow, and has but little current, or perhaps pretty much the same water flows to and fro with each successive tide. As may readily be surmised, these towns are ordinarily flat, the highest point is but a short distance above high tide, and the street system commonly consists of two, three or four very long streets running parallel with the beach, intersected by short cross streets.

THE COLLECTION SYSTEM.

The foregoing conditions affect the design of, first, the collecting system, and second, the disposal plant. Some of the ordinary canons of sewer design must be deliberately departed from to a greater or less extent, if the best results are to be obtained, and other things, permissible elsewhere, are inadvisable here.

The collecting system should be designed to meet the conditions imposed by the level site and the nearness of ground water to the surface. In other words, grades and infiltration are the two main elements. In order to prevent deposits which clog them and cause odors by putrefying, sewers should be laid at such a grade that the flow of sewage will wash along all such solids, or in other words, flow at a self-cleansing velocity. It is desirable that this velocity should not be less than 2 ft. per second in sanitary sewers. But giving such fall to a sewer, while most desirable where it is feasible, may result in running the outfall down so low that pumping is necessary, while lighter gradients would permit of a gravity system.

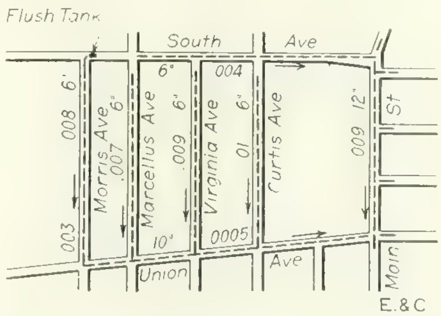


Fig. 1. Plan of Union Ave. Sewer, Manasquan, N. J., Showing Use of Light Gradient to Avoid Necessity of Pumping Sewage.

The porous sandy soil commonly found is so permeable that a deep sewer, apart from the difficulty of construction, is almost sure to suffer from a most objectionable amount of infiltration of ground water. At one resort where the ground lay practically level for a mile back from the beach, the writer in 1908 adopted grades in three of the trunk sewers producing a velocity of 1.1 ft. per second, with some short stretches at still lower velocity. Forty per cent was saved in the cost of the system, and, an even more important consideration, pumping was avoided. It is the writer's contention that it would have been bad engineering and bad financing to have done otherwise. These sewers have been in satisfactory operation for the past six years.

In the report of the Committee on Collection and Disposal of Sewage, presented to the American Public Health Association at the Colorado Springs meeting in September, 1913, (see American Journal of Public Health, Vol. III, No. 12, p. 1348), the question of velocity of flow is considered in its broader aspects. They affirm the fact that:

> The gradients of all sewers should be such as to develop self-cleansing velocities, which the best practice shows, should not be less than 2 ft. per second in the separate system and 2½ ft. per second in the combined system. Steep gradients, however, necessitate deeper trenches, and here, as in most engineering problems, a solution must frequently be found between the ideal and that economically possible. . . . Where the expense of obtaining steeper gradients is material an actual velocity of 1 ft. per second in a well constructed sewer, carrying domestic sewage, will, with a reasonable amount of flushing, keep the sewer clean.

Figure 1 shows a situation in which a more radical departure was made from accepted standards. Without this expedient, a pumping station would have of necessity been put in at Main street and Union avenue. This sewer has been operating for about eleven years, and though it has been flushed only at irregular intervals, has given no trouble from either stoppages or odors. A flush tank installed at the head of Morris Ave. has not been used at all.

At Ocean Grove, N. J., Neptune township operated a sewage pumping station which had cost about $20,000. They were expending $6,000 per year pumping sewage, which capitalized, is 5 per cent upon $120,000, or a total of $140,000. A 15-in. gravity outfall on a gradient of .0008 with a clarification tank at the head of the outfall line, eliminated this expenditure at a capital cost of but $35,000. A heavier gradient was impracticable as the height was governed by the existing sewers at one end and by the ocean at the other.

It would be wrong to infer from the foregoing, that the writer advocates an indiscriminate use of such grades. They are to be employed only when the adoption of steeper ones would be attended with difficulty or expense, incommensurate with the advantages gained. It is essential that great care be taken in giving lines and grades for such sewers, and that equal care be used in constructing them. A rough, uneven sewer or one laid with but ordinary care on such light gradients will cause trouble. If the sewer is given a steeper slope, regardless of these conditions, it is often a case of substituting Scylla for Charybdis, since there is then infiltration to contend with. How serious this may become can be illustrated by condition in a section of the collecting system at Ocean Grove, N. J., 3.25 miles long, a part of the town known as West Grove. (See "The Infiltration of Ground-Water Into Sewers," by John N. Brooks, Trans. Am. Soc. C. E., Vol. LXXVI, p. 1909-1941.) In dry autumn weather the infiltration averaged about 15,000 gals. per day per mile of pipe. On December 30, of the same year, after a combined rain and thaw, it rose to 100,000 gals. per day per mile.

No matter how carefully the sewer may be laid, each house connection becomes a source of infiltration. In some instances underdrains may relieve this condition greatly, but ordinarily, in the branches situated in the lower portions of seaside resorts, and in the interceptors and trunk sewers, the ocean or bay determines the minimum height of ground water, which it is obviously impossible to lower by any system of underdrains, not to mention the lack of an outlet for the drains themselves. In such wet places cement joints are not desirable. Even if, despite the practical difficulties obtaining in a wet ditch, the joint is properly made, the slightest motion or settlement of the pipe will cause a fine crack to form, that will admit water. A bituminous joint is not only tight, but has a certain amount of flexibility; the writer would therefore recommend its being adopted for all such conditions.

The proximity of ground water to the surface effectually precludes the construction of cellars in many of the places under consideration. This in turn obviates the necessity for deep sewers. At times it is necessary to have them so close to the surface of the streets that cast iron water pipe must be employed instead of vitrified terra cotta pipe. "Y" connections are made to these just as in the case of terra cotta pipe.

So far as the collecting system is concerned, all of the factors tending to differentiate it in any way from sewers elsewhere may be found separately or together at points far removed from the coast. These factors are, nevertheless, characteristic of coast resorts in general, and a disregard of them has frequently led to both trouble and expense.

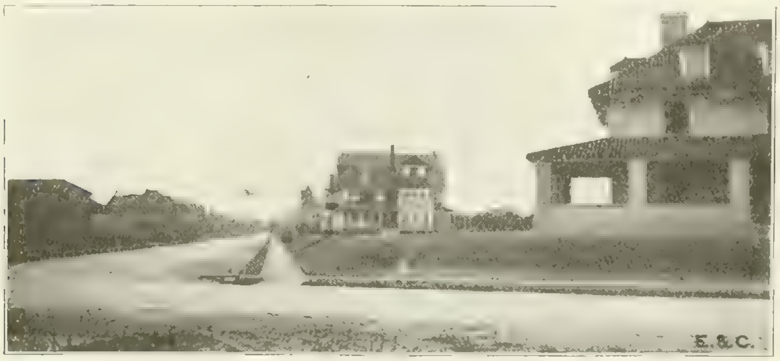


Fig. 2. View of All That is Apparent of a Sewage Clarification Tank at Spring Lake, N. J. —Tank Under Street in Foreground—Note Character of Contiguous Improvements.

Fig. 3. Operating Chamber, Under Street, of Sewage Clarification Tank, Neptune Township, Ocean Grove, N. J.

THE DISPOSAL PLANT.

It is in the disposal plant that the most pronounced differences occur. The variation in seasonal flow, since the quantity contributed to the plant in summer sometimes amounts to 1,000 per cent of the winter average, plainly requires to be taken into account in the design. An Imhoff tank, for example, working on a retention period of 1½ hours on a flow of 500,000 gals. a day, would work with a 15-hour retention on a flow of 50,000 gals. per day. The unsatisfactory result may readily be imagined. Such a condition must needs be foreseen and provided for in the design.

The fact that the ocean lies at hand, with its boundless capacity to dilute and digest sewage, has frequently determined the type of plant. A pipe running to the water's edge or somewhat beyond, and supported on piling, carries the crude sewage to sea, from which every breaker hurls the floating solids high up the beach to flow back again as the waters retreat. Where an inlet or bay is at hand the process is still more economically accomplished, since there are no breakers, and the piling is often omitted. The fact that the sewage solids may strand on the bank, that there may not be current sufficient to diffuse the sewage and enable it to secure enough dissolved oxygen from the water to be inoffensively made way with, troubles no one for a time. But since the chief asset of a resort is the bathing beach, such conditions soon react upon the prosperity and fair name of the community. Bays and inlets are so popular for boating that putrid waters are soon noticed, and banks fouled with sewage sludge cause undesirable comment. At least one such place has had a typhoid epidemic which appears to be traceable to flies carrying the infection from banks polluted with sludge to the kitchen of a boarding house not very far removed. Lime sprinkled on sludge has been found tracked by flies upon the surface of a cake with chocolate icing, standing in a window a couple of hundred feet away. At Crisfield, Maryland, in 1913, out of 43 cases of typhoid, 33 were in houses within 300 ft. of a drainage ditch. This ditch has now been sewered.

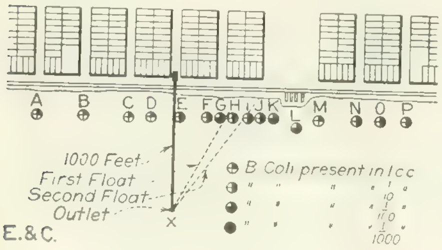


Fig. 4. Diagram Representing Coli Content of Shore Water ½ Hour After Discharge of Settled Effluent 1,000 Ft. From Shore.

It is such imperfect methods of discharging the sewage that have caused a prejudice against utilizing the ocean, although sewage can be effectually disposed of by means of a proper sea outfall, with greater efficiency and at less expense than in any other way.

The organic matter in sewage may be divided into quickly putrescible, slowly putrescible, and non-putrescible. The various juices, fecal matter, animal and vegetable tissues putrify readily. The fatty compounds are but slowly putrescible, while hair, horn, bone, cloth, wood and similar substances are non-putrescible. Living organisms, bacteria, algae, fungi and protozoa are all at work promoting the decomposition of the complex organic compounds into simpler forms. These decomposition products are frequently gaseous, liquid or soluble. If crude sewage be discharged into the ocean, the floating solids may be carried by favorable conditions of wind and tide a long distance, and cause offensive conditions on bathing beaches. Garbage (not sewage) from New York City has been carried 70 miles and cast up on the beach. If, however, the solids are removed or comminuted by sedimentation or otherwise, upon discharge into a large body of water nature quickly disposes of the impurities. Traces of contamination can be detected in the ocean and the great lakes only within a short distance of highly polluted rivers or outfalls.

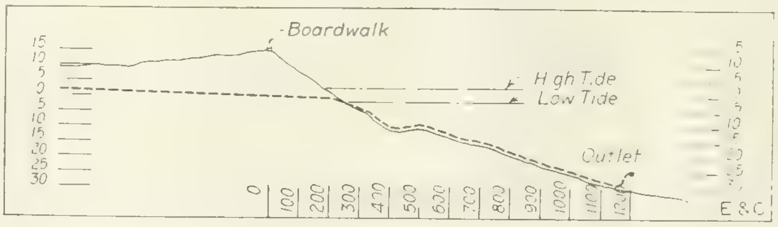


Fig. 5. Profile of Sewer Outfall Pipe at Ocean Grove, N. J.

The waters of the ocean dissolve oxygen from the air, the amount depending upon the temperature of the water. The more easily oxidizable substances in the sewage abstract this oxygen directly, while the various bacteria and other organisms are the agencies by means of which the ammonium compounds and other organic constituents are oxidized. If sewage be discharged into a body of water of insufficient capacity to furnish the necessary supply of dissolved oxygen; in other words, if the sewage removes it more rapidly than it can be reabsorbed from the air putrefactive decomposition, with an accompaniment of foul odors, will ensue. It is this condition that so frequently occurs when the discharge takes place along tidal meadows and other inland reaches of water frequently found adjacent to resorts, and which has created such a prejudice against disposal by dilution.

These troubles are not inherent in the method, if it be properly carried out. No less an authority than Dr. Gilbert J. Fowler says, see Report of the Metropolitan Sewerage Commission of New York, Vol. III, April 30, 1914, pp. 174-175:

> The conditions which must be realized if the constituents of sewage are to be rendered inoffensive or finally mineralized are essentially the same whether the disposal be by irrigation upon land, filtration through artificial biological filters, or dilution with fresh or salt water. The process is in all cases one of oxidation, i. e., practically speaking, combustion, and if it is to be conducted without nuisance, enough oxygen must be present at all stages of the process to prevent the formation of evil-smelling products.
>
> It is perfectly legitimate to use the oxygen dissolved either in sea or river water in order to oxidize sewage. 'Under proper conditions of discharge, complete transformation and miner-

alization of the sewage matters can be effected in this way with less nuisance than often accompanies treatment on filters or on land.

Messrs. Rudolph Hering, of New York, and John D. Watson, of Birmingham, England, reporting upon the disposal of sewage at Toronto, Canada, state that "while it is possible from an engineering standpoint to attain a high degree of purification for the sewage, such a process is unnecessarily expensive. . . . Sewage is finally purified by oxidation, whether this be on land or in water: on land by percolation through beds of sand or broken stone, and in water by dissolved oxygen. We are of the opinion that the large body of water will successfully and satisfactorily dilute and dispose of the sewage effluent." To which the late Emil Kuichling pertinently adds: "It must be remembered that the best method is always the one whereby a desired end is reached with the least expense."

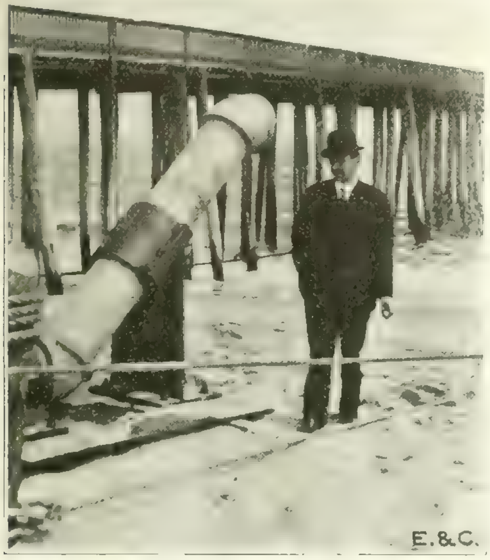


Fig. 6. View of Outlet Anchor for End of Sewer Discharging Outward in the Sea.

Nuisances from sewage thus discharged can be obviated at such moderate expense that, under conditions ordinarily found along the shore, it is the best method of dealing with the problem.

In many places when prejudice exists, on account of the supposed harm to bathers, the discharge has been made into bodies of water either of insufficient capacity or with too little change of water, properly to care for the burden imposed.

In view of the conditions affecting the disposal of sewage that exist at a large portion of seaside resorts, it may be stated that the first requirement is the removal so far as possible of solids, before discharging into the ocean.

Fine screening would doubtless accomplish this result satisfactorily, but it is not in use along our eastern coast line, to the writer's knowledge. It would seem probable that the expense would be much higher than that of tank treatment, and in addition, the disposal of screenings would present far greater difficulties than sludging the tanks.

Nor have two-story or Imhoff tanks found much favor. In the first place, the expense of going down to a desirable depth would ordinarily be very great. Quicksands and an abundance of water make it difficult to make deep excavations. The desirable character of the Imhoff tank sludge, both as to odor and quick drying properties, on the coast count for but little, since sludge from one-story tanks may be discharged at sea in the winter, upon an outgoing tide, without harm or offense. Furthermore, the short retention period and freedom from septicization, that are such desirable features in an Imhoff tank when the effluent is sprayed upon sprinkling filters, have but little if any advantage over a one-story tank effluent when that effluent is discharged many feet beneath the surface of the ocean. Conditions may arise, which will shortly be referred to, producing a nuisance from such septicized effluents, but the remedy is of easy application.

The great variation in seasonal flow, owing to the winter and summer changes in population, has already been referred to in its connection with Imhoff tanks. At times, too, variations in the flow line, due to changes in the tides, have a markedly disadvantageous effect.

Imhoff tanks should preferably be open. Many disadvantages ensue from covering them. Moreover they should have careful and constant attention. Where the character of the sludge and effluent are of moment this care is amply justified, but in the conditions obtaining in the places now under consideration, such is not the case, and the disadvantage of having an uncovered tank may be readily understood from an inspection of Fig. 2. This shows all that is apparent of one of the clarification tanks at Spring Lake, N. J. It is situated under the street and is entirely invisible. A majority of such plants are, from the exigencies of the case, similarly placed, owing to the difficulty of securing a site away from the street. Surrounded by the most desirable and expensive properties in the town, as they generally are, the public and the residents alike are entirely oblivious of their presence.

Figure 3 shows the operating chamber in the Neptune township tank, Ocean Grove, which is also situated under a street. The only evidences at the surface are some manholes similar to those found at every street intersection along sewer lines.

One important precaution needs to be taken, the neglect of which may cause much trouble. Reference has previously been made to the fact that septicized effluents may give rise to nuisance. The flow line of the tank is frequently at such an elevation that each high tide, or in some instances only exceptionally high tides, may back up into the tank, intermixing with its contents. Of the solid constituents of sea water, SO_4 amounts to about 7 per cent. It would appear that in a septic tank, species of bacteria frequently are present that reduce the mineral sulphates, with liberation of mal-odorous H_2S, and in consequence of this, a bronze seated check valve should be placed at the outlet end of each septic tank liable to such flooding.

In a report by Mr. F. E. Daniels, director of Water and Sewage Inspection of the New Jersey State Board of Health, to Mr. R. B. Fitz-Randolph, chief of the Bureau of Foods, Drugs, Water and Sewerage, a number of observations were made upon a tank in which the absence of a check valve permitted such flooding. At the beginning of ebb tide "a strong odor was noticed on the board walk, coming in from the sea, from the direction in which the wind was blowing, in a direct line from a point over the end of the outfall sewer pipe. This odor was noticed both on the evening and on the morning tide on the next day, the odor in the morning being in a different place on the board walk, but still directly in the wind, as the wind had changed more to the east during the night." Since no odor could be detected along the board walk during either low water or flood tide, the New Jersey authorities have concluded that a sufficient quantity of gas was produced and stored up during high tide, to cause a nuisance when liberated. As indicating the amount of sea water that had entered the tank, the raw sewage had 105 P.P.M. chlorine. The tank sewage on half ebb showed 390 P.P.M. chlorine, and at low water 480 P.P.M.

About two weeks later the chlorine figures in the tank were as given in Table I.

TABLE I.

	P. P. M. chlorine.
Sample 2 ft. below surface of liquid....	840
Sample 4 ft. below surface of liquid....	1,070
Sample 6 ft. below surface of liquid	3,400
Sample 1 ft. above bottom of tank......	4,200
Sea water contains..........................	17,500

This would seem to be proof positive of the presence of large amounts of sea water in the tank, and from its greater specific gravity, it was most pronounced at the bottom in contact with the accumulated organic matter. The lesson from this is that it is desirable to take measures to prevent sea water entering at any time.

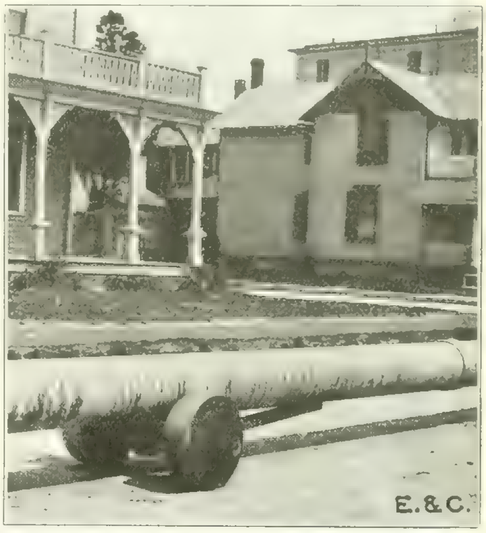


Fig. 7. View of Truck Used in Running Out Sewer Outfall Pipe Line, Assembled on Shore, at Ocean Grove, N. J.

What effect will the discharge of a clarified effluent to sea have upon adjacent bathing beaches? This is the question which has in numerous instances provoked much discussion and been the cause of great differences of opinion among residents of resorts.

That the nuisance from floating or drifting solids is absolutely done away with, is unquestionable. That a properly designed tank, free from admixture of sea water, will discharge an effluent that will not cause odors at the beach, if the outlet pipe is of adequate length and the discharge takes place in several feet of water, is also true. The ability of the ocean to effect the self-purification of its waters from such discharges is undoubted. Through the action of certain forms of bacteria, the organic nitrogen of the sewage is converted into nitrates by aid of the dissolved oxygen in the water, while other kinds of bacteria seize the dissolved oxygen and causing its combination with the carbonaceous matter of the sewage, form carbon dioxide. A third class cause this same carbon to unite with hydrogen to form methane.

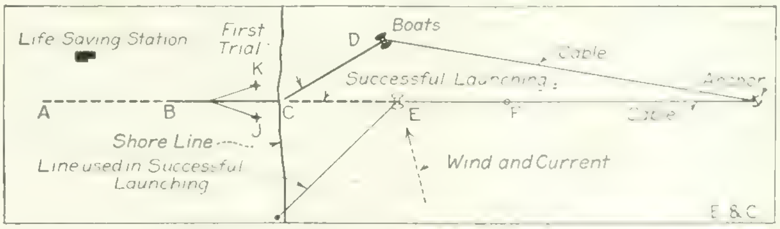


Fig. 8. Diagram to Illustrate the Launching of the Sewer Outlet Into Ocean at Manasquan, N. J.

A higher form of life, the algae, contain chlorophyll, the green color found in leaves. Like the latter, under the action of sunlight they dissociate the carbon from the carbon dioxide, combining it with nitrogen to form albumen, and liberating the oxygen. The protozoa, next higher in the scale of life, feed on the foregoing and in turn are consumed by the crustacea. These latter furnish food for fish, thus completing the chain of transformation.

The bacteria present in all waters are for the most part harmless, but certain types found in the excreta of human beings, such as typhoid and cholera bacilli, are well known sources of disease. The b. coli, or intestinal bacilli, are used as an index of pollution in sanitary analyses of water. These are not in themselves dangerous, but indicate contamination. It is, therefore, a matter of great interest to see just what effect sewage discharges have upon the color content of the bathing waters.

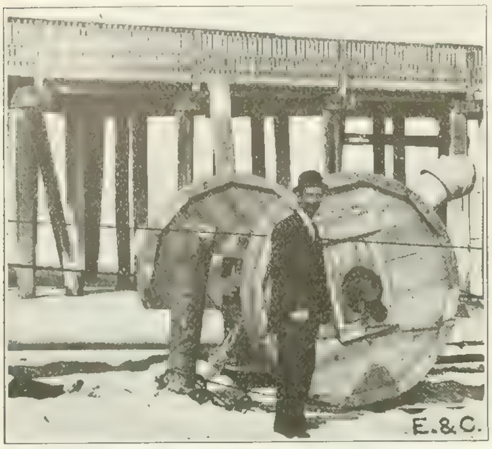


Fig. 9. View of Truck Used in Launching Ocean Outfall of Sewer for Neptune Township at Ocean Grove, N. J.

Unfortunately, observations upon this subject are meagre. What follows must be taken with due allowance for the fact that a long series of experiments alone serve to establish a safe basis for our guidance.

Of one thing we are certain: the ocean is not sterile, even at a distance from land, but its bacterial content is low. In midocean it has been found by Minervini to contain from 8 to 140 bacteria per cc. Ocean water at a distance from shore contains no b. coli. At points unquestionably removed from points of sewage pollution b. coli do occur. Whether these bacteria are a normal inhabitant of the intestines of fish is a question not fully settled, but there is no doubt that fish have been found at times to contain this organism, and it also is present in the fecal discharges of seagulls and other birds. Boats may add some contamination. It is apparent that these causes do not have a marked effect upon the ocean. The question of bathers and the resulting pollution, have never, to the writer's knowledge, been studied.

Experience had in swimming pools, with a limited quantity of water, slowly changed, can evidently show but the tendency, not the amount of pollution, caused by a large crowd of bathers in the ocean. Nevertheless, as indicative of the fact that such pollution does occur, some few figures are given.

The Yale swimming pool, used by from 300 to 400 men daily, the bathers first using showers and soap, and wearing trunks only, was filled after thorough scrubbing, and at 10:30 a. m. the next day, contained 45,800 bacteria per cc. Twenty-four hours later the count had risen to 304,000 per cc. (Engineering News, 66, p. 637.) At Purdue University a freshly drawn tank contained 109 bacteria per cc. with no coli. After use by 30 bathers supposed to wash with soap before going into the pool, there were 109,200 bacteria per cc. with b. coli present, Engineering News, 65, p. 680. Dr. Selter of the University of Bonn reports that a stoker bathed in a tub, but did not use soap. Before the bath the water contained 24 bacteria per cc. and no coli. After bathing for 3 minutes, there were 1,900 bacteria per cc. and 40 b. coli per cc.

The point of the above is that there is an unquestionable introduction of b. coli into the water of the ocean upon a crowded bathing beach.

An examination made by the New Jersey State Board of Health and given here indicates a satisfactory result under conditions most favorable for pollution. Figure 4 will illustrate this. Sewage, after tank treatment, is discharged 1,000 ft. from shore at "X." Two floats were placed in the water at this point, which was determined by ranges on shore, since no indications of the sewage were apparent on the surface. The tide was running flood, and the wind E.S.E. In about half an hour the floats reached shore at H and J, respectively. Table II gives the results.

TABLE II.—B. COLI IN WATER AT THE BEACH.

Location.	1 cc.	1/10 cc.	1/100 cc.	1/1000 cc.
A	+			—
B	+			
C	+			
D	+		—	—
E	+	+		
F	+	+		
G	+	+	+	—
H	+	+	—	—
I				
J				
K				
L			+	—
M				—
N			—	
O	+	+	—	—
P	+	+	—	—

There were but few bathers at the time of these observations. A crowded beach would probably have obscured these results. The wind and tide were in the most favorable state for producing a maximum of contamination. It must be borne in mind, moreover, that sea water is not a popular drink, and that it is much less likely to be swallowed than the water of a swimming pool.

The typhoid death rate in Atlantic City, N. J., where no effluent is discharged to seaward of the bathing beach, was 1.90 per 10,000 in 1910 and 1911. The typhoid death rate at Ocean City, N. J., also with no effluent reaching the beach, was at the rate of 5.1 per 10,000 in 1910.

The rate at Neptune township when a prepared effluent was discharged to sea, in the same year, and also in 1911, was 1.8 per 10,000, and at Asbury Park where similar conditions obtain it was 1.96 per 10,000.

These statistics are not conclusive, without fuller information regarding collateral conditions, but they do not lend themselves to an indictment of making use of the assimilative and purifying powers of the ocean. In recent plants the writer has placed a division wall near the outlet end of the tanks, forming a compartment in which the tank effluent may be treated with liquid chlorine or bleach.

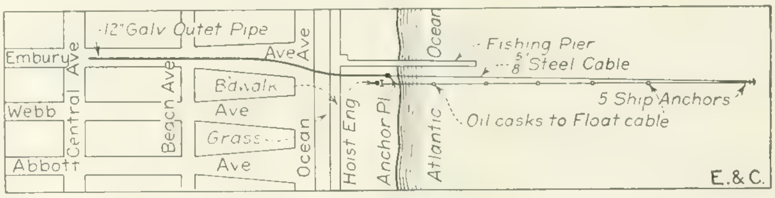


Fig. 10. Diagram to Illustrate the Launching of Sewer Outlet Into Ocean for District No. 1, Neptune Township, Ocean Grove, N. J.

It should be borne in mind that the discharges of sewage at each of the various places dealt with in this paper is materially less than that from a great metropolitan center. Also that the amount of money that it is possible to expend in disposal is proportionately less. Even with large discharges, however, self-purification becomes strikingly apparent. Mr. X. H. Goodnough, see Report of the Metropolitan Sewerage Commission of New York, Vol. III, April 30, 1914, pp. 335-336, in describing the effect of the discharge of Boston sewage at Deer Island, says that the outlet, which is at the end of a long sand bar, is placed at the level of low water, or a little below it. In spite of this unfavorable condition, and the large flow of from 2,000,000 to 3,000,000 gals. per hour, "Observations of the number of bacteria in the water show that they diminish with great rapidity as the distance from the outlet increases, and the number found at a distance of a mile from the outlet is about 300 per c. c." The sea water in the neighborhood of this outlet where the sewage is densest, was found on one examination to contain about 3 per cent of sewage. It is a very foul sewage, much of it coming from tanneries, slaughter houses and manufacturing establishments, and though pumped twice, is not treated in any way.

In another Boston outfall at Peddock's Island, the outlet is 30 ft. deep at low water. Though the discharge of some 2,500,000 gals. per hour is sent vertically upward, and rises rapidly through the salt water, it is greatly dispersed and diluted before reaching the surface of the sea. All the above observations are based on conditions in calm weather and in summer, when pollution is most noticeable

DESIGN, CONSTRUCTION AND LAUNCHING OF OUTFALL.

A short discussion of the practical considerations affecting the design, construction and launching of the outfall, may not be amiss.

Its length should be governed by the configuration of the ocean floor, by the depth of water at the outlet end, by the proximity of a bathing beach, and finally by the amount of sewage.

A discharge, such as from the Boston outlets, of 60,000,000 to 70,000,000 gals. per day necessarily needs to be carried much further away from places of resort than a discharge of 1,000,000 gals. per day. As will be seen by Fig. 5, which shows a profile of the outfall at Ocean Grove, N. J., the pipe is carried over the bar and discharges the sewage beyond this point in about 30 ft. of water. It is not desirable to have it terminate within the bar, hence the distance of the bar from the beach is one important factor in determining the length. It is preferable to end in deep water, and with a large sewage flow in the neighborhood of a bathing beach the outlet should be farther from shore than otherwise would be necessary. The outer end must be securely held by an anchor of sufficient weight to prevent its being shifted by the action of the waves. For the same reason, the outlet should be elevated above the bed of the ocean, since it would otherwise become choked by sand. The sewage stream should be directed *outward* and not *upward,* as is too frequently done. Such an outlet anchor is shown in Fig. 6. It consists of a rectangular cast iron base plate, supporting a 45° bend which deflects the pipe upward. A straight pipe is inserted in this bend of sufficient length to bring the outlet end from 5 to 6 ft. above the bed plate. Another 45° bend at the top directs the sewage flow outward.

The sewer leading to the outlet anchor may be made of either cast or wrought iron. Flexible joints, so useful in river and harbor crossings, have frequently given trouble in ocean work. The changes made at the beach in a single storm frequently tear out such cavities that the cast iron pipe, in spite of flexible joints, is snapped off. The writer's experience leads him to prefer wrought iron (not steel) galvanized. This pipe will temporarily bridge across these cavities till they fill up again. One such outlet, put in eleven years ago, was undamaged till a heavy storm this year, when two lengths separated about at low water line. They were repaired at a cost of $48 and it was found that the galvanizing at this most trying part of the line was absolutely intact, and that no sign of rust was visible. This, with air and salt water outside and sewage inside was a most excellent showing. Such pipe are preferably screwed together with long couplings, and with the beach end protected in addition by sleeves over the couplings, such sleeves being about 2 ft. long, and leaded and caulked precisely like water pipe.

The pipe just referred to was first assembled on shore, and was screwed together while resting on rollers, as shown in Fig. 7. The diagram, Fig. 8, shows the entire operation. The pipe upon its rollers lies between A and C. A heavy anchor was placed at G and a line taken from it to the boats shown at D. These were two ordinary fishermen's boats, lashed together and with a platform between them. Upon the platform was a windlass to which was attached the line from G. The boats were backed up to the beach and the outlet anchor, plugged at the end to keep the water out, was slung between them. Lines from two additional windlasses at J and K were attached to the pipe, and at the sound of a whistle, men on boats and shore began tramping round the windlasses. As the pipe rolled forward, when it reached the points B-D, the wind and current shown by the arrow had deflected the boats so far northward that the pipe broke at C.

A second attempt made some two weeks later guarded against this disaster by having a line from the boats to "H," which enabled them to be stayed in the true course, and the pipe was successfully placed in position C-F with the anchor at F. Assurance against pulling the pipe apart was given by threading a steel cable through it, to take part of the strain.

A great difficulty met with in this way of launching a pipe is the fact that sometimes weeks and even months may elapse before the sea is quiet enough to permit attaching the anchor to the boats at the water's edge. Ordinarily even the slight swells present, make the danger of snapping the pipe very great.

To obviate this, and to enable the work to be done more expeditiously, the truck shown in Fig. 9 was used in launching the Neptune township's outfall at Ocean Grove, N. J. A plan of the same operation is shown in Fig. 10.

The galvanized pipe was assembled on Embury avenue, and mounted on small wooden trucks. Where it passed over the board walk and beach, it was necessary to have stationary rollers blocked up to the proper grade. Since the fishing pier came directly opposite the prolongation of Embury avenue, it was necessary to deflect the pipe at the board walk as shown in Fig. 10. The outlet anchor had a wooden plug loosely placed in it, and plentifully lubricated with thick white lead, to prevent the entrance of water. The outlet pipe was 12-in. standard wrought iron pipe, galvanized, and since such pipe floats when filled with air and so might be injured by the swell of the ocean, a 3-in. "ballast" pipe was placed inside it and filled with water, so as to partially sink the larger pipe.

At 1,325 ft. from shore, as gaged by a taut line, five ordinary ship anchors were sunk. These anchors were tied together by a cable to which was attached an 18-in. sheave. Through this sheave was passed a ⅝-in. steel cable, one end of which was attached to the drum of a hoisting engine on shore, and the other end to the truck carrying the anchor. This truck had wheels built up of two thicknesses of 2-in. plank, and had a hook in the back of a 6x6-in. stick of wood parallel to and above the axle, to which it was firmly fastened. This hook supported the anchor by means of an eye, while extending from the axle was a long tongue. To this was attached the other end of the line leading out to the sheave in the ocean. To prevent the outgoing and incoming lines fouling, the incoming cable was floated by five oil casks which were attached to it at intervals.

When all was in readiness a succession of east winds and storms held up operations for eleven days. When this had ceased, the launching was made on an ideal day. A light wind was blowing from the west and the sea was smooth.

As in the other launching described, not only was the cable pulled at the anchor end, but a rope from the gipsy on the hoist was taken back toward Ocean avenue and attached to the pipe to assist in the pulling.

When the engine was started, the truck and anchor moved easily forward, gradually disappearing as they reached deeper water. Since the auxiliary line from the gipsy had to be detached, the block and fall pulled back and re-attached to the pipe, the operation went on by stages. These stoppages made the entire time of launching 2¼ hours, though the actual time the pipe was in motion was 39½ minutes.

Upon the anchor reaching its designated place, 1,200 ft. from the board walk, a bushing was screwed into the short end of the outfall, and a 2-in. pipe attached through which water was forced by means of a steam pump. This compressed the air in the pipe, till the plug in the anchor blew out like a cork from a pop-gun. The pipe then filled with water and settled into place, except a part near the shore in which some air was trapped. A ¼-in. hole was tapped into it, allowing this air to escape. The hole was then closed by a bolt. The pipe now lay along the bottom of the ocean, the end at the beach being about 3 ft. below high water mark, and the outer end about 30 ft. below. The 3-in. ballast pipe was withdrawn, and the tension on the cable released. This resulted in the tongue of the truck being thrown upward by the weight of the anchor on the back of the axle. The hook became disengaged from the eye, and the truck floated to the surface.

Such are some of the considerations, theoretical and constructive, affecting the disposal of sewage at seaside resorts.

To summarize, we may briefly say that these considerations are as follows:

THE COLLECTING SYSTEM

1. Use self-cleansing velocities where possible, but do not be bound by them when they result in a cost incommensurate with their benefits.

2. When self-cleansing velocities can not be wisely adopted, make adequate provision for flushing. The sewers must be kept clean.

THE DISPOSAL PLANT

1. The plant must be adapted to great seasonal variations in flow.

2. The capacity of the ocean to digest and purify the sewage, being the most economical and effective means of attaining this end, should be made use of.

3. When bathing is an asset, the discharge of crude sewage to sea is not permissible.

4. Single story tanks furnish in general the method best adapted to treating the sewage of resorts before its discharge to sea.

5. Nuisances from such effluent do not arise if tanks and appurtenances are correctly planned, and the discharge effected through a properly designed outlet at a sufficient distance from shore, and in 10 ft. or more of water.

6. It would appear from what evidence we now possess, that no ill effects to health result from the proper discharge of such effluent.

7. Owing to the difficulties encountered in work along the coast and under the surface of the ocean, careful consideration must be given to durability and to the means of executing the work called for by the plans.

BRIDGES

Design, Construction and Detailed Costs of the McKinley Ford Bridge, La Salle County, Illinois.

(Staff Article.)

The McKinley Ford Bridge, the design, construction and costs of which are fully covered in this article, is located in Sarena township, La Salle county, Illinois. It consists of two 50-ft. reinforced concrete through girder spans on a concrete pier and abutments (see Fig. 1). The clear width of roadway is 16 ft., and the height of the pier and abutments, from bottom of footing to bridge seat, is 16 ft. 11 ins. The bridge was designed under the "General Specifications for Bridge Work" of the Illinois State Highway Department. It is a standard type, and was built during the latter part of 1913, at an actual cost of $3,893.13.

DESIGN OF SUBSTRUCTURE.

Pier.—The center pier has a thickness of 3 ft. and a width of 23 ft. 1 in., under coping; a thickness of 4 ft. 2 ins., and a width of 24 ft. 3 ins. at the base; and a height, from bridge seat to bottom of footing of 16 ft. 11 ins. The coping has a width of 3 ft. 8 ins., a length of 23 ft. 9 ins., and a thickness of 15 ins. The footing has a width of 8 ft., a length of 25 ft., and a thickness of 2 ft., and it is reinforced with a layer of ½-in. square bars, spaced 12 ins. on centers. Figure 2 shows a half plan, half elevation and a cross section of the center pier. At the top, near each end of the pier, there is a recess 20x25 ins. x 15 ins. deep for the cast iron rockers. A concrete mixture consisting of 1 part cement, 3 parts sand, and 5 parts gravel was used. The pier extends 4 ft. 6 ins. below the bed of the stream.

Abutments.—The concrete abutments, which have a height, from bridge seat to bottom of footings, of 16 ft. 11 ins., are reinforced and are of the wing-wall type, the wing-walls being of the cantilever type. The abutments have a thickness of 12 ins., with vertical faces, this thickness being increased to 18 ins. under the girders (see Fig. 3, b). The footings have a width of 4 ft. 6 ins., a thickness of 20 ins., and extend to the same depth as the pier. The size and arrangement of the reinforcement are given in Fig. 3 (a) and (b).

The wing-walls have a top thickness of 12 ins., and a bottom thickness of 18 ins. Their footings have a width of 6 ft. 3 ins. and a thickness of 20 ins. The type of section and the size and arrangement of the reinforcement are shown in Figs. 3 (b) and (c). A concrete mixture consisting of 1 part cement, 2½ parts sand, and 4 parts gravel was used for the abutments and wing-walls.

DESIGN OF SUPERSTRUCTURE.

Girders.—The girders have a depth of 5 ft. 6 ins., a thickness of top flange of 26 ins., and of web of 23 ins., and are paneled as shown in Fig. 1. They are spaced 18 ft. 2 ins. on centers. All exposed edges of the girders are beveled with a ¾-in. triangular molding, and all edges of panels have a 45° bevel. The girders are heavily reinforced, the main reinforcing bars being arranged in four rows, spaced 5 ins. on centers. The concrete mixture for the girders and floor system consists of 1 part cement, 2½ parts sand, and 4 parts gravel.

Figures 4 (a) is an elevation of a girder, and Fig. 4 (b) is a cross section of the bridge. These drawings show the principal dimensions, and give the size and arrangement of the reinforcement.

Floor System.—The [illegible] the reinforced concrete floor slab is flush with the bottoms of the girders, while the top is crowned to conform with the finished roadway. The thickness of the floor slab at the crown is 13 ins., and at the curb 10 ins. Drainage of the roadway is secured by placing 3-in. tile drains through the slab and near the curb on 8-ft. centers. The wearing surface (which is not included in this contract) consists of a 6-in. layer of macadam.

Details of the floor slab, and of the reinforcement used in it, are shown in Figs. 4 (b) and (c). These drawings show the size and arrangement of the reinforcement, and the manner of extending the reinforcing bars of the floor slab up into the girders. Other details of the reinforcement are also shown in Fig. 4.

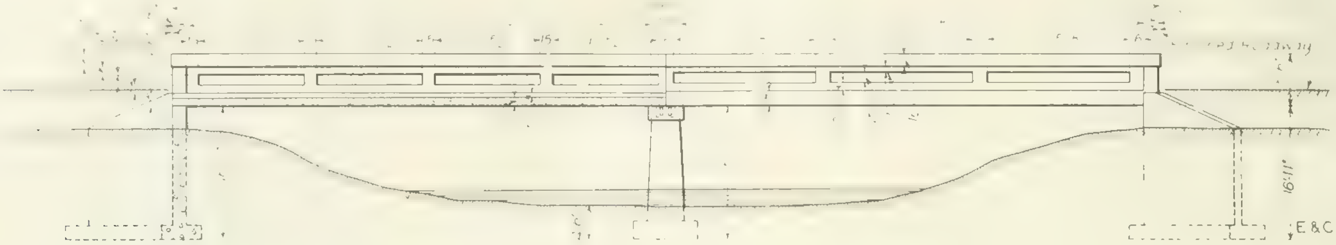


Fig. 1. General Elevation of McKinley Ford Bridge, La Salle County, Illinois.

Cast Iron Rockers.—Cast iron rockers are used under the ends of the girders which rest on the center pier; they are not used under the abutment ends of the girders. These segmental rockers have a thickness of 3½ ins., a depth of 14 ins., and a length of 2 ft., the top and bottom surfaces of which are turned to a diameter of 7 ins.

Steel bearing plates, 9 ins. wide, 1 in. thick and 2 ft. long, are placed at both the top and bottom of the rockers.

Figure 4 (d) shows details of the rockers and plates.

Expansion Joint.—A ¼-in. tar paper expansion joint is provided between the two girder spans. Tar paper is also placed on the top of the piers between the rockers and the edges of the piers. The space around the rockers is filled with asphalt.

Figure 4 (e) shows details of the expansion joint.

BILL OF MATERIALS.

Inasmuch as this bridge is a standard design of the Illinois Highway Commission the following bill of materials is pertinent. The various reinforcing bars are represented in the drawings by letters, the sizes being given in the bill of materials.

PIER.

Concrete, Class B, 1:3:5 mix, cu. yds....... 60.4
25 bars "t," ½ in. square x 7 ft. 6 ins., lbs. 160

ABUTMENTS.

Bar.	No. of bars.	Size. Ins. square.	Length. Ft.	Ins.
A	[illegible]	½	[illegible]	0
A	12	⅝	13	6
[illegible]	16	⅝	1[illegible]	0
[illegible]	20	⅝	10	6
[illegible]	20	⅝	9	0
b	12	¾	26	0
h	12	⅝	26	0
h	[illegible]	½	26	0
k	[illegible]	½	20	0
m	[illegible]	½	3	6
n	68	¾	7	0
r	40	½	4	3
t	68	½	6	0
[illegible]	68	¾	6	0

Reinforcing steel, as listed above, lbs.....6,360
Concrete, Class A, 1:2½:4 mix, cu. yds.... 103.8

SUPERSTRUCTURE.

Bar.	No. of bars.	Size. Ins. square.	Length. Ft.	Ins.
a	[illegible]	⅞	21	6
[illegible]	67	⅞	19	[illegible]
[illegible]	67	⅞	[illegible]	0
a_3	67	⅞	26	6
[illegible]	[illegible]	½	19	0
b_1	84	⅜	19	0
[illegible]	[illegible]	1¼	[illegible]	6
d	12	1¼	[illegible]	6
[illegible]	12	1¼	56	0
f	[illegible]	1¼	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	160	⅞	11	0

Reinforcing steel, as listed above, lbs....36,070
Steel bearing plates, 8 required, as detailed, lbs. 490
Cast iron rockers, 4 required, as detailed, lbs. 1,190
Concrete, Class A, 1:2½:4 mix, cu. yds... 140.4

SUMMARY OF MATERIALS REQUIRED.

Reinforcing steel:	Lbs.
In pier	160
In abutments	6,360
In superstructure	36,080
Total	42,600
8 steel bearing plates	490
4 cast iron rockers	1,190
Concrete:	**Cu. yds.**
Class B, in pier	60.4
Class A, in abutments	103.8
Class A, in superstructure	140.4
Total Class B	60.4
Total Class A	244.2
Total concrete in bridge	304.6

As actually constructed there were used in the construction of this bridge 308.3 cu. yds. of concrete, the extra 3.7 cu. yds. being placed in the substructure. Square twisted bars were used for reinforcement.

CONSTRUCTION FEATURES.

Construction work was started Sept. 13, 1913, and the bridge was completed Nov. 28, 1913. The bridge is located about four miles from the railroad station, and the materials, with the exception of the sand and gravel, were hauled that distance. The sand was removed from the creek and was transported in wheelbarrows a distance of 150 ft. The gravel was also obtained near the site, being hauled about 400 ft. About 125 cu. yds. of the total of 187.4 cu. yds. of gravel required were screened. The prices of the materials are given under "Cost Data."

The pier was located in the bed of the stream, and the abutments, one on each bank. About 500 ft. B. M. of sheet piling were required for the cofferdam of the center pier.

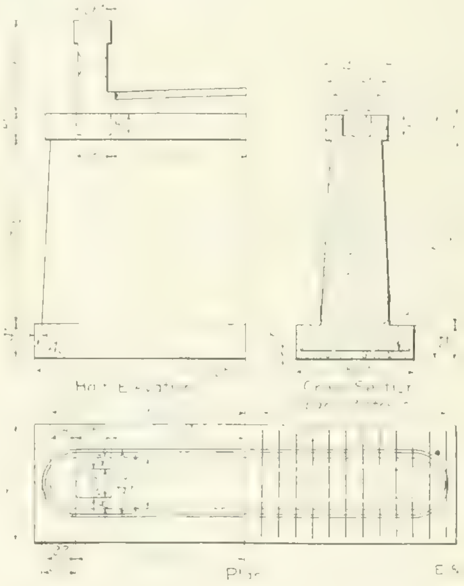


Fig. 2. Half Plan, Half Elevation and Cross Section of Center Pier of McKinley Ford Bridge.

Of the 240 cu. yds. of excavation required, about 108 cu. yds. were classified as dry excavation and 132 cu. yds. as wet excavation. Foremen were paid 65 cts. per hour and workmen 25 cts. per hour. The rate of pay for teams was 45 cts. per hour.

As the construction of this bridge was carried on under conditions similar to those often applying in country highway bridge work the detailed data given in Table I on the procedure followed and time required to build the structure should be of value.

TABLE I.—CONSTRUCTION PROGRESS AND PROCEDURE AND FORCE ACCOUNT.

Work started with 5 men, including foreman, on Sept. 13, 1913.

1913—
Sept. 13—40 hrs. dry excavation, south abutment; 10 hrs. fixing camp.
14—25 hrs. dry excavation, south abutment.
15—30 hrs. wet excavation, south abutment; 20 hrs. fixing camp.
16—22½ hrs. wet excavation, south abutment; 15 hrs. unloading steel.
17—20 hrs. unloading steel; 30 hrs. screening gravel; 5 hrs. with team hauling material.
18—31 hrs. wet excavation, south abutment; 2 hrs. fixing camp; 12 hrs. screening gravel.
19—44 hrs. wet excavation, south abutment; 6 hrs. fixing camp; 7 hrs. with team hauling supplies.
20—20 hrs. wet excavation, south abutment; 30 hrs. building cofferdam for center pier; 8 hrs. with team hauling lumber.
22—14 hrs. dry excavation, center pier; 33 hrs. wet excavation, south abutment; 3 hrs. bending steel; 2 hrs. building cofferdam for center pier; 13 hrs. with team hauling lumber.
23—30 hrs. dry excavation, center pier; 20 hrs. bending steel.
24—30 hrs. wet excavation, center pier; 20 hrs. bending steel.
25—30 hrs. wet excavation, center pier; 18 hrs. bending steel; 2 hrs. fixing cement shed.
26—50 hrs. wet excavation, south abutment.
27—25 hrs. wet excavation, south abutment; 25 hrs. dry excavation, center pier.
28—16 hrs. wet excavation, south abutment.
29—40 hrs. wet excavation, south abutment; 10 hrs. dry excavation, center pier.
30—20 hrs. wet excavation, south abutment; 30 hrs. fixing camp.
Oct. 1—45 hrs. wet excavation, south abutment; 10 hrs. setting up concrete mixer.
2—46 hrs. dry excavation, center pier; 4 hrs. wet excavation, south abutment; 20 hrs. unloading car of material; 5 hrs. teaming.
3—10 hrs. wet excavation, south abutment; 20 hrs. wet excavation, center pier; 41 hrs. mixing and placing concrete, center pier; 40 hrs. wheeling gravel.
4—64 hrs. wet excavation, south abutment; 6 hrs. wet excavation, center pier; 16 hrs. mixing and placing concrete, center pier; 18 hrs. wheeling gravel; 10 hrs. repairing pump.
6—97½ hrs. wet excavation, south abutment; 18 hrs. building form, center pier.
7—70 hrs. wet excavation, south abutment; 10 hrs. wet excavation, center pier; 35 hrs. building forms, center pier; 10 hrs. placing steel; 4 hrs. wheeling gravel.
8—75 hrs. wet excavation, south abutment; 15 hrs. wet excavation, center pier; 25 hrs. building forms, center pier; 3 hrs. mixing and placing concrete; 32 hrs. wheeling gravel.
9—20½ hrs. wet excavation, south abutment; 25 hrs. building forms, center pier; 81 hrs. mixing and placing concrete, center pier; 20 hrs. wheeling gravel.
10—20 hrs. dry excavation, north abutment; 26 hrs. wet excavation, south abutment; 16 hrs. building forms, center pier; 12 hrs. mixing and placing concrete, south abutment; 23 hrs. wheeling gravel.
11—29 hrs. dry excavation, north abutment; 23 hrs. building forms, center pier; 70 hrs. mixing and placing concrete, center pier; 21 hrs. wheeling gravel.

13—36 hrs. dry excavation, north abutment; 11 hrs. wet excavation, south abutment; 18 hrs. building forms, center pier; 17 hrs. wheeling gravel.

14—40 hrs. wet excavation, south abutment; 6 hrs. building forms, center pier; 16 hrs. building forms, south abutment; 43½ hrs. wheeling gravel.

15—77 hrs. wet excavation and 20 hrs. building forms, south abutment; 23 hrs. mixing and placing concrete, center pier; 3 hrs. wheeling gravel.

16—31 hrs. wet excavation and 14 hrs. building forms, south abutment; 16 hrs. wheeling gravel.

17—55½ hrs. wet excavation, 34 hrs. building forms and 14 hrs. mixing and placing concrete, south abutment; 2½ hrs. removing forms, center pier; 18 hrs. wheeling gravel.

18—21 hrs. wet excavation, 17½ hrs. building forms, and 10 hrs. mixing and placing concrete, south abutment; 17½ hrs. removing forms, center pier; 60 hrs. wheeling gravel.

19—28 hrs. wet excavation, and 10 hrs. mixing and placing concrete, south abutment.

20—20 hrs. wet excavation, and 31½ hrs. building forms, south abutment; 14 hrs. building and placing steel; 44 hrs. wheeling gravel.

21—5 hrs. wet excavation, 35 hrs. building forms, 14 hrs. bending and placing steel, and 21 hrs. mixing and placing concrete, south abutment; 40 hrs. wheeling gravel; 10 hrs. unloading car, equipment.

22—12 hrs. wet excavation and 21 hrs. building falsework, south abutment; 18 hrs. wet excavation, north abutment; 6 hrs. wheeling gravel; 4 hrs. erecting tent for tools.

23—60 hrs. wet excavation, north abutment; 40 hrs. building forms, south abutment; 5½ hrs. unloading car, equipment.

24—28 hrs. wet excavation, north abutment; 35 hrs. building forms and 42 hrs. mixing and placing concrete, south abutment.

25—33 hrs. wet excavation, north abutment; 16 hrs. building forms and 35 hrs. mixing and placing concrete, south abutment.

27—28 hrs. dry excavation, north abutment; 20 hrs. removing forms, south abutment.

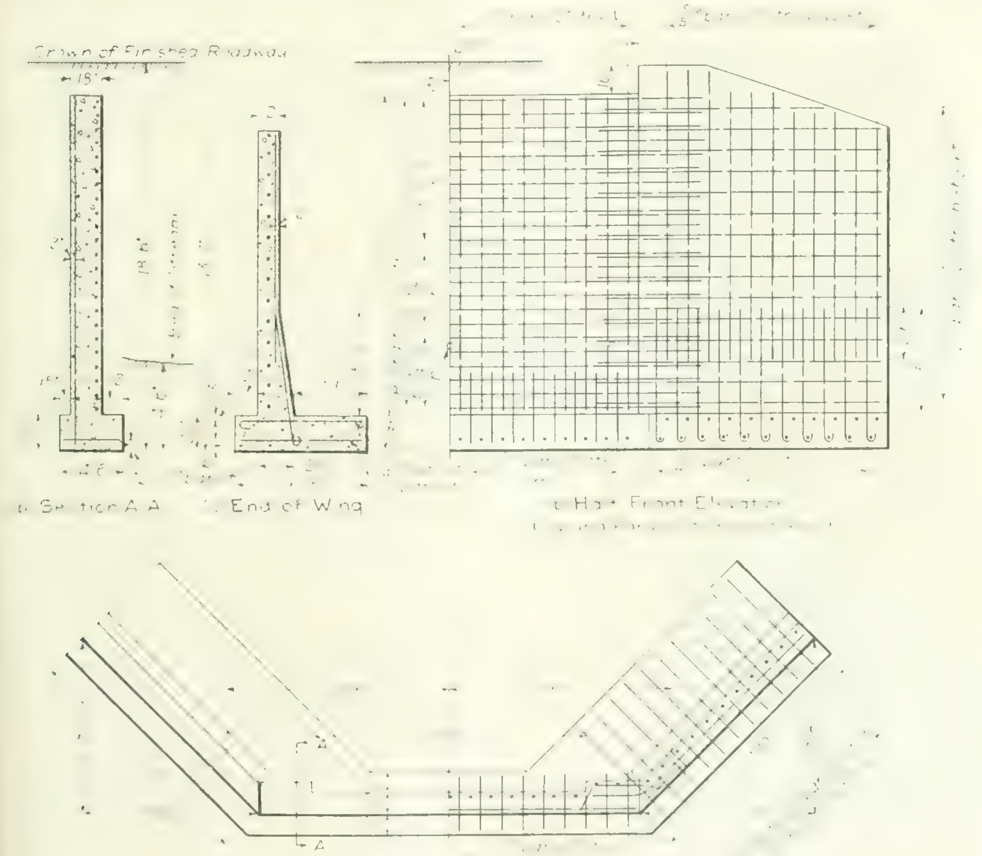


Fig. 3. Half Plan, Half Elevation, Cross Section and End View of Abutment of McKinley Ford Bridge.

28—60 hrs. wet excavation, north abutment; 7 hrs. mixing and placing concrete and 5 hrs. removing forms, south abutment; 23 hrs. building falsework for south span.

29—12 hrs. building falsework, south floor; 25 hrs. building falsework for south span; 8 hrs. removing forms, south abutment; 2 hrs. loading car.

30—16 hrs. wet excavation, north abutment; 20 hrs. mixing and placing concrete, north abutment; 20 hrs. building falsework, south span; 2½ hrs. north span; 20 hrs. removing forms, south abutment; 2 hrs. loading car and 8 hrs. teaming; 4 hrs. wheeling gravel.

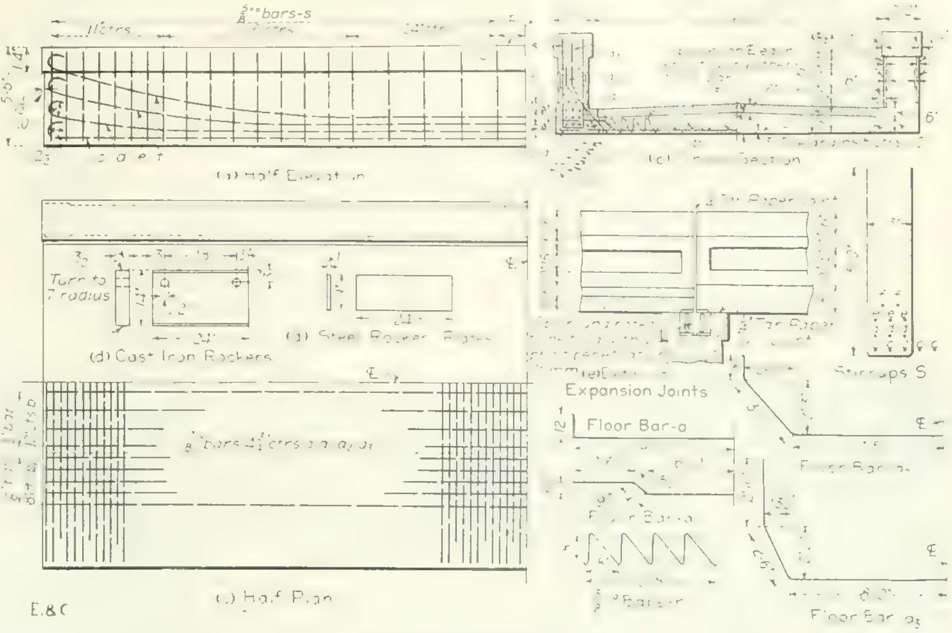


Fig. 4. Half Plan, Half Elevation, Cross Section and Details of Superstructure of McKinley Ford Bridge.

31—23 hrs. wet excavation, north abutment; 7 hrs. cleaning lumber; 5 hrs. on south rail and 46½ hrs. on south span, building forms; 15 hrs. building falsework, south span; 10 hrs. loading car and 10 hrs. teaming; 30 hrs. wheeling gravel.

Nov. 1—2 hrs. building forms and 14 hrs. mixing and placing concrete, north abutment; 12 hrs. loading car and 10 hrs. teaming; 54 hrs. wheeling gravel.

2—10 hrs. pumping while excavating north abutment; 22½ hrs. building forms, north abutment; 30 hrs. wheeling gravel; 20 hrs. loading car and 10 hrs. teaming.

3—7 hrs. pumping while excavating north abutment; 27 hrs. building forms, north abutment; 2½ hrs. building forms and 14 hrs. building and placing steel in south span; 28 hrs. mixing and placing concrete, north abutment; 36 hrs. wheeling gravel and 10 hrs. teams.

4—4 hrs. wet excavation, 30 hrs. building forms, and 13 hrs. mixing and placing concrete, north abutment; 2½ hrs. building forms and 18 hrs. bending and placing steel, south span; 4 hrs. mixing and placing concrete, center pier; 45 hrs. wheeling gravel and 6 hrs. teaming; 4 hrs. hauling lumber.

5—5 hrs. pumping while excavating, north abutment; 32 hrs. building forms, north abutment; 5 hrs. building forms and 40 hrs. bending and placing steel, south span; 2 hrs. mixing and placing concrete, center pier; 45 hrs. wheeling gravel; 3 hrs. hauling lumber.

6—35 hrs. wet excavation and 2 hrs. pumping, north abutment; 10 hrs. building forms and 30 hrs. bending and placing steel, south span; 8 hrs. mixing and placing concrete, center pier; 39 hrs. wheeling gravel and 5 hrs. teaming; 1 hr. unloading cement.

7—2 hrs. wet excavation, 3 hrs. pumping while concreting, 21 hrs. building forms, and 44 hrs. mixing and placing concrete, north abutment; 10 hrs. building forms and 20 hrs. bending and placing steel, south span; 3 hrs. mixing and placing concrete, center pier; 30 hrs. wheeling sand and 10 hrs. teaming; 1 hr. unloading cement.

8—17 hrs. building forms and 16 hrs. mixing and placing concrete; 4 hrs. building forms and 5 hrs. mixing and placing concrete, south span; 14 hrs. bending and placing steel; 44 hrs. wheeling gravel and 10 hrs. teaming.

(In the following data the division of work, expressed in hours, between foremen and workmen is indicated; "a" represents foremen at 65 cts. per hour, and "b" laborers at 25 cts. per hour.)

9—2a and 14b building forms, north girders; 2a and 14b bending and placing steel, north floor system; 2b on miscellaneous work.

10—20b building forms for north girders; 2a and 25b bending and placing steel, north floor; 4a and 35b building falsework for north floor; 3a and 50b screening gravel.

11—4b building forms for north girders; 3b bending and placing steel, north floor; 8a and 93b mixing and placing concrete, north floor; 1a and 20b building falsework, north floor; 1a and 10b screening gravel.

12—16b building forms, north girders; 5b bending and placing steel, north floor;

2a and 22b mixing and placing concrete, north girders, 2a and 6b building falsework, south floor, 3a and 29b removing forms, north abutment; 3a and 32b taking gravel from creek.

13—2a and 20b building forms, north girder; 5a and 65b building falsework, south floor; 5b finishing, north abutment; 3a and 30b taking gravel from creek.

14—2a and 20b building forms, north girders; 2a and 15b building forms, south floor; 3a and 30b building falsework, south floor; 15b finishing, north abutment; 3a and 30b taking gravel from creek.

15—2a and 20b building forms, north girders; 1a and 10b building forms, south floor; 3a and 30b mixing and placing concrete, north girder; 18b building falsework, south floor; 2a and 21b screening gravel; 2a and 21b getting gravel from creek.

16—3a and 20b building forms, north girders; 4a and 40b bending and placing steel, north floor; 2a and 20b building falsework, south floor, 1a and 20b screening gravel; 20b getting gravel from creek.

17—2a and 20b building forms, north girder; 3a and 30b bending and placing steel, south floor; 3a and 30b building falsework, south floor; 1a and 30b screening gravel; 1a and 20b getting gravel from creek.

18—25b building forms, north girders; 1a and 9b building forms, south floor; 3a and 33b bending and placing steel, south floor; 4a and 25b mixing and placing concrete, north girders; 1a and 10b building falsework, south floor; 1a and 28b screening gravel.

19—12a and 144b mixing and placing concrete, south floor; 10b building falsework, south floor.

20—1a and 9b building forms, north girders; 5a and 40b mixing and placing concrete, north girders; 4a and 25b removing forms; 29b screening gravel; 2a getting gravel from creek.

21—5a and 46b building forms, north girders; 37b mixing and placing concrete, north girders; 50b screening gravel.

22—5a and 46b building forms; 24b mixing and placing concrete, north girders; 41b screening gravel.

23—3a and 30b building forms, south girders.

24—32b building forms and 52b mixing and placing concrete, south girders; 23b removing forms, north girders; 16b screening gravel; 9b finishing; 5 hrs. teaming.

25—10b finishing.

26—46b building forms, south girders; 29b mixing and placing concrete, south girders.

28—51b building forms, south girders; 53b mixing and placing concrete, south girders; 30b removing forms, south girders; 20b removing forms. Job completed.

The quantity of concrete placed during each day that concreting operations were carried on is shown in the accompanying table. On a few days such a small quantity of concrete was placed that the amount is included in the quantity recorded on a following day. The part of the work where the quantity noted below was placed, and the number of hours required to mix and place it, may be noted by referring to the data given in Table I. Concreting was started Oct. 3, 1913.

Date.	Quantity concrete placed, cu. yds.
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Oct. 10	3.5
Oct. 11	9
Oct. 15	5.5
Oct. 17	5
Oct. 18	4.5
Oct. 19	4
Oct. 21	8.5
Oct. 24	20
Oct. 25	8
Oct. 28	1
Oct. 30	12
Nov. 1	9
Nov. 3	3
Nov. 4	5
Nov. 7	14
Nov. 8	7
Nov. 11	35
Nov. 12	5
Nov. 15	9.5
Nov. 18	5.6
Nov. 19	35
Nov. 20	9
Nov. 21	4.5
Nov. 22	5.7
Nov. 24	9
Nov. 26	9
Nov. 28	11
Total	308.3

Figure 5 shows one girder completed and the reinforcement in place for the adjacent girder; and Fig. 6 shows a view of the completed structure. The latter view shows the topographical conditions at the site.

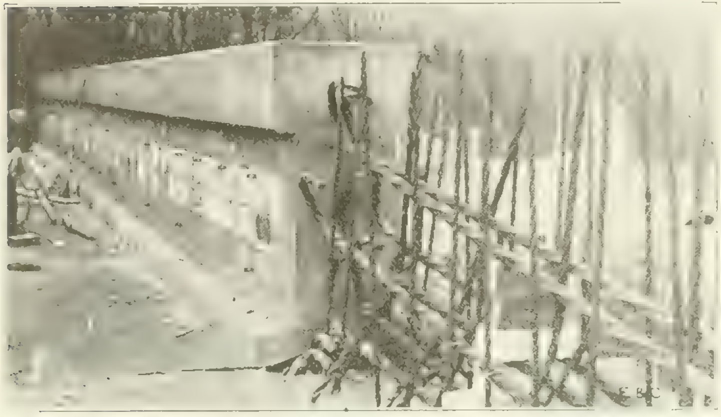


Fig. 5. View of McKinley Ford Bridge Showing One Girder Completed and End Reinforcement of Adjacent Girder.

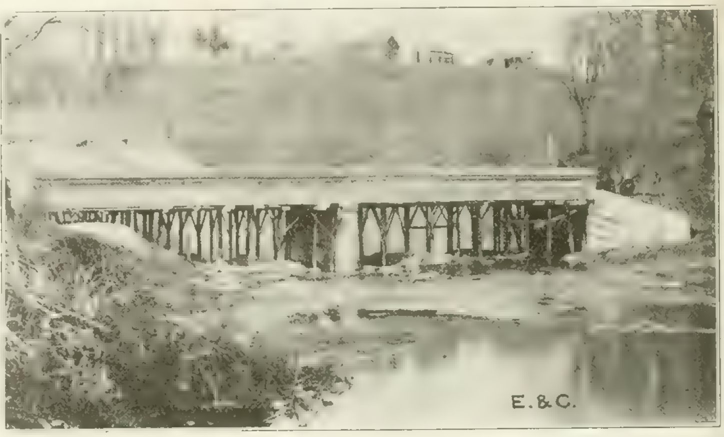


Fig. 6. View of Completed McKinley Ford Bridge — Falsework Still in Place.

COST DATA.

The data in Table II give the quantities of materials used, the unit prices, the cost of each item, and the total actual cost of the bridge to the contractor.

Table III gives the unit costs of the various items of the bridge. There were 308.3 cu. yds. of concrete and 42,600 lbs. of steel placed. There were used on this work 416 bbls. of cement, 117.2 cu. yds. of sand, and 187.4 cu. yds. of gravel. The costs given do not include the cost of removing the old bridge.

The cost of the excavation per cubic yard of substructure concrete was $5.435, and the cost of the falsework per cubic yard of superstructure concrete was $1.278.

TABLE II.—QUANTITIES OF MATERIALS, UNIT PRICES AND TOTAL COSTS.

Cement, 416 bbls. at $1.25		$ 520.00
Hauling cement 4 miles		65.84
Sand, in place, 117.2 cu. yds. at 30 cts.		35.16
Hauling sand 150 ft. in wheelbarrows from creek		98.40
Gravel, in place, 187.4 cu. yds. at 30 cts.		56.22
Screening 125 cu. yds. of gravel		78.20
Hauling gravel 400 ft.		187.18
Form lumber, 6,000 ft. B. M. at $22.67		136.00
Falsework lumber, 3,000 ft. B. M. at $15		45.00
Wire, nails, etc., 240 lbs. at 5 cts.		12.00
Hauling form lumber 4 miles		15.00
Hauling falsework lumber 4 miles		7.00
Reinforcing steel, 42,600 lbs.		816.80
Hauling steel 4 miles		32.00
Rockers and plates, 1,680 lbs. at 2 cts.		33.60
Asphalt, 50 gals. at 15 cts.		7.50
Hauling rockers and asphalt at $4.50 per day		3.50
Sheet piling, 500 ft. B. M. at $20		10.00
Cost of driving sheet piling		8.00
Cost of removing sheet piling		5.00
Labor on 108 cu. yds. dry excavation:		
Foreman, 40 hrs. at 65 cts.	$ 26.00	
Laborers, 344 hrs. at 25 cts.	86.00	112.00
Labor on 132 cu. yds. wet excavation:		
Foreman, 130 hrs. at 65 cts.	$ 84.50	
Laborers, 1,272 hrs. at 25 cts.	318.00	402.50
Cost of pumping during excavation:		
Foreman, 9 hrs. at 65 cts.	$ 5.85	
Laborers, 104 hrs. at 25 cts.	26.00	31.85
Cost of pumping during concreting:		
Foreman, 4 hrs. at 65 cts.	$ 2.60	
Laborers, 34 hrs. at 25 cts.	8.50	11.10
Labor, building forms:		
Foreman, 115 hrs. at 65 cts.	$ 74.75	
Laborers, 1,146 hrs. at 25 cts.	286.50	361.25
Labor, building falsework:		
Foreman, 35 hrs. at 65 cts.	$ 22.75	
Laborers, 350.5 hrs at 25 cts.	87.63	110.38
Labor, bending and placing steel:		
Foreman, 36 hrs. at 65 cts.	$ 23.40	
Laborers, 361 hrs. at 25 cts.	90.25	113.65
Labor, mixing and placing concrete:		
Foreman, 115 hrs. at 65 cts.	$ 74.75	
Laborers, 1,142 hrs. at 25 cts.	285.50	360.25
Labor, removing forms:		
Foreman, 20 hrs. at 65 cts.	$ 13.00	
Laborers, 231 hrs. at 25 cts.	57.75	70.75
Traveling expenses of men from Chicago and back		100.00
Gasoline, oil and incidentals		97.00
Total		$3,943.13
Salvage on lumber and falsework		50.00
Total net cost to contractor		$3,893.13

PERSONNEL.

The bridge was designed by the Illinois Highway Department, Clifford Older, bridge engineer. It was constructed by the George Quinlan Construction Co.

TABLE III.—UNIT COSTS OF VARIOUS ITEMS.

Item.	Cost per cu. yd. of concrete.
Cement	$1.971
Sand	0.448
Gravel	1.125
Labor on forms	1.525
Form materials	0.315
Labor on falsework	0.421
Falsework materials	0.161
Steel, in place	3.241
Mixing and placing concrete	1.379
Excavation	1.897
Miscellaneous, not included in above	0.145
Total	$12.628

The Design of Reinforced Concrete T-Beams and Rectangular Beams With Steel in Compression.

Contributed by M. J. Lorente, Lynn, Mass.

The methods universally employed in analyzing reinforced concrete rectangular beams have given rise to a few simple formulas. If we know the values of R (the coefficient of resistance) and of p (the ratio of the area of the steel in tension to the effective area of the beam), for any given stresses, we can find the beam section for a certain bending moment in a very short time. Moreover, as values of both R and p can be easily tabulated for various stresses, the design of such beams becomes extremely simple. In the case of T-beams and beams with steel in compression, the formulas offered by authorities on the subject are cumbrous and impracticable and contain constants which are very troublesome to tabulate. However, this difficulty is not due to the nature of the problem, but rather to the methods which have been followed in its analysis.

In the analysis of simple beams it is absolutely necessary to find the arm of the couple resisting the bending moment, as the constants used in the formulas depend on that arm. But it does not follow that in T-beams and beams with steel in compression it is also necessary to find the arm. Yet authorities invariably proceed along the same analytical lines followed in deriving formulas for simple beams and give the following formulas for the distance of the neutral axis from the top of the beam, on which the arm depends.

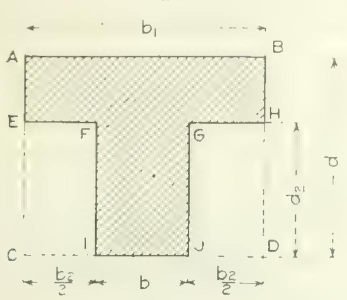


Fig. 1.

For T-beams:

$$kd = \sqrt{\frac{2ndAs + (b-b')t^2}{b'} + \left(\frac{nAs + (b-b_1')t}{b'}\right)^2} - \frac{nAs + (b-b')t}{b'} \quad \ldots\ldots (1)$$

For beams with steel in compression:

$$k = \sqrt{2n\left(p + p'\frac{d'}{d}\right) + n^2(p+p')^2} - n(p+p') \quad (2)$$

Such formulas are, to say the least, clumsy. They also are unnecessary, for by the following methods of analysis (which the writer believes to be entirely new) we do not need to find the arm of the resisting couple, but can arrive at formulas which are very simple and whose constants can readily be tabulated.

FORMULAS FOR T-BEAMS

Assume a T-beam such as *ABHGJIFE* (Fig. 1). It is evident that the moment of resistance of the T-beam is equal to that of a rectangular beam *ABDC* less that of two rectangular beams *EFIC* and *HDJG*.

Likewise the area of steel required for the T-beam will be that required for a rectangular beam *ABDC* less the quantity required for the two beams *EFIC* and *HDJG*.

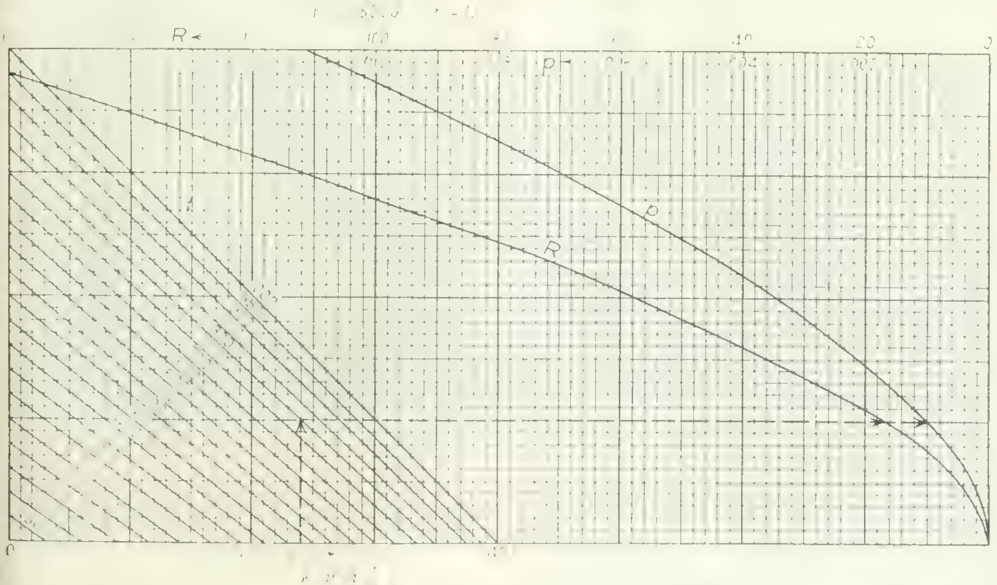


Fig. 2. Diagram for Determining Values of R and p for Values of k, f. and t d When $f_s = 18{,}000$ and n = 12.

We thus have reduced the problem of the T-beam to that of rectangular beams.

Expressing the above statements in formulas, we have:

$$M = R_1b_1d^2_1 - R_2b_2d^2_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

and

$$A_s = p_1b_1d_1 - p_2b_2d_2 \quad \ldots\ldots\ldots (4)$$

where

M = bending moment in inch-pounds,

A_s = required area of steel in square inches,

R_1 = coefficient of resistance for the large beam *ABDC*,

R_2 = coefficient of resistance for the small beams *EFIC* and *HDJG*,

p_1 = ratio of area of steel to effective area of beam for *ABDC*,

p_2 = ratio of area of steel to effective area of beam for beams *EFIC* and *HDJG*.

It should be borne in mind that the steel stress will be the same for both the large and the small beams but that the stresses in the concrete will be different. In the large beam it will be the maximum allowable stress; in the small ones it will be the stress corresponding to the underside of the slab forming the wings of the T-beam. If we know the position of the neutral axis we can easily find the latter stress by simple proportion.

Suppose now that we have prepared a table, such as Table I, giving the values of the constants *R*, *p* and *k* for a stress of 18,000 lbs. in the steel, a ratio of moduli of 12, and stresses in the concrete ranging from 0 to 1,000 lbs., and that we wish to find the moment of resistance of a T-beam 25 ins. deep, with a stem 10 ins. wide, a flange width of 30 ins. and a slab thickness of 6 ins. Assuming that the maximum stress in the concrete is 800 lbs., that in the steel is 18,000 lbs., and that the ratio of moduli is 12, the stress in the underside of the slab will be:

$$\left(k - \frac{t}{d}\right)\frac{f_c}{k} = \left(0.348 - \frac{6}{25}\right)\frac{800}{0.348} =$$

250 lbs. per square inch.

From Table I we find that for stresses of 800 lbs. and 250 lbs., respectively, R_1 = 123, p_1 = 0.0077 and R_2 = 17, p_2 = 0.001.

Substituting these values in equations (3) and (4) we have:

$$M = 123 \times 30 \times 25^2 - 17 \times 20 \times 19^2 = 2{,}183{,}510 \text{ in.-lbs.}$$

and

$$A_s = 0.0077 \times 25 \times 30 - 0.001 \times 20 \times 19 = 5.40.$$

To avoid interpolating for values which are not given in Table I, and also to simplify the operation of finding the stress in the underside of the slab, a set of curves can be drawn for a given stress in the steel, similar to that shown in Fig. 2. In these curves the required constants can easily be picked out as follows:

Along the scale representing $\frac{t}{d}$ (where t = thickness of slab and d = effective depth of beam) find the required value. From this point follow the line at right angles to the scale until it intersects the oblique line representing the allowable stress in the concrete. From this point of intersection follow the line parallel to the scale of $\frac{t}{d}$ until it meets the curves marked *R* and *p* and read the corresponding values on their respective scales.

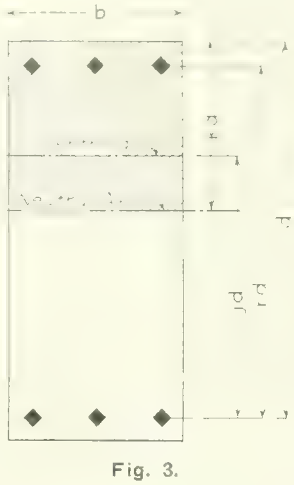


Fig. 3.

Not only is this method very simple, but it does not neglect the compression in the stem of the beam.

RECTANGULAR BEAMS CONTAINING COMPRESSIVE REINFORCEMENT.

The following discussion refers to rectangu-

TABLE I.—DATA FOR DESIGNING T-BEAMS WHEN f_s = 18,000 and n = 12.

Fc.	k.	p.	R.
1000....	.400	.01110	174.00
950....	.388	.01020	160.00
900....	.376	.00950	149.00
850....	.362	.00850	134.00
800....	.348	.00770	123.00
750....	.334	.00700	112.00
700....	.316	.00620	100.00
650....	.302	.00550	89.00
600....	.286	.00480	78.00
550....	.268	.00410	67.00
500....	.250	.00350	58.00
450....	.231	.00290	48.00
400....	.211	.00230	38.50
350....	.190	.00190	32.00
300.............	.167	.00140	24.00
250....	.143	.00100	17.00
200....	.118	.00065	11.00
150....	.091	.00039	6.00
100....	.062	.00017	[illegible]
50....	.032	.00005	[illegible]

TABLE II.—FORMULA CONSTANTS FOR 18,000 LBS., FOR REINFORCED CONCRETE BEAMS WITH STEEL IN COMPRESSION.

F. = 600 and p = .00477				Fc = 650 and p = [illegible]			
r.	C1.	C2.	C3.	r.	C1.	C2.	C3.
.96	.000183	.0142	.316	.96	.000173	.0153	[illegible]
.94	.000204	.0158	.291	.94	.000183	.0162	.322
.92	.000228	.0177	.264	.92	.000204	.0181	.297
.90	.000250	.0201	.238	.90	.000230	.0203	[illegible]
.88	.000296	.0230	[illegible]	.88	.000261	.0231	.241
.86	.000345	.0268	.187	.86	.000300	.0266	.214
.84	.000410	.0318	.161	.84	.000350	.0310	.188
.82	.000500	.0388	.136	.82	.000418	.0370	.162
.80	.000632	.0490	.110	.80	.000512	.0453	.135
F. = 700 and p = .0062				F. = 750 and p = .00695			
.96	.000154	.0154	.375	.96	.000149	.0160	.402
.94	.000169	.0169	.350	.94	.000158	.0175	.375
.92	.000187	.0187	.316	.92	.000175	.0193	.347
.90	.000209	.0209	.295	.90	.000194	.0215	.318
.88	.000235	.0235	.268	.88	.000217	.0240	.292
.86	[illegible]	.0267	.241	.86	.000244	.0270	.265
.84	.000310	.0310	.213	.84	.000281	.0310	[illegible]
.82	.000363	.0363	.186	.82	[illegible]	.0360	[illegible]
.80	.000135	.0435	.159	.80	.000382	[illegible]	.182
F. = 800 and p = .00775				Fc = 850 and p = [illegible]			
.96	.000135	.0165	.428	.96	.000126	[illegible]	.463
.94	.000147	.0180	.403	.94	.000136	.0184	.428
.92	.000161	.0197	.375	.92	.000149	.0202	[illegible]
.90	.000177	.0218	.347	.90	.000165	[illegible]	.376
.88	.000198	[illegible]	.318	.88	.000182	.0246	.349
.86	.000222	.0273	.290	.86	.000203	.0275	.319
.84	.000252	.0310	.261	.84	.000229	.0310	[illegible]
.82	.000287	.0353	.235	.82	.000260	[illegible]	.261
.80	.000336	.0412	.206	.80	.000299	.0405	[illegible]
F. = 900 and p = .00940							
.96	[illegible]	.0171	[illegible]				
.94	.000127	.0189	.463				
.92	.000139	.0206	[illegible]				
.90	.000152	.0225	.406				
.88	.000169	.0250	.371				
.86	.000187	.0277	.346				
.84	.000209	.0310	.316				
.82	.000236	.0350	.287				
.80	[illegible]	[illegible]	[illegible]				

lar beams containing both tensile and compressive reinforcement:

Referring to Fig. 3 the moment of resistance of the concrete in compression equals

$$b.k.jd^2.\frac{f_c}{2},$$

and the moment of resistance of the steel in compression equals

$$p^1.b.d^2.r.f_c.n\frac{kd-d+rd}{kd}.$$

If the two moments are equal, then

$$p^1=\frac{k^2}{2.n.r(k-1+r)}.$$

If M = the bending moment in the beam, then

$$M=x.b.d^2.k.j.\frac{f_c}{2}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where x = number of times which the area of the concrete, or its equivalent area of steel in compression, must be used to resist the bending moment. Hence

$$p^1.b.d(x-1)=p_c.b.d,$$

where p_c is the required ratio of steel in compression. Therefore

$$x=\frac{p_c}{p^1}+1.$$

Substituting this value of x in equation (5), we have

$$M=\left(\frac{p_c}{p^1}+1\right)b.k.jd^2.\frac{f_c}{2}=$$
$$(p_c+C_2)\frac{b.d^2}{C_1}.$$

Hence $p_c=\frac{M.C_1}{b.d^2}-C_2,$

and

$$d=\sqrt{\frac{M.C_1}{b(p_c+C_2)}}.$$

The moment of resistance of the steel in tension corresponding to the concrete in compression = $p_1.b.d.jd.f_s$.

The moment of resistance of the steel in tension corresponding to the steel in compression = $p_2.b.d.rd.f_s$.

If these two moments are equal, then $p_1.j = p_2.r$.

Now,

$$M=x.p_1.b.d.jd.f_s,$$

where x = number of times which $p_1.j.b.d^2$, or its equivalent $p_2.r.b.d^2$, must be used to resist the bending moment.

Hence

$$(x-1)p_2.b.d^2.r=p_3.b.d^2.r;$$

therefore,

$$p_3=(x-1)p_2=(x-1)p_1\frac{j}{r}.$$

Hence,

$$x=\frac{p_3}{p_1}.\frac{r}{j}+1=\frac{p_c}{p^1}+1;$$

therefore,

$$p_3=\frac{p_c.p_1.j}{p^1.r}=C_3.p_c;$$

and total A_s in tension = $(p+C_3.p_c)\,b.d$.

It should be noted that jd is the distance of the centroid of the compressive forces acting on the concrete *alone*, and that p is the ratio of steel required for tension when the beam has no steel in compression.

All of the constants in the preceding formulas are easily tabulated, as shown in Table II, which gives the constants when f_s = 18,000 lbs.

When the constants are tabulated in a similar form to that shown in Table II the design of beams with steel in compression is very materially facilitated.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

Electric Steam Tunnel Crane.

(Contributed.)

A combination wrecking crane built for either steam or electric operation has recently been received by the Michigan Central R. R. Co. for use in and about the Detroit River Tunnel. It is hoped, of course, that an accident may never occur in the tunnel itself, and in order that the crane need not be idle under normal everyday conditions, it is adapted for ordinary uses outside the tunnel as well as the special use underground. To this end, current for operation may be taken from a third rail or from a flexible cable carried on the crane, but if outside the limits of the electric zone and beyond the reach of the power cable, the crane can be operated by steam from any outside source such as an accompanying locomotive. It is then available for regular wrecking duty, or for construction and yard work.

In general the construction is like the 120-ton capacity steam wrecking cranes which are standard on American railroads. The car body is 26 ft. long and 9 ft. 6 ins. wide, and the weight of the crane is distributed over a wheel base of 19 ft. 8 ins. Telescopic outriggers are provided for adding stability during heavy lifting. Air and hand brakes are furnished with provision for both automatic and straight air. The complete air brake system is under the control of the operator, with engineer's valve, electric air compressor, etc.

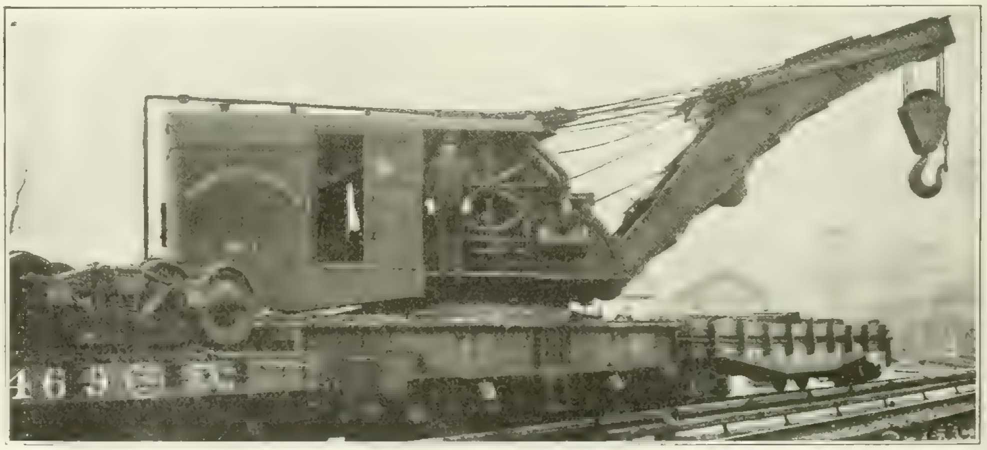
No boiler is furnished with the crane, but when desired steam is taken from an outside source through a suitable system of piping. This is so arranged by means of a steam-tight skip joint at the center of revolution that the crane will slew more than 180° in either direction beneath the pipe without interference. When the crane is operated by electricity this piping revolves with the crane. Both the steam engine and the electric motor meet equally well all operating requirements.

For electric operation there is provided a motor wound for 600 volts d. c. and having a capacity varying from 200 hp. for a short period, to 115 hp. for one hour's continuous service. This motor will operate on fluctuations of line voltage ranging from 300 to 700 volts. The controller is of the street railway type with cast grid resistance. Current is taken from the third rail shoes through a collector ring. It is delivered to a switchboard that is furnished with all necessary switches and instruments for operating the electric air compressor, cable reel, third rail shoes, lights, etc.

An interesting feature is the automatic cable reel for paying out and reeling in the main power cable. This reel has capacity for 500 ft. of insulated power cable. It is operated by a motor and automatic control is obtained by the action of the motor alone, without the use of any intermediate or external mechanical devices, such as friction clutches, etc. This motor has current on at all times the crane is in service and taking current through the cable, so that practically constant torque is exerted by the motor with consequently practically constant pull on the cable. Any change in the pull on the cable, such as would be produced by the crane moving forward or back results automatically in the desired paying out or reeling in of the cable. The motor is capable of standing "stalled" continuously without danger to its parts from over heating.

The motions of hoisting with either the main or auxiliary hoist, varying the boom radius and slewing, are independent of each other and with loads up to the limit of its power, these motions can be performed simultaneously. With its maximum load of 120 tons the crane is capable of slewing at the rate of a complete revolution in one minute if deemed of safe speed. The boom may be raised or lowered under full load. There is provided a special drag or pulling line connection attached to the underside of the boom. When self propelled by either steam of electricity the crane has a speed of about four miles an hour, but it may be safely hauled in regular trains over main line tracks at a speed of 60 miles an hour.

The maximum radius of the main block is 25 ft. and the minimum is 16 ft. Capacities of the crane are as follows: With outriggers in position: Main hoist 240,000 lbs. at 17 ft. radius; main hoist 150,000 lbs. at 20 ft. radius. With end outriggers only: Main hoist 140,000 lbs. at 16 ft. radius; auxiliary hoist 30,000 lbs. at 25 ft. radius. Without outriggers: Main hoist at right angles, 44,000 lb. at 16 ft. radius, 32,000 lbs. at 20 ft. radius. Auxiliary hoists: 24,000 lbs. at 25 ft. radius.



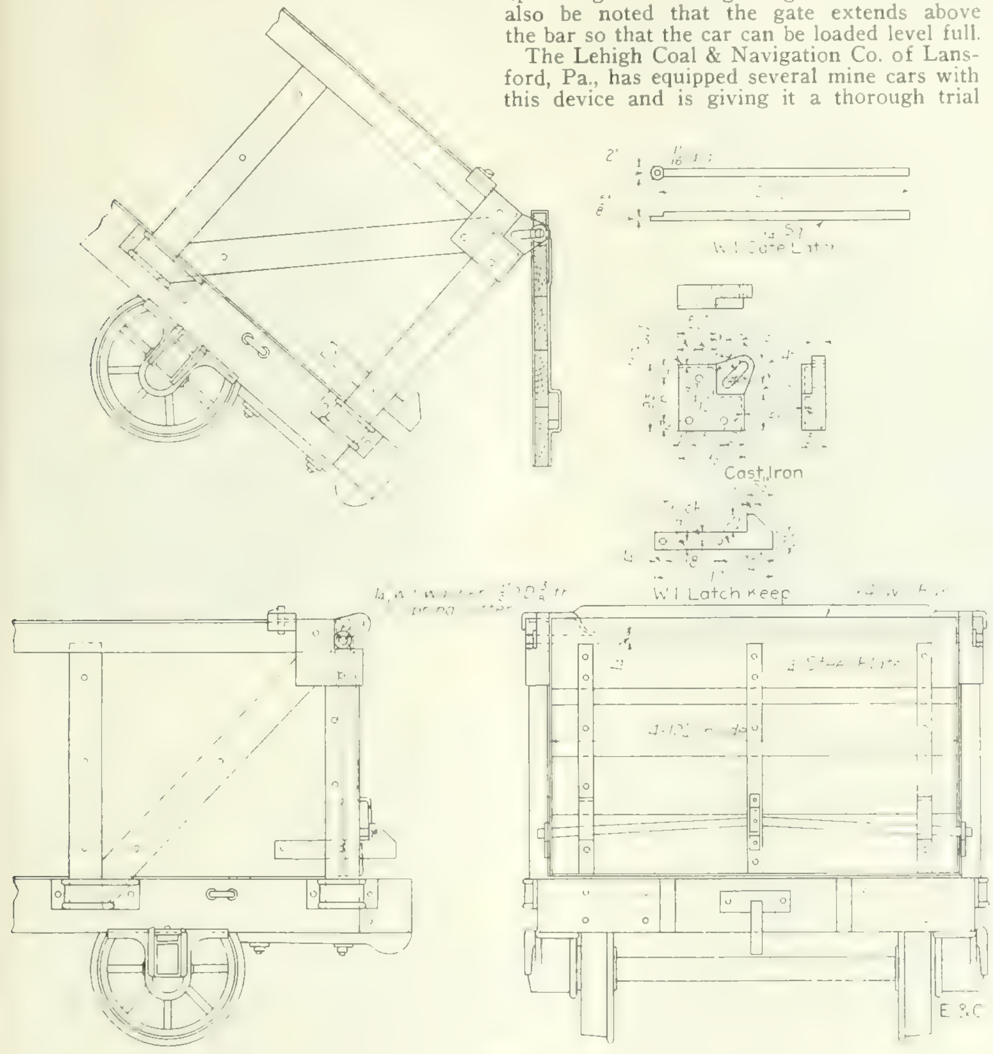
Electric Steam Tunnel Crane for Michigan Central R. R.

This crane differs from the electric tunnel crane of the Pennsylvania Railroad and the Grand Central Terminal in that it may be operated by steam in addition to electricity. Furthermore it is not a double end crane as are those built by the same company for the work in the tunnels of New York. The crane was built by the Industrial Works of Bay City, Mich.

An Automatic End Gate for Mine Cars.

Contributed by Adolphe G. Morlock

An automatically operated gate for mine cars has been patented by C. W. Stickler, of



Automatic End Gate for Mine Cars.

Lansford, Pa., which should become popular for the simple reason that it has no parts to get out of order, no levers to operate, will not bump open on level track, dumps easily and surely, and latches itself automatically. The attachment can be placed upon any mine car now in use at but a small cost.

A mine car equipped with this automatic device has been in use more than five months, making frequent trips from mine to tipple, and has never failed to dump or latch itself.

It is an economical device in that it does away with the services of the men now required to set and operate the car latches between the shaft and the headhouse.

As may be seen from the accompanying drawing, the attachments consist of a casting fitted to the top of the car at the gate end and the ordinary car latch, shortened, so as not to extend beyond the body of the car.

The casting, as the detail shows, has a slot for the gate bar to slide in. This slot, for five-eighths of the thickness of the gate bar, has a pitch of 60° to form a pocket for the bar, so that the gate cannot be bumped open on level track. From that point it pitches at 45° to a height sufficient to lift the latch from the keep.

As the car runs on the dump the center of pressure of the contents shifts from the bottom of the car to the gate, while the momentum causes great pressure to be exerted thereon. Meanwhile, the car is tilting downward and the 45° slot is assuming a horizontal position which permits the bar to slide, lifting the latch out of the keep and releasing the contents of the car. As the car returns to the horizontal, the bar slides down the slot into the pocket and the gate slams shut, dropping the latch into the keep and automatically locking the gate.

A tie is placed across the top of the car near the gate casting to prevent the sides from spreading and binding the gate bar. It should also be noted that the gate extends above the bar so that the car can be loaded level full.

The Lehigh Coal & Navigation Co. of Lansford, Pa., has equipped several mine cars with this device and is giving it a thorough trial preparatory to installing it on all their mine cars.

A Tractor Truck for Contractors' Hauling.

(Contributed.)

An entirely new machine called a tractor-truck is illustrated here; it has been developed by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., to fulfill a dual requirement: (1) As a tractor for general hauling purposes for contractors, mines, smelters, plantations—in fact, wherever a powerful and substantial machine is required. (2) As a truck for truck hauling and for use in rough and unbroken country where the roads are poor and under all conditions where the usual type of truck cannot be used on account of the road conditions.

Tractor Truck for Contractors.

As a truck the equipment has a capacity of five tons; as a tractor the draw-bar pull at first speed is 9,000 lbs.; on second speed, 4,125 lbs.; and at third speed, 2,370 lbs. The makers do not recommend the machine for use as a tractor on the fourth speed. Its first speed forward is 1½ miles per hour; second speed, 3½ miles; third speed, 6 miles, and the fourth speed 8 to 10 miles per hour; reverse speed, 1⅓ miles per hour. The fourth speed is recommended only for light loads and emergency purposes.

This tractor-truck is equipped with a four-cylinder T-head, automobile type engine, developing 68 HP. at 1,000 R.P.M. It is water cooled, positive circulation with centrifugal pump. The radiator is of the square tube type with belt driven fan. The carburetor is of the automatic float feed type with water jacket for warm water, and air inlet shut-off for starting in cold weather; gravity feed.

Auto truck practice has been very closely followed in the rest of the equipment, the clutch being large cone leather faced with adjustable spring inserts underneath leather, allowing gradual engagement. There is a full universal between clutch and transmission, also Spicer joints on drive between the transmission and differential. The transmission, differential and jack shaft is in one unit, extra heavy; the sliding gear, selective type, with four speeds forward and reverse, direct drives on third speed; F. & S. annular ball bearings; chrome vanadium steel gears. The differential is of large size and made of chrome vanadium steel; pinion shaft supplied with two Timken bearings, also Timken bearings on differential.

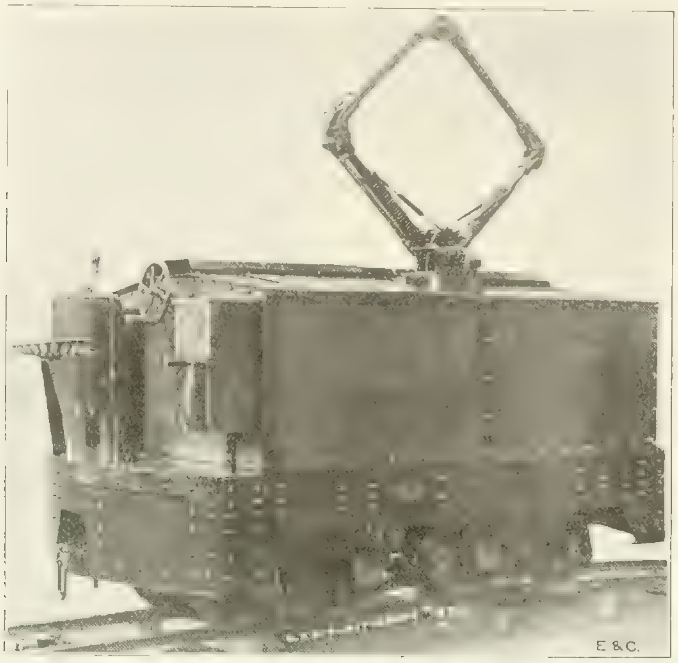
The final drive consists of special alloy steel sprockets on jack shaft and track wheel connected by side roller chains of extra heavy type. The treads of the track wheel form an endless chain which runs over two steel sprockets, the rear sprocket being keyed to the same shaft as the sprocket driven by roller chain. The entire weight carried by the track wheel is supported on chain connected rollers, eliminating journal friction at this point. At the rear axle there are two semi-eliptic springs and two coil springs on the front axle; foot brake equalized, contracting on drums connected to countershaft. The steering gear consists of worm and double nut with very large bearing surface and the wheel pivots turn on Timken roller bearings fitted with 20-in. hand wheel.

The main frame consists of 7-in. rolled steel channel section, extra heavy and heavily trussed with angle steel sub-frame; castings are chrome vanadium, annealed and heat treated.

A Double Truck Electric Locomotive.

(Contributed.)

The Orenstein-Arthur Koppel Co., of Koppel, Pa., have just perfected a new locomotive embodying two distinctly new features, a flexible diamond shaped trolley and a double truck, permitting use on track layouts where sharp curves are encountered. Each of the two features alone presents a great stride in the designing of industrial locomotives and both have successfully stood all tests to which the recently erected machine has been subjected.

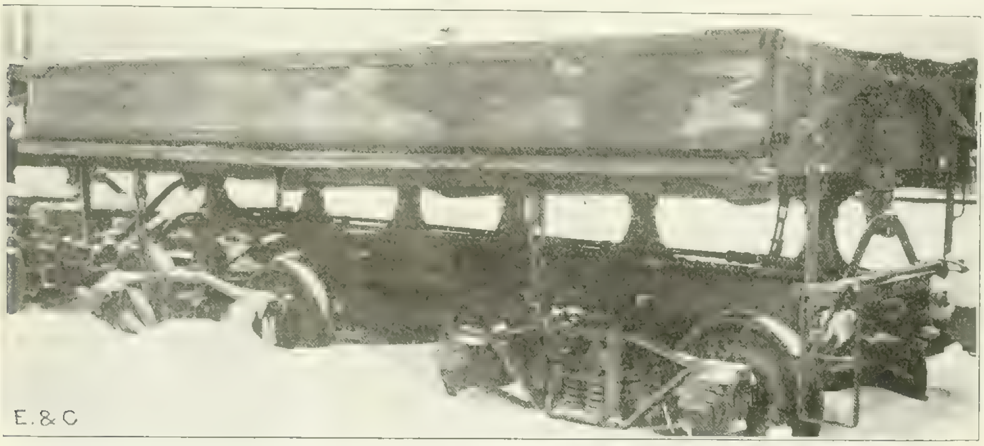


Double Truck Electric Locomotive.

For years most of the larger industrial concerns in the country, which installed the electric system, have experienced difficulty in arranging track layouts so as to exclude sharp curves, so much time and money has been lost in derailments and excessive power needed while hauling around curves. The greatest difficulty has been experienced in plants where tracks have been installed after the plant had been built for some time and as a result curves of 15 ft. radius and less often have been encountered.

The new locomotive can take a curve of even 12 ft. radius while hauling a train without excessive power being required and without derailment. By the use of small wheels it is possible to make the wheel-base of the trucks short, allowing room for the double truck on the same size locomotive formerly used for a single truck.

Because of the small wheels and the accompanying low body of the locomotive, it is not possible to mount the motor directly on the truck frame, so in the new design the motor is mounted on the frame of the car and the wheels are driven by means of flexible silent chains.



Contractor's Car with Improved Side Door.

The ordinary trolley pole is also unsuitable for small curves as the trolley wheel invariably comes off the wire. Another disadvantage in the pole system of current-carrying is in reversing the pole when changing direction. To counteract these difficulties the new arrangement contains the diamond-shaped trolley, equipped with two large springs allowing flexibility in all directions. This trolley is permanent and requires no attention on the part of the operator.

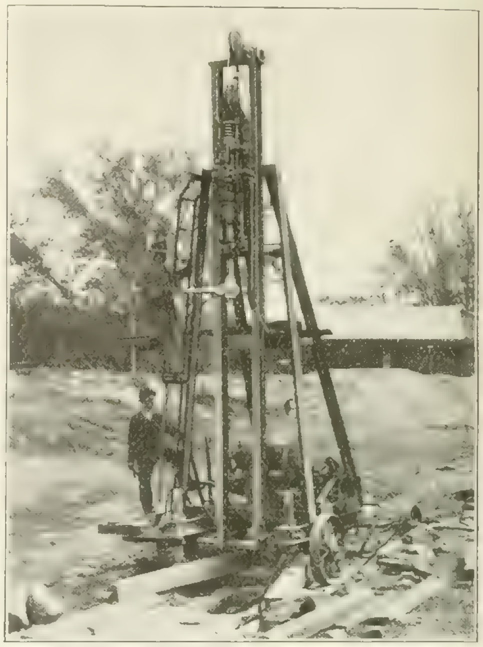
The locomotive has been thoroughly tested and has proven its merit by passing through a series of successive sharp curves, including those of a 12 ft. radius and in addition to holding to the tracks has pulled a train.

An Improved Side Door for Contractors' Dump Car.

The illustration shows a side door for dump cars. The construction is of plank bound tops and bottoms by steel rails, the plank edges setting into the gap between head and base of rail. To the ends of the rails are connected four trunions which set into holes in the end bars as indicated by the illustration. The car pictured is one of ten employed for one year in handling rock; the door remains true and unbroken. This car door is controlled by the Improved Car Side Co., 1778 50 Church St., New York.

Autotraction Drill Rig and Hollow Piston Drill.

Hollow piston drills were used with exceptional success in excavating for the power station at Turners Falls at Montague City, Mass. When the earth on the river bank had been removed, the rock on the level portion was drilled to a depth of 30 ft. and shot for removal by a steam shovel. This work was done with a Sullivan class "FV-14" submarine type rock drill with hollow piston and hollow drill steel, mounted on an autotraction carriage, Fig. 1, to facilitate moving from hole to hole. The drill and the carriage engines were operated by compressed air from the central power house. With this machine, 3-in. holes 30 ft. deep were drilled 10 ft. apart, averaging from 150 to 210 ft. per 10-hour day. The best day's work accomplished was eight 30-ft. holes, the outfit being moved seven times.

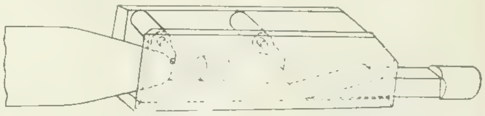


Autotraction Drill Rig and Hollow Piston Drill.

The formation consisted of partially disintegrated sandstone, increasing in solidity and hardness with depth, until some rock of considerable hardness was encountered in the last few feet of the holes. The rock lay on a pitch of 20 to 30 degrees away from the river, in thin strata. In this formation, the cleaning action secured by the blast of exhaust air, discharged to the face of the bit through the hollow piston and drill steel, was particularly valuable. It prevented the clogging of the bit by accumulated chips and dust, and secured a clean rock face for the bit to strike at all times. The drill described is made by the Sullivan Machinery Co., Chicago, Ill.

A Device for Recovering Rods or Tools from Underground Conduit.

The accompanying diagram shows a pickup tool for recovering rods or tools lost in clay conduit. Ordinarily when tools become detached or rods are broken in conduit an excavation from the surface to recover them is required. As the sketch indicates the new tool consists of a metal box on the end of a rod; this box has two flaps or doors as shown. When a tool is lost and remains in the conduit the box is pushed in until it reaches the lodged tool end which slides up into the box past the first door and is "caught" as indicated. If a broken rod is being recovered the second flap or door catches it. When the box is pulled back out of the conduit the tool or rod comes with it. The inventor, Mr. M. Blumenthal, states that he has repeatedly with this device recovered a rod or set of rods in five minutes. The pickup device is manufactured by B. S. Barnard & Co., 50 Church St., New York, N. Y.



A New Pickup Tool for Conduit Work.

Engineering and Contracting

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An editorial urging the importance of applying a test of some kind to determine whether the professional man is keeping up with the times or is lagging behind. E. & C., Feb. 24, 1915; ½ col.

BRIDGE WORK: Legislation Affecting.

Dangerous Legislation Affecting Bridge Work 162

Editorial comment on a proposed act now before the Pennsylvania Legislature, the main purposes of which are to require that competitive plans and specifications be permitted at bridge lettings, and that no bidder shall submit a bid covering plans in which a patented device is used unless accompanied by the signed terms under which the patentee will permit its use. E. & C., Feb. 24, 1915; ½ col.

ROADS: Surveys and Plans, Michigan Trunk Lines.

Surveys and Construction Plan for Trunk Line Road Construction in Michigan 162

Discusses trunk line road law, preliminary surveys, location surveys, cost of surveys, construction plans and gives typical specifications. E. & C., Feb. 24, 1915; 15 cols.

ASPHALT: Melting Point.

Comment on the Cube Method for Determining the Melting Point of Asphalts ... 167

Letter commenting on an article on the above subject in previous issue of Engineering & Contracting. Makes corrections as to credits. E. & C., Feb. 24, 1915; ¼ col.

SURVEYOR: Judge for County.

A Judge for County Surveyor 167

Letter commenting on editorial in issue of February 17. Tells of engineers who were candidates for the above position, and their qualifications. E. & C., Feb. 24, 1915; ¼ col.

APPRAISAL: City Real Estate.

Appraisal of City Real Estate 167

Abstract of a paper on "Technical Information for Real Estate Experts." Gives a formula for calculating value of city lots, and compares with "Hoffman rule." Also gives detailed cubic foot costs of two large buildings. E. & C., Feb. 24, 1915; 9½ cols.

PUMPS: Water Works; Choice for City.

Choice of Pumps for City Water Works .. 171

Discusses economic choice of pumps for cities having daily consumption of water under 1,000,000 gals., from 1,000,000 to 5,000,000 gals. from 5,000,000 to 12,000,000 gals., and over 12,000,000 gallons, respectively. E. & C., Feb. 24, 1915; 2½ cols.

WATER WORKS: Operation, Faulty.

The Faulty Operation of the Average Public Utility with Special Reference to Water Works—Suggested Betterments .. 171

Gives a few examples of poor water works design in Kansas. Discusses faulty operation of well designed and constructed water and light plants. Discusses betterments under headings of management, accounting, and record-keeping. Advocates taking plants out of politics and the placing of trained men in charge. E. & C., Feb. 24, 1915; 4¼ cols.

WATER STERILIZATION: Liquid Chlorine and Hypochlorite of Lime.

Data and Discussion on Relative Efficiency of Liquid Chlorine and Hypochlorite of Lime 173

Gives results of studies made at Valhalla, N. Y., during past three years. Data on relative efficiency given. Summarizes advantages of liquid chlorine over hypochlorite of lime. E. & C., Feb. 24, 1914; 4 cols.

WATER WORKS: Distribution System: Development Plan at San Diego, Calif.

The Development Plan for the Water Distribution System of the City of San Diego, Calif. 174

Describes plan followed at San Diego in planning extensions to distribution system, and gives general discussion on the layout of new and the reinforcement of old systems. E. & C., Feb 24, 1915; 2 cols.

SEWAGE: Collection and Disposal at Seaside Resorts.

Some Considerations Affecting the Collection and Disposal of Sewage at Seaside Resorts 175

In collection secure self-cleaning velocities where cost is not too high; where they cannot be wisely adopted make provision for flushing. In disposal provide for great seasonal variation in flow, dispose finally by dilution in ocean, discharge of crude sewage at bathing beaches not permissible, single-story tanks are preferable, no nuisance created by tank effluents if discharged far enough from shore in at least 10 ft. of water. Describes and illustrates plant and works employed in launching sea outfall pipe lines. E. & C., Feb. 24, 1915; 13½ cols.

BRIDGES: McKinley Ford, Design, Construction and Costs.

Design, Construction and Detailed Costs of the McKinley Ford Bridge, La Salle County, Illinois 179

Describes and illustrates the design and construction features of the McKinley Ford Bridge, La Salle County, Illinois. The bridge consists of two 50-ft. reinforced concrete girder spans. Also gives force accounts and complete cost data on the work. E. & C., Feb. 24, 1915; 6½ cols.

CONCRETE, REINFORCED: Design of Rectangular and T-Beams.

The Design of Reinforced Concrete T-Beams and Rectangular Beams With Steel in Compression 182

Deduces some formulas intended to facilitate the design of reinforced concrete T-beams and rectangular beams with steel in compression. Also gives a diagram and tabular data to aid in solving the formulas. E. & C., Feb. 24, 1915; 4¼ cols.

CONSTRUCTION PLANT: Materials, Machines, Devices.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Tramway Supplies.—The Melbourne, Brunswick & Coburg Tramways Trust is asking tenders for the supply and delivery of car equipment and air brakes for single-type trucks; single-truck combination car bodies; and wheel guard equipment and operating gear. Copies of the specifications, forms of tender, and drawings may be obtained from the offices of the Melbourne, Brunswick & Coburg Tramways Trust, Coburg, Victoria, Australia, upon payment of the required fee. No. 15,646.

Electrical and Hydraulic Power Machinery.—Business man in Near East wishes to get in touch with manufacturers of electrical and hydraulic power plants, flour-milling machinery, gasoline boats, and gasoline engines. He desires to utilize waterfalls for the purpose of creating energy for a power and light plant. No 15,662. [For address see first paragraph.]

Corrugated Iron Sheets.—One of the foreign legations in Washington has informed the Bureau of Foreign and Domestic Commerce that a firm wishes to purchase corrugated iron sheets for manufacture into "roll-laden," or sliding windows. No. 15,615. [For address see first paragraph.]

Nails, Barbed Wire, Etc.—Business man in Italy would be glad to receive quotations on nails, tacks, wire, and barbed wire. Correspondence may be in English. No. 15,628. [For address see first paragraph.]

CATALOGUE OF ENGINEERING AND MINING SOCIETIES IN CHILE.

Arrangements have been made for filing and indexing any American catalogues on railway equipment, materials, construction machinery, etc., that may be sent to the Institute of Engineers of Chile. The address is Instituto de Ingenieros de Chile, Santiago, Chile. Such catalogues as may be sent to the institute should be the best available, preferably in Spanish, although not necessarily so, and prepared in such form as will facilitate filing. If sent in loose-leaf form, as some American manufacturers send out advertising matter, they should be inclosed in neat envelopes. These catalogues will be used only as reference books by practicing engineers, and if the prices are not shown in the catalogue some information should be given as to the easiest method of obtaining prices. For instance, if there is a local representative of the firm in Chile or Buenos Aires, or some other near-by city, it would be well to so advise, in order that time may be saved to the engineers in making estimates in the event that they seem pleased with the American article. Similar arrangements have been made with the Sociedad Nacional de Mineria, which desires catalogues of mining and metallurgical machinery. The Society of Mining Engineers is organizing a technical department for the purpose of assisting Chilean miners in the selection of machinery, and inasmuch as it is a semiofficial institution, it will probably attract a good many local miners. The same care in sending catalogues to it should be exercised as when sending catalogues to the Institute of Engineers, which is the civil-engineering branch. The catalogues for the Mining Society should be addressed as follows: Departamento Tecnico, Sociedad Nacional de Mineria, Ministerio de Industrias y Obras Públicas, Santiago, Chile.

INDUSTRIAL NOTES

Mr. J. L. Keir, manufacturer's agent, with offices in the Abbott Bldg., Broad and Race Sts., Philadelphia, Pa., has been appointed representative of the Troy Wagon Works Co., in that city. He will handle Troy motor truck trailers, reversible traction-drawn wagons, and dump wagons.

The C. H. & E. Mfg. Co., Inc., of Milwaukee, Wis., manufacturers of contractors' machinery and equipment, will soon move into its new 3-story brick, mill constructed, factory building at the corner of Clinton and Mineral Sts., Milwaukee. The new plant is being equipped with the latest approved machinery and manufacturing facilities.

The Troy Wagon Works Co., Troy, O., has started building a new motor truck trailer works to accommodate its growing business in this feature of its line. The new building will cover 16,800 sq. ft. of ground, being 120 ft. by 140 ft. It will enable the company to turn out more than 60 trailers a week. The Troy Wagon Works Co. is now making trailers in three sizes, 1½-ton, 2½-ton, and 5-ton. The 1½-ton is non-reversible, while the other two may be obtained in either reversible or non-reversible types.

The MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York City, has been awarded the following contracts recently: Concrete pile foundation of the coke bin and coal unloading pocket at the plant of the Philadelphia Suburban Gas & Electric Co., Chester, Penn. R. C. Cornish, Engineer. Pile foundation of the Sylvan Ave. Viaduct, Pittsburgh, Pa. Drave Contracting Co., General Contractors, Pittsburgh, Pa. Foundation (including piles and reinforced concrete capping) of the pan house and extension to boiler house at plant of Paterson Parchment Paper Co., Passaic, N. J. W. W. Christie, Engineer, Paterson, N. J.

Cement Show Mixer Contest.

One of the special features of the recent 8th Annual Chicago Cement Show was the guessing contest conducted by the Archer Iron Works, Chicago, Ill. The prize in this contest was a No. 1 Archer Special concrete mixer. The mixer was given away free to the contractor or builder, or anyone directly engaged in concrete construction work, who would guess the nearest to the number of stones contained in the batch hopper attached to one of the machines belonging to the Archer exhibit.

During the evening of the last night of the show, the stones were counted by a committee composed of representatives of the various engineering and trade publications. There were 13,299 stones in the hopper. The nearest guess was 13,313 stones, made by N. G. Rasmussen, 293 34th Ave., Milwaukee, Wis. Mr. Rasmussen is a member of the firm of Charles Fisher & Son, Milwaukee, Wis. This firm manufacturers all classes of cement products and also are contractors on miscellaneous classes of concrete construction work.

The contest proved a feature of interest to all visitors at the Cement Show and especially among contractors, all of whom seemed anxious to submit a good guess. The No. 1 Archer Special concrete mixer is one of the successful smaller type drum batch mixers which has been on the market for the past number of years. It possesses the distinctive feature of having the engine mounted on top of the mixer frame out of the way. The mixer is end-discharge and very portable, one man being able to lift it at the platform end.

The Archer Iron Works claim the mixer has a daily capacity of 50 cu. yds. of wet concrete which is their guarantee although they state many contractors using the machine claim records greatly exceeding 50 yds. It is a mixer which sells at $225.

NEW CATALOGUES

Road Machinery.—Paper, 10x6¾ ins.; 68 pp. Austin-Western Road Machinery Co., 910 Michigan Blvd., Chicago.

Describes and illustrates many of the machines manufactured by the company, including various reversible road machines, rock crushers, telescope bins, elevators, revolving screens, motor rollers, scarifiers, dump wagons, sweepers, sprinklers, etc.

Drills.—Paper; circular. Wood Drill Works, Paterson, N. J.

Describes the "Brownie" drill, designed especially for breaking up boulders for crushers and road work, small tunnel and sewer work. Illustrated.

Tractor Trucks.—Paper, 12x9 ins.; 12 pp. Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Consists of a number of interesting photographic reproductions showing Allis-Chalmers tractor trucks and their adaptability to varying conditions.

Locomotives.—Paper, 9x6 ins.; 32 pp. The Baldwin Locomotive Works, Broad St., Philadelphia, Pa.

Illustrates and describes the exhibit of the Baldwin Locomotive Works at the Panama-Pacific Exposition. Lists materials and appliances used in construction and gives general dimensions.

CATALOGUE REVIEWS

Rocmac Roads.—Paper, 6x9 ins.; 4 pp. Philadelphia Quartz Company, 121 South Third street, Philadelphia, Pa.

A pamphlet containing specifications for Rocmac roads. Gives concise and explicit instructions as to grade, foundations, wearing surface, screenings, stone, and construction methods.

Two methods of constructing the wearing surface are described, i. e., the "Pressure Method" and the "Mixing Method."

Particular instructions for rolling and brooming are given.

Turbine-Driven Centrifugal Pumps.—Paper, 6x9 ins.; 64 pp. The Terry Steam Turbine Co., Hartford, Conn.

"Terry Turbines for Pump Drive" is the title of Bulletin No. 19, which sets forth in detail the advantages and limitations of turbine-driven centrifugal pumps, and shows the wide range of experience of the Terry Steam Turbine Co., in this field of turbine application. The principles of operation and construction of the centrifugal pump are clearly explained as are the details of the steam turbines which have been successfully used during the last ten years for driving them.

The various uses to which these pumps may be applied are described, and the several types of pumps so driven are shown. These include boiler feed pumps, condenser pumps, high duty pumps for water works service, fire service pumps, ballast pumps, sluicing and contractors' pumps, and pumps for miscellaneous liquids and dredging service. Terry vertical pump sets and the automatic pump governor are then described.

Several pages at the end are devoted to the mathematics of centrifugal pumps. The theory of centrifugal pump design and methods of testing centrifugal pumps, are explained, and tables of pressure in pounds per square inch for different heads of water, and of friction of water in pipes are given.

Sewage Ejectors.—Paper, 6¼x9½ ins.; 32 pp. Pacific Flush-Tank Co., The Temple, Chicago.

For the information of engineers, architects, contractors and city officials the Pacific Flush-Tank Co., submits Catalogue No. 17, descriptive of the P. F. T. Automatic Sewage Ejector and appurtenances thereto.

The advantages of these ejectors for handling crude, unscreened sewage are summed up, and the operation with details of construction described. The Woodall Operating and Trip Valve, used in connection with the ejectors is explained. The various compressors and compressor control and regulation are then taken up. The remaining pages are devoted to air receivers and pressure reducing valves, sump pumps, notes on design and operation of plants, standard dimensions of ejectors and tables and useful information.

The illustrations are numerous and include diagrams and views showing various arrangements of ejectors, typical compressor stations, etc.

CURRENT NEWS

The Doings of the Week.

Continued improvement in industry and trade has been shown during the past week. The new controversy between this country and Germany and England was the only unfavorable development of the week, and this had little effect except upon the securities markets. Big trade gains were shown by the bank clearings for the week ending Feb. 20; these figures totaled $3,273,000,000, which is a gain of over $17,000,000 over the corresponding week of last year. This is the first increase over the corresponding period of any previous year that has been shown since the war started. Other favorable developments of the week were the heavy exports of food and cotton, the improvement in the steel industry, larger sales of copper, and greater buying of machinery and tools by industries, indicating that these concerns were preparing for greater demands upon them. Official figures from Washington show that the excess of exports over imports for the month of January was $145,536,103, the largest trade balance in the history of the country. Unofficial figures for the first two weeks of February give a trade balance on only partial returns of over $67,000,000. In the construction field the activity of the previous week has been continued. A considerable amount of new work reached the call for bids stage, and several exceptionally large undertakings were placed under contract. Road construction is beginning to make its appearance and numerous opportunities in this line are now being advertised for bids. In the municipal field many jobs are now ready for contractors. The improvements now being advertised are well up to the average of the corresponding period of other years. In the iron and steel trade there has been encouraging features. The U. S. Steel Corporation's mills are now operating at 70 to 75 per cent capacity, a gain of 10 to 15 per cent since Feb. 1. Some of the independent concerns are even operating at full capacity. Structural materials are being ordered more freely for public undertakings and it is expected that orders for private enterprises will soon come before the trade. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Feb. 17 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Feb. 17. Cts.	Feb. 10. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia...	1.20	1.20
Iron bars, Pittsburgh.........	1.10	1.10
Iron bars, Chicago....... ..	1.07½	1.02½
Steel bars, Pittsburgh........	1.10	1.10
Steel bars, New York..........	1.26	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York....	1.26	1.26
Beams, etc., Pittsburgh......	1.10	1.10
Beams, etc., New York........	1.26	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh.	1.15	1.15
Steel hoops, Pittsburgh.......	1.20	1.20
Sheets, Nails and Wire. Per lb. to large buyers		
Sheets, black, No. 28, P'gh .	1.80	1.80
Galv. sheets, No. 28, P'gh.....	3.25	3.00
Wire nails, Pittsburgh.....	1.60	1.55
Cut nails, Pittsburgh.........	1.55	1.50
Fence wire, base, P'gh...	1.40	1.35
Barb wire, galv., P'gh..... ..	2.00	1.95

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railroads.—No direct developments leading to the commencement of railroad construction, with the exception of the union terminal at Chicago, appears to have taken place during the past week. It is now practically assured that work will be well underway this year on the $65,000,000 project of the Pennsylvania and other railroads at Chicago. About 200 men are already engaged in demolishing buildings to make way for the temporary freight houses. The Union Depot Co. is reported to have secured $5,000,000 in New York for actual commencement of the improvement. The Illinois Central R. R. has taken bids on 6 miles of line in Illinois, and several other roads also are said to be about to take up betterments and double tracking.

Roads and Streets.—A considerable amount of work both in the highway and municipal paving fields reached the call for bids stage during the past week. Illinois is advertising its second state highway letting of the year and Ohio is calling for bids on a $70,000 state road contract. Winona county, Minnesota, opens proposals March 23 on 104 miles of road, estimated to cost $540,000; Bremond Road District No. 2 of Robertson County, Tex., is calling for bids on 50 miles of earth, sand-clay and gravel roads. The municipal paving jobs include 40,000 sq. yds. at West Liberty, Ia.; a $50,000 undertaking at Washington, Ia.; a $382,000 grading, paving, curbing and storm sewer contract at Pittsburgh, Pa.; a 49,100 sq. yds. street asphalt job at Baltimore, Md. The contracts let include a 8½-mile street improvement at Pueblo, Colo., awarded to the Anderson-Hamill Contracting Co., Pueblo, at $137,263; a $101,000 job at Emmetsburg, Ia.; and $112,000 of work at Birmingham, Mich.

Bridges.—Numerous bridge undertakings came up for advertising for bids during the past week. No notably large structures with one exception are included in this week's bridges. Cleveland, O., is calling for bids for steel superstructure of the Clark Ave. viaduct, the estimated cost being $500,000. Bids are being asked on two fair sized undertakings in Nebraska, one of them, the bridge at North Platte, being estimated to cost $50,000. The County Auditor at Mason City, Ia., is calling for bids on bridge and culvert work to cost about $25,000. Bids also are being asked on a 300-ft. reinforced concrete bridge at Garfield, Kan., and a 270-ft. concrete bridge at Superior, Neb. No particularly large contracts appear to have been let.

Drainage and Irrigation.—No especially large jobs in the drainage or irrigation fields appear to have reached the call for bids stage during the past week. The principal feature of the week was the awarding of 6,591,911 cu. yds. of floating dredge work in the Little River Drainage District of Cape Girardeau, Mo. The Hoosier Land & Investment Co., Sikeston, Mo., secured the work at 6.19 cts. per cu. yd.

Waterworks.—The work in the waterworks field this week is mostly for small undertakings. Notasulga, Ala., is calling for proposals for a small waterworks system; Perth Amboy, N. J., opens bids March 24 for 12,000,000-gal. pumping engine; Akron, O., is asking bids for furnishing 2,500 tons cast iron pipe; Salem, Mass., is asking bids for additional works for supply from Ipswich River; Chillicothe, Mo., is asking bids for waterworks extension requiring the laying of 28,000 ft. of 6-in. to 12-in. pipe.

Sewerage.—A considerable amount of sewerage work reached the call for bids stage in the last few days. Upper Darby, Pa., is asking proposals for 23 miles of pipe sewer; Baltimore, Md., opens bids March 10 on a storm drain requiring 1,200 ft. 15 by 12½ ft. sewer; Parkesburg, Pa., is calling for bids on 4 miles of sanitary sewer and concrete treatment tanks; Mount Morris, N. Y., is calling plant.

Buildings and Rivers and Harbors.—The principal development of the past week in the public building field was the opening of bids for the $2,000,000 county court house at Cincinnati, O. The Charles McCall Co., Philadelphia, Pa., at $1,945,000 on a granite and marble structure was the low bidder. In the river and harbor field an important feature was the awarding of the contract for the Government breakwater at Cape Lookout, N. C. The work was let to D. L. Taylor & Co., Medina, N. Y., at $1.98 per ton for all stone deposited in accordance with specifications. The contract includes building as much of the breakwater and shore protection as the available funds of $1,260,000 will permit.

The Local Bidder.

The local bidder is still the favorite of fortune in some sections of the country. At two recent lettings —one in the east, the other in the west—the native son did not even have to come anywhere near the figures of the low bidders. In one case there were four contractors whose bids were lower than that of the man receiving the contract. On the other job the local contractor would have been low had there not been three other bidders. The award of both contracts was made on the grounds that the contractors were residents of the towns where the work was to be done, were taxpayers and would employ local labor. Both improvements were advertised widely and as a result many outside contractors submitted estimates. This competition, of course, kept down somewhat the prices of the local men. Possibly this was one of the reasons for inviting outsiders to figure on the work. These towns, by letting the improvements to home men will have to pay about 20 per cent more than they would if the low bidders had secured the contracts. They also have acquired a reputation that will be remembered by contractors when asked to bid on their other lettings.

Signs of Spring.

A robin was seen last week. The sun runs higher in the sky. The days are perceptibly longer. All these are signs of spring. There are also other signs best indicated by the following quotation from a daily paper: "The building trades unions of Chicago are demanding an increase of wages aggregating $2,000,000 over the scale of a year ago." The structural iron workers want a raise from 68 cts. per hour to a sliding scale of 70, 70½ and 75 cts. per hour for three years, and the architectural iron workers are asking a similar increase. The carpenters want an increase from 65 cts. to 70 cts. per hour; lathers, from 71⅛ cts. to a sliding scale of 72½ and 75 cts.; stone cutters from 62½ to 67½ cts.; sheet iron workers, from 68¾ to 75 cts.; roofers, from 65 to 70 cts.; cement finishers, 65 to 70 cts.; hod carriers and laborers, 40 to 50 cts. Judging from the increases asked some of the union men are more interested in the amount of money in these weekly pay envelopes than they are in the number of weeks that they will get them. Labor demands and threats of strikes and lockouts are sure harbingers of spring for the building contractor.

Grade Crossing Elimination.

Possibly 20 cities expect that railroads will make a start this season on the elimination of grade crossings in their respective localities. Some of these municipalities will be disappointed, but there will be undoubtedly a large amount of work of this kind undertaken this year. In the middle west a number of large track elevation projects have about reached the construction stage. Cleveland, Columbus and Indianapolis have undertakings that will call for an aggregate expenditure of several million dollars, and it is likely that work will be started this spring in these cities. Similar projects in other places also will be taken up. Much of this work has been under consideration for years. The preliminary features have been developed, the legal obstacles removed, and the plans and specifications prepared. In many cases financial provision has been made both by the railroads and the cities. Present indications are that contractors will have an exceptionally busy season in separating city streets and railroad tracks.

RIVER CHANNEL IMPROVEMENT AT KANSAS CITY, MO.

Bids Asked on a 1,000,000 Cu. Yd. Excavation Contract.

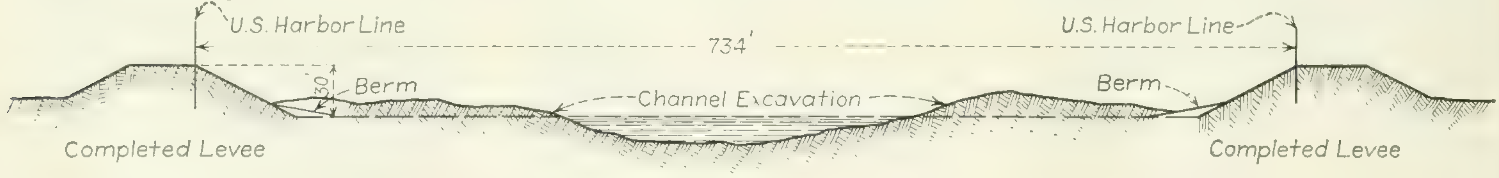
Work to be Done for Kaw Valley Drainage District.

A 1,000,000 cu. yd. excavation contract is now being advertised for bids by the Kaw Valley Drainage District of Wyandotte County, Kansas. The work is located at Kansas City, Kan. It calls for the excavation of the material lying within the present channel of Kansas River to an approximate depth of 30 ft. below the top of the adjacent levees. The improvement covers the section lying between the present levee slopes from the 5th St. bridge to the mouth of the river. The material is to be deposited on top and back of the levees and in waste pits secured by the Drainage Board. It also will be used for strengthening the levee from the 5th St. bridge to the Argentine wagon bridge along the west bank by raising the present levee 3 ft. and widening to a 40 ft. crown. A berm will be left adjacent to and along the levees extending downward from a point 1 ft. above the bottom of the revetment on the levee on a slope of 5 on 1 to low water, or less if required. The approximate estimate is as follows:

Section.	Excavation, cu. yds.*	Enbankment and waste pits, cu. yds.	Station.
D.	126,000	126,000	L. B. 263 to 170
D1	....	83,700	....
E	313,000	331,600	L. B. 170 to 114
F	150,000	300,000	L. B. 114 to 75
G	158,000	182,000	L. B. 75 to 38
H	....	....	L. B. 38 to 22
I..	....	200,000	L. B. 22 to 0
K	....	134,000	R. B. 5 to 14
Q	59,700	....	R. B. 14 to 27
P.	119,900	20,000	R. B. 27 to 65
S	114,000	114,000	R. B. 65 to 116
O........	21,000	106,600	R. B. 116 to 180

*Includes berms.

The contractor will be required to begin work within 90 days after notification of acceptance of bid and must complete the contract within 16 months. Payments will be made in cash or in Series "B" bonds at par; 10 per cent of each estimate will be retained. The work will be in charge of the Kaw Valley Drainage Board, of which S. H. McNeil, 719 Osage Ave., Kansas City, Kan., is Chief Engineer. Bids for the excavation will be received by the Drainage Board until 10 a. m., Feb. 26. On Feb. 27 the Board also will open bids for furnishing a hydraulic dredge and equipment for the improvement of the Kansas River. Bidders are invited to submit proposals for a 15 in. and an 18 in. dredge delivered at Kansas City, Kan., steam or electric power, on a design of their own, together with complete and detailed plans and specifications therefor. The maximum length of discharge is 3,000 ft. and the maximum height of discharge is 40 ft.



Channel Excavation Required for Improvement of Kansas River at Kansas City, Kansas.

HIGHWAY CONSTRUCTION IN KENTUCKY.

$3,000,000 of County Bond Issues Proposed.

Details of Work to Be Done in 26 Counties.

A large amount of highway construction is contemplated by counties in Kentucky for the present season. This will be carried out by means of bond issues voted by various counties, by appropriations of the several fiscal courts and by moneys from the State Aid fund. The State road fund was created by act of the legislature approved March 24, 1914. It is obtained by a tax of 5 cts. on every $100 of property, and will amount to perhaps $600,000 for 1915. The greater part of the mileage will consist of gravel and macadam roads. There also will be a considerable number of concrete bridges and culverts built. The work will be carried out under the direction of the County Road Engineers.

Many counties already have taken steps to issue bonds for road construction purposes. The following table shows some of the counties that contemplate issuing bonds or already have voted in favor of bonding:

County,	County seat.	Amount.	Election.
Bell	Pineville.	$250,000	*
Ballard	Wickliffe.	300,000	Feb. 27.
Bracken	Brooksville	400,000	......
Caldwell	Princeton	300,000	....
Carter	Grayson.	150,000	*
Elliott	Sandyhook.	.....	....
Greenup	Greenup.	200,000	*
Knox	Barbourville	200,000	Mar. 16
Laurel	London.	100,000	†
Lawrence	Louisa.	100,000	Mar. 15.
Mason	Maysville.	200,000	May.
McCracken	Paducah.	300,000	Feb. 27.
Nicholas	Carlisle.	125,000	Mar. 27.
Rockcastle	Mt. Vernon.	100,000	Mar. 25.
Whitley	Williamsburg.	250,000	Apr. 24.

*Issue authorized. †Contemplated.

Table I gives a summary of the highway work contemplated for 1915 by 26 counties. Further details regarding this construction follow:

Boone County has $30,000 available for road purposes and will construct 14 miles of macadam. Part of this work will be carried out by contract. C. W. Goodrich, Burlington, Ky., is County Road Engineer.

Boyd County has $40,000 available for road purposes. It will construct 1.7 miles of brick pavement on concrete base. The work will be done by contract and the letting probably will be held soon. W. E. Van Horn, Lockwood, Ky., is County Road Engineer.

Boyle County will grade 30 miles of earth roads, will construct 1 mile of gravel road, resurface 15 miles of macadam and repair 70 miles of macadam. Part of the work will be carried out by contract. The county at present has approximately $27,000 available for road construction purposes. Will P. Caldwell, Danville, Ky., is County Road Engineer.

Bracken County will spend only about $5,500 from its regular road fund for construction purposes. It will, however, vote on a $400,000 bond issue, and if this carries about 300 miles of macadam will be constructed. Omar Myers, Brooksville, Ky., is County Road Engineer.

Bullitt County has about $10,000 available for road purposes. W. C. Herps, Shepherdsville, Ky., is County Road Engineer.

Caldwell County will vote in a few days on a bond issue which, if favorable action is taken, will give it about $300,000 for building improved roads. If the issue carries the work will be done by contract, the letting to be held probably in June. The county has $13,500 available for maintenance of dirt roads. J. E. Pilant, Princeton, Ky., is County Road Engineer.

Clark County has $35,000 available for road purposes and will construct about 5 miles of macadam. Part of the work will be done by contracts; these have been already let. S. C. Boone, Winchester, Ky., is County Road Engineer.

Edmonson County will repair about 300 miles of earth road and will build about 2 miles of gravel road and 2 miles of macadam. The work will be done by day labor system by private donation. John A. Logan, Brownsville, Ky., is County Road Engineer.

Elliott County will vote on a bond issue for road purposes. If the issue carries several miles of macadam will be constructed by contract. S. L. Green, Ibex, Ky., is County Road Engineer.

Estill County appropriation for road work will not be made until the Fiscal Court meets in April. No decision as to improvements to be undertaken will be made until that time James Winn, Witt, Ky., is County Road Engineer.

Garrard County has $24,000 available for highway purposes. It will reconstruct 18 miles of macadam and may build some gravel road. A part of the work will be done by contract, the letting to be held April 6. J. O. Bogie, Lancaster, Ky., is County Road Engineer.

Grant County will reconstruct 10 miles of macadam and also build 5 miles of new macadam. The work will be done by contract; the letting will be held in the spring. W. H. Beverly, Mason, Ky., is County Road Engineer.

Graves County has $50,000 available for road purposes. It will construct 18 miles of gravel road, and if State aid is secured it will build 30 miles of this type of highway. The work will be done by contracts which probably will be let in July. J. E. Carman, Mayfield, Ky., is County Road Engineer.

Henderson County obtains its funds for construction and maintenance of roads and bridges by a tax of 25 cts. on the $100 for a valuation of $16,000,000. A tax of 10 cts. on the $100 on the above valuation provides funds for rock roads. About 565 miles of earth roads are to be worked under contract and about 65 miles of gravel and macadam are to be maintained under the control of the county. Contracts for the work will be let March 20 and April 1. S. H. Kimmel, Henderson, Ky., is County Road Engineer.

Hopkins County has $24,000 available for road purposes and will construct about 5 miles of macadam. It has not been decided whether the work will be done by contract.

Larue County has $8,000 available for road purposes. It will construct 7 miles of macadam. Jacob Strous, Hodgenville, Ky., is County Roads Engineer.

Lawrence County will vote March 15 on a $100,000 bond issue for road improvements. If the issue carries about half of the improvement will be carried out by contract. In any case the county will have about $24,000 for road purposes and will do some grading. B. J. Calloway, Louisa, Ky., is County Road Engineer.

Lewis County has $135,000 available and will construct 20 miles of macadam. The work will be done by contract, the letting to be held about May 1. I. W. Sanders, Beattyville, Ky., is County Road Engineer.

Madison County will construct 40 miles of earth road and 9 miles of macadam. Contracts for the work will be let about April 1. The county has $22,000 available for new construction and $28,000 for maintenance and repairs of existing roads. J. G. Baxter, Richmond, Ky., is County Road Engineer.

Marion County appropriations for road purposes in 1915 will not be made until meeting of Fiscal Court on Feb. 25. It is possible that some of the improvements will be carried out by contract, which will be let sometime in April.

Mercer County will construct 5 miles of macadam and repair 50 miles. It also will repair 50 miles of earth road. The county does its own work. The sum of $30,000 is available for highway purposes. Thomas McGlone, Harrodsburg, Ky., is County Road Engineer.

Oldham County has asked State aid in the construction of several miles of new road. The county has about $15,000 available for all road purposes. The county may vote on an issue of bonds, and if this carries it is hoped to reconstruct all of the old pikes in the county (about 100 miles) and to build a few miles of new road. The construction would be done by contract. The county constructs only macadam roads, but does some repairing with gravel. There is no County Road Engineer at present. S. E. De Haven, La Grange, Ky., is County Judge.

Pendleton County has $10,000 available for highway purposes. It proposes to construct 25 miles of macadam. No contracts will be let. H. H. Shoemaker, Falmouth, Ky., is County Road Engineer.

Scott County proposes to reconstruct 50 or 60 miles of macadam during the present season. Contracts for the work will be let April 1. The county at present has $30,000 available for highway purposes. It has asked for State aid and if this is secured it will have about $45,000 available. The county has about 450 miles of macadam and only about 30 miles of earth road. J. B. Prather, Georgetown, Ky., is County Road Engineer.

Shelby County has $40,000 available for road purposes. The improvements will be made by contract: G. M. Middleton, Shelbyville, Ky., is County Road Engineer.

Warren County will repair 600 miles of earth road and will construct 5 miles of gravel road and 10 miles of macadam. No contracts will be let. M. H. Crump, Bowling Green, Ky., is County Road Engineer.

TABLE I ROAD WORK FOR 1915 IN [illegible] COUNTIES IN KENTUCKY.

	—Type of road—		
County.	Earth, miles.	Gravel, miles.	Macadam. miles.
Boone	..	.	14
Boyd	..	..	[illegible]
Boyle	30[2]	1	15
Bracken	.	.	300[4]
Bullett	[illegible]	[illegible]	[illegible]
Caldwell	..		[illegible]
Clark	.	.	[illegible]
Edmonson	200[6]	2	[illegible]
Elliott	..	..	[illegible]
Estill	[illegible]	[illegible]	[illegible]
Garrard	..	[illegible]	18
Grant	.	..	[illegible]
Graves	.	18	[illegible]
Hopkins	..	...	[illegible]
Hudson	565[11]		[illegible]
Larue	..	.	[illegible]
Lawrence	[illegible]		..
Lewis	.	.	20
Madison	40	.	[illegible]
Marion	[illegible]	[illegible]	[illegible]
Mercer	[illegible]		[illegible]
Oldham	.		[illegible]
Pendleton	.		[illegible]
Scott	.		[illegible]
Shelby	[illegible]	[illegible]	[illegible]
Warren	627[13]	[illegible]	10

[1]4.7 miles of brick on concrete base. [2]Graded. [3]15 miles resurfaced, 75 miles repaired. [4]If bond issue carries. [5]If $300,000 bond issue carries surfaced roads will be built. [6]To be repaired. [7]Several miles to be built if bond issue carries. [8]Reconstruct. [9]Also reconstruct 10 miles. [10]Perhaps 30 miles if state aid is received. [11]To be worked out under contract. [12]Grading. [13]Repaired. [14]450 miles to be repaired. [15]If bond issue carries. Reconstruct 50 or 60 miles.

The $15,000,000 Union Terminal at St. Paul, Minn.

Work probably will be started early this spring on the first improvement for the new $15,000,000 Union terminal at St. Paul, Minn. The first work to be done will be the changing of the Mississippi River channel so as to provide an additional area for the terminal. This provides for moving the channel to the south for a maximum distance of about 400 ft. and calls for dredging and the construction of a riprap wall to hold the new bank in place. It is probable that work of changing the river channel will require about 12 to 15 months. While this is going on detailed plans for the terminal proper will be made. The work will be done for the St. Paul Union Depot Co., of which W. C. Armstrong, Hackney Bldg., St. Paul, Minn., is Chief Engineer. Mr. Armstrong was in charge of the construction of the Chicago & Northwestern Ry. terminal at Chicago, and when that was completed he became bridge engineer. He resigned from that position early this month to take charge of the work at St. Paul.

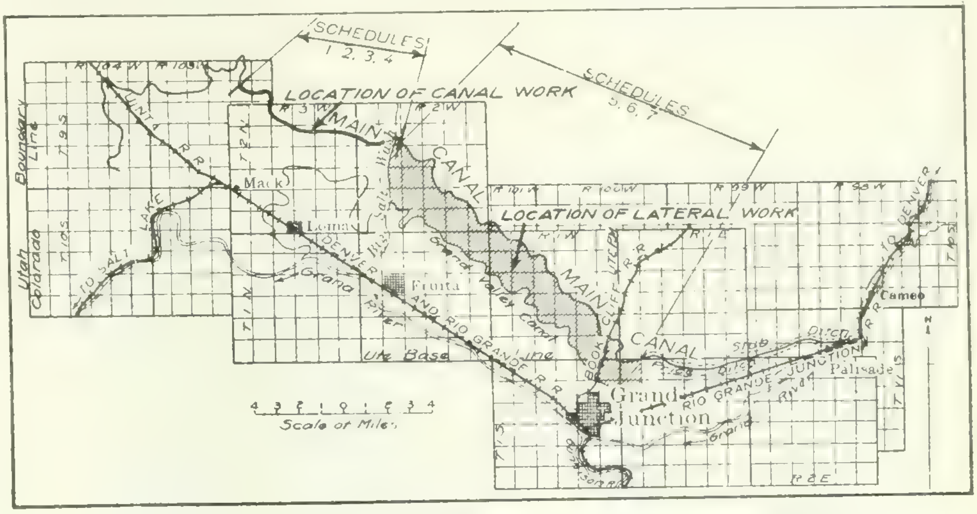
A 640,000 CU. YD. EXCAVATION CONTRACT.

Main Canal and Lateral Construction for U. S. Reclamation Service.

Bids to be Opened at Grand Junction, Colo., on March 10.

Bids are now being asked on the largest excavation contract advertised so far this year by the U. S. Reclamation Service. The work is to be done in the Grand Valley Project, Colorado, and is situated in the vicinity of Grand Junction and Fruita. It provides for the construction of a portion of the main canal, and laterals to serve the area between Indian Waste and Big Salt, Wash., and involves 640,000 cu. yds. of excavation. The canal work extends from a point 7 miles north of Fruita to a point 5 miles north of Mack.

The improvement is divided into seven schedules, the first four covering the excavation of the main canal and the remainder the laterals. The approximate quantities are as follows



Location of Canal and Lateral Excavation, Grand Valley Project.

Schedule.	Excavation, Class 1, cu. yds.	Excavation, Class 2, cu. yds.	Excavation, Class 3, cu. yds.	Excavation, Class 4, cu. yds.	Overhaul, yds.
1......	119,000	1,500	1,000	100	210,000
	119,300	2,500	500	100	15,[illegible]
[illegible]	[illegible]	1,500	400	100	15,000
	[illegible]	1,500	400	100	15,000
[illegible]	90,000	5,000	1,000	100	[illegible]
	85,000	100	[illegible]	10	
[illegible]	75,000	100	[illegible]	10	
[illegible]	60,000	100	70	10	

The main canal will have bottom widths of either 7 ft., 11 ft. or 14 ft. The standard canal section for a length of 2,000 ft. will be as follows: bottom. 14 ft.; bank, 13 ft.; bank crests 8 and 12 ft.; depth water, 7 ft. For a length of 36,900 ft. the standard canal section provides for a 11 ft. bottom, 12 ft. bank, 8 and 12 ft. band crests and a water depth of 7 ft. The standard canal section for a length of 11,500 ft. call for a 7 ft. bottom, a 10 ft. bank, 8 ft. and 12 ft. bank crests and a water depth of 5.2 ft.

The laterals will have bottoms ranging in width from 2 ft. to 5 ft. The following gives the details of this work:

Length, ft.	Bottom, ft.	Bank height, ft.	Bank crest, ft.	Depth water, ft.
1,500	[illegible]	4	4	[illegible]
11,300	4	3½	[illegible]	2
31,200	[illegible]	3	[illegible]	1½
38,150	[illegible]	3	[illegible]	1½
52,800	[illegible]	[illegible]	3	1¼
92,100	[illegible]	[illegible]	3	1
117,000	2	2	[illegible]	1

Bids for the excavation work will be received at the office of the U. S. Reclamation Service, Grand Junction, Colo., until 2 p. m., March 10.

Three Grade Crossing Elimination Project.

A considerable amount of grade crossing elimination work probably will be commenced by the railroads during the present year. The indications are that a start will be made this season on a number of projects of this kind that will call for an expenditure of several million dollars. In several cities in the Middle West extensive undertakings are now nearing the construction stage.

It is expected that definite announcement as to track elevation work at Indianapolis, Ind., will be made by the middle of next month. At the present time the Indianapolis Union Ry. Co. is getting ready for a $10,000,000 bond issue for the improvement. The issue will be guaranteed by the Pennsylvania, Big Four and Vandalia railroads, and the directors of the several roads will vote on this guaranty before March 15. It is proposed to sell the bonds as the work progresses, approximately as follows: In 1915, $1,000,000; 1917, $1,500,000; 1919, $1,500,000. A total of $860,000 of this issue will be reserved for redemption of present bonds, and $5,140,000 will be reserved for future corporate purposes. The company is reported to have asked prices three weeks ago on 20,000 tons of structural steel for use in the work, It is possible these figures were asked in order to make estimates for the financing. P. J. Landers, Indianapolis, is Engineer for the Indianapolis Union Ry. Co.

At Cleveland, it is probable, the city will start work in the near future on the separation of the West Side grade crossings of the New York, Chicago & St. Louis R. R. This improvement will cost approximately $2,500,000. A resolution was introduced in the Council of this city last week providing for a special election on Nov. 2 to vote on issuing bonds for the completion of the elimination of the grade crossings of the Pennsylvania R. R. and the New York, Chicago & St. Louis R. R. on the East Side. The cost of this would be about $4,253,000. It is also proposed that additional work on the West Side and in the South End be provided for at the same time. This would bring the total cost of the contemplated improvements to $5,000,000.

Work on the elimination of grade crossings of the Norfolk & Western Ry. at Columbus, O., according to recent reports, is to be started early in the spring. The plan here provides for track elevation from a point near the County Infirmary to Maryland Ave., underpasses being constructed at Livingston Ave., Main St., Bryden Road, Franklin Park South, Broad St., Long St., Clifton Ave., Mt. Vernon Ave. and Maryland Ave. The city's share of the improvement will be about $300,000.

Winona County, Minnesota, is calling for bids for the construction of 104 miles of road, estimated to cost [illegible]

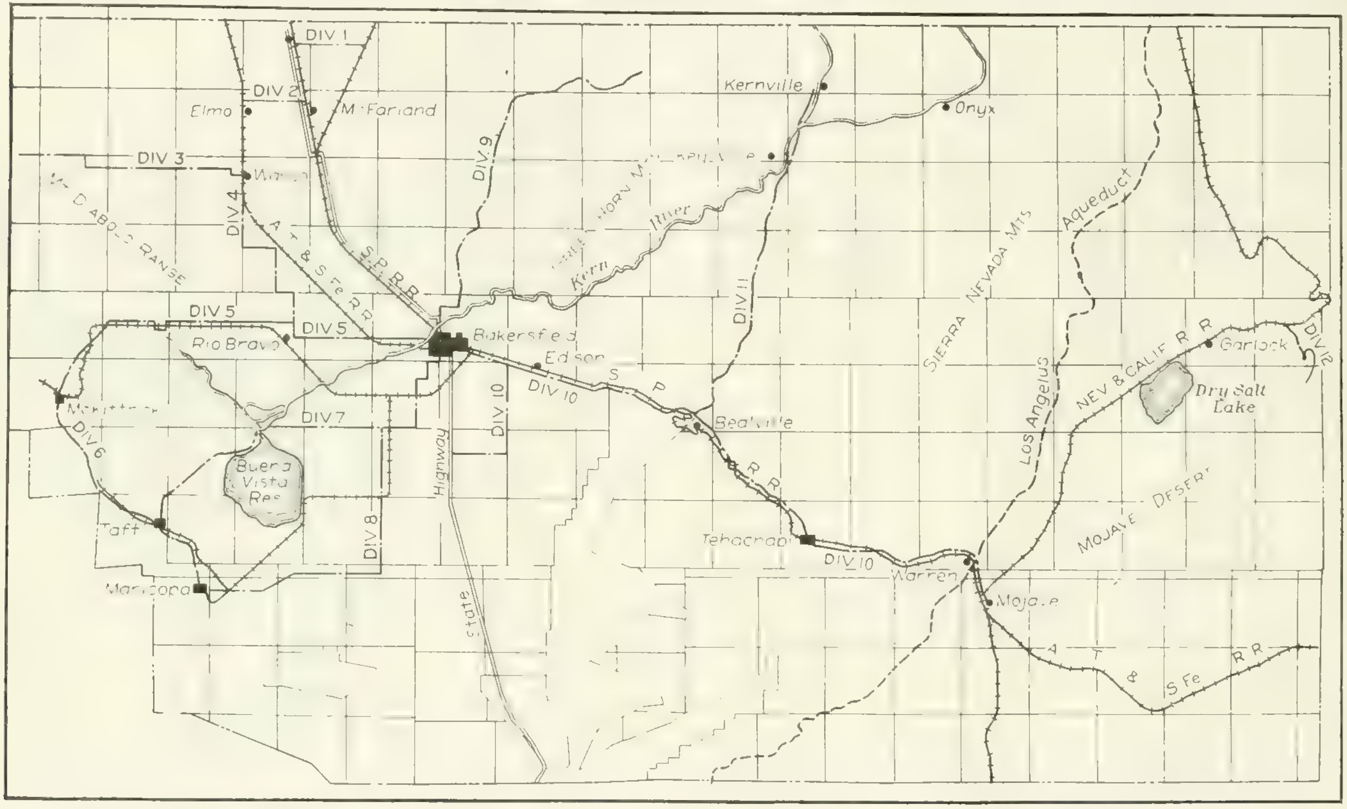
HIGHWAY SYSTEM OF KERN COUNTY, CAL.

Expenditure of $2,500,000 To Be Made.

Oiled Macadam and Bituminous Surfaced Concrete.

Kern County, California, will offer many opportunities to the highway contractor during the next few months. The county is just starting construction on a highway system that will call for an expenditure of $2,500,000. Five contracts have been let already, four of these providing for grading only, and the fifth for paving. The latter was awarded to George S. Benson & Son, Los Angeles, Cal. It covers the surfacing of 11½ miles of road in Division 7 from Bakersfield to Old River. Of the four grading contracts, one is in Division 11 and has been completed; two are in Division 9, and one of them has been completed, and one is in Division 5.

The layout of the county highway system is shown on the accompanying map. A large part of the mileage will be of the oiled macadam type, 16 ft. wide, and in general 6 ins. thick after rolling. This thickness will be increased when it is deemed expedient to do so. For the bituminous macadam work the county will furnish to the contractor, f. o. b. cars at the nearest available railroad siding, the necessary broken stone and asphaltic oil.



Layout of the Highway System of Kern County, to Be Constructed Under a $2,500,000 Bond Issue.

Some of the projected highways will of necessity be constructed on adobe and alkali soil. Where this condition exists it is the intention to use concrete pavement surfaced with asphaltic oil and screenings. The Portland cement, broken stone and asphaltic oil will be furnished by the county, f. o. b. cars at the nearest available railroad siding.

All of the Highway Commission's work will be done by contract, the sections being advertised in approximately 10 mile lengths. The grading will be light as all of the roads to be paved are in the level valley.

The county has constructed a crushing plant at Keene, designed to have an output of 1,000 tons in 8 hours. This will be operated by the Commission to furnish broken stone for road construction. The rock is a fair quality of granite.

The system will be constructed under the direction of the County Highway Commission of which P. H. Everett, Bakersfield, Cal., is Chief Engineer.

COUNTY ROAD IMPROVEMENTS IN IOWA.

Details of Work To Be Done in 9 Counties.

Earth and Gravel Road Construction.

In our issue of Feb. 17 we gave some details of the road work proposed for this season by 36 counties of Iowa. Since that article was compiled reports have been received from 9 additional counties. A summary of the construction contemplated by these counties is given in the table below:

	Type of road	
County.	Earth, miles.	Gravel, miles.
Bremer	10	..
Buena Vista	20	8
Cedar	10[1]	1
Cherokee	20[2]	..
Marion	4	..
Osceola	60[3]	..
Sac	20	6[4]
Scott	2[5]	3
Tama	6[6]	..

[1] Also 1 mile macadam, and will grade 155 miles of earth road. [2] Standard highway. [3] 60 to 80 miles. [4] 6 to 8 miles. [5] 2 or 3 miles. [6] 6 or 8 miles of heavy cutting.

Further details regarding these improvements follow:

Bremer county has $25,000 available for highway purposes and will construct 7 to 10 miles of earth road. It is probable that no contracts will be let. C. A. Cool, Waverly, Ia., is County Engineer.

Buena Vista has $40,000 available for construction purposes and proposes to build 20 miles of earth road and 8 miles of gravel. The work will be done by contract, the lettings for which will be held about March 1. George K. McCullough, Storm Lake, Ia., is County Engineer.

Cherokee County will construct 20 miles of standard highway this season. The work will be done by contract and the lettings will be held some time in May. The county has $50,000 available for bridges and culverts and $45,000 for roads. J. F. Chapman, Cherokee, Ia., is County Engineer.

Marion County has $25,000 available for road construction and repairs. It will build 4 miles of earth road, the work probably being carried out by day labor. W. O. Price, Knoxville, Ia., is County Engineer.

Osceola county during the present season will construct 60 to 80 miles of earth road. No contracts will be let. L. A. Wilson, Sibley, Ia., is County Engineer.

Sac county has about $75,000 available for highway purposes and will construct 20 miles of earth road and 6 to 8 miles of gravel road. Part of the improvements will be carried out by contract. Dates for the lettings have not been set. W. D. Maxwell, Sac City, Ia., is County Engineer.

Scott county will construct 2 or 3 miles of earth road and 3 miles of gravel road. The sum of $38,000 is available. The work will be done by contract, and the lettings will be held in May or June. J. M. Malloy, Davenport, Ia., is County Engineer.

Tama county probably will undertake about 6 or 8 miles of heavy cutting, besides blade grader work. About $15,000 is available for cutting down hills. Part of the work, at least, will be done by contract. No date, however, has been set for awarding contract. F. O. Nelson, Toledo, Ia., is County Engineer.

Cedar county has $36,000 available in its road fund and $50,000 in its bridge fund. It will construct 10 miles of earth road, 1 mile of macadam and also will grade 155 miles of earth road in the county system. The work will be done by contract, the letting to be held probably in May. J. C. McLean, Tipton, Ia., is County Engineer.

Dredging at Port Aransas, Texas.

A fair sized dredging contract in Texas waters is now being advertised for bids by the U. S. Engineer at Galveston, Tex. The work provides for improving the deep water harbor at Port Aransas and the channel from Aransas Pass to Corpus Christi, Tex. Aransas Pass is situated on the Gulf of Mexico, in the state of Texas, and is about 188 miles southwest of Galveston Harbor. Jetties have been constructed to improve the channel leading from the Gulf of Mexico to the Pass, and there is at present a navigable channel 20 ft. deep throughout this distance. During 1911 and 1912 a deep water harbor or roadstead was excavated beginning at the upper end of the Pass and extending between Harbor Island and St. Joseph Island, 1,200 ft. wide and 3,000 ft. long, with an extension 1,900 ft. long and 150 ft. to 400 ft. wide. This harbor was completed in October, 1912, but has since shoaled to 18 to 19 ft. During December, 1913, and January, 1914, an area 600 ft. wide and about 1,500 ft. long immediately in front of the wharf of the

Aransas Pass Channel & Dock Co., was dredged to 25 ft. depth. This has since shoaled somewhat.

The Aransas Pass-Corpus Christi channel extends from Aransas Pass through Turtle Cove into 12 ft. natural depth in Corpus Christi Bay. Across this bay there is a natural depth of over 12 ft. The channel begins again at the 12 ft. natural depth in front of Corpus Christi and extends to the turning basin which has been excavated in front of the Corpus Christi wharves. The entire channel was dredged in 1911 and 1912 to a depth of 12 ft., 100 ft. wide, with turning basin 12 ft. deep. In February, 1914, it was partly redredged. The ruling depth at present is about 8½ ft.

The work to be done at Aransas Pass is the redredging of the area 600 ft. wide and 1,500 ft. long immediately in front of the wharves to 25 ft., the extension of this area about 200 ft. further to the northward with width of 600 ft., and depth of 25 ft. and the removal of an area south of the present deep water harbor to a depth of 25 ft. The approximate quantity is 408,000 cu. yds. place measurement, and the amount available is $50,000. The material is believed to be sand and mud. The spoil must be deposited on shores, behind the established bulkhead lines and behind existing dumps, on either St. Joseph Island, Harbor Island or Mustang Island.

The work in the Aransas Pass-Corpus Christi channel will consist of redredging the channel and turning basin wherever necessary. It is expected that all the redredging necessary will be confined to the section between Aransas Pass and McGlains Bluff. The redredging will be carried to a depth of 12 ft. and a width of 100 ft. The approximate quantity is 100,000 cu. yds. place measurement. The material is believed to be sand and mud. Approximately $10,000 is available. The material removed from the turning basin will be deposited between walls or behind bulkheads, not over 1,000 ft. away from the dredge. The material removed in redredging the channel will be deposited along the existing dump, and in case no dump exists it will be placed at least 500 ft. from the channel.

Bids for dredging at Port Aransas and in the channel from Aransas Pass to Corpus Christi will be received until noon, March 3, by Lt. Col. C. S. Riche, U. S. Engineer, Galveston, Tex.

PERSONALS

Mr. Clarence K. Clarke has been chosen as city manager of Tucson, Ariz. He will have supervision of the water, street, sewerage, fire, police and health departments, and of river control work.

Mr. Sidney D. Waldon has severed his connection with the Packard Motor Car Company of Detroit after a long service. Mr. Jesse G. Vincent will succeed him as vice president, in charge of the engineering department.

Mr. H. G. Sparks has been appointed division engineer of the Illinois division, Chicago & Eastern Illinois Railroad, with headquarters at Salem, Ill. Mr. Sparks has been in continuous service with that railroad since May, 1905, entering it as assistant engineer at Danville, Ill. He has since held the position of assistant engineer at Salem, Ill., again at Danville, chief draftsman at Chicago, office engineer at Chicago, and division engineer at Evansville, Ind.

Mr. Arthur N. Johnson, formerly chief engineer of the Illinois State Highway Department and now highway engineer with the Bureau of Municipal Research of New York City, on Feb. 5 delivered a lecture on "Methods of Cost-Keeping for Highway Engineers and Contractors" before the graduate students in highway engineering at Columbia University. On Feb. 12 Mr. George C. Warren, president of Warren Brothers Company, delivered a lecture on "Public Recognition of and Specifications for Patented Pavements" before the same class.

New President of the American Society of Engineering Contractors.

Mr. Hillis F. Hackedorn, whose portrait appears on this page, was elected president of the American Society of Engineering Contractors at the annual meeting of the society held in New York City, Jan. 15. Mr. Hackedorn was one of the charter members of the society and has devoted a great deal of time to advancing its interests so that his elevation to the highest office is a merited recognition of his efforts.

Mr. Hackedorn is president of the Hackedorn Contracting Company of Indianapolis, one of the most successful contracting companies of the Middle West. The company specializes in concrete bridges, having built many of the notable structures of this class, among which are the Leonard street bridge, over the Grand river at Grand Rapids, Mich.; Washington avenue bridge over the Black river at Elyria, Ohio (a 150-ft. span); the Bluff Drive bridge in Edgewater Park, Cleveland; the Big Creek bridge in Brookside Park, Cleveland, the flattest semi-elliptical bridge in the world; and the Bradford and Adams street bridges over the Great Miami river at Troy, Ohio, which were the only highway bridges withstanding the 1913 flood, for a distance of fifty miles along the river.

Hillis F. Hackedorn

The company has now under construction the Lorimer bridge at Piqua, Ohio, five spans, and the Levee Road bridge at Middletown, Ohio, nineteen spans, total length 1,947 ft.; both over the Great Miami river.

Mr. Hackedorn is a pioneer in reinforced concrete bridge construction in the Middle West, having organized the Block Bridge & Culvert Company in 1900, which was succeeded by the present company in 1907, both concerns confining their activities to the design and construction of concrete bridges and being continuously under Mr. Hackedorn's management.

Mr. Hackedorn was first vice-president of the society of which he has been elected president, and is also a member of the American Concrete Institute, and of the Indiana Engineering Society.

Mr. W. S. Clark has been appointed city engineer of Anacortes, Wash. Mr. Clark was for a time with the Pacific Traction Company in Tacoma. Since 1910 he has been associated with the Arnold Company of Chicago in development of water power projects in Washington.

Mr. Edward P. Burch, consulting engineer, 922 Plymouth building, Minneapolis, Minn., has opened a branch office in Detroit for general engineering practice. The office is on the 23d floor of the Dime Bank building, and is in charge of Mr. Lester M. Sears. The work will include mechanical, civil, electrical, hydraulic and railway engineering in the vicinity of Detroit. Mr. Burch has had twenty-two years of engineering experience, including seven years as electrical engineer for the Twin City Rapid Transit Co., and fifteen years as consulting engineer with offices in Minneapolis and St. Paul. During the past six months he has been employed as engineer in charge of valuation work for the Detroit Electric Railway Commission. Associated with Mr. Burch are Mr. Tresham D. Gregg and Lester M. Sears, the latter, as stated, being in charge of the Detroit office.

Mr. A. G. Wulff, civil engineer, announces that he has opened an office at 309 Provident Bank building, Cincinnati, where he will conduct a general civil engineering practice, specializing in municipal work. Mr. Wulff graduated in civil engineering from the University of Cincinnati in 1895. For a brief time thereafter he was with the U. S. Government Engineers on surveys of the Ohio river. In 1896 he was employed by the Engineer Commission on city water works at Cincinnati. The following year he entered practice as draftsman and engineer and was engaged on architectural iron works and brick making machinery. For seven years he was engineer and superintendent for a firm of chemical engineers, and from 1904 to 1908 he was in business as a general contractor, specializing in reinforced concrete work. From 1908 until opening up his present office he has been assistant city engineer of Cincinnati.

Mr. R. M. Hosea, who has resigned as chief engineer of the Colorado Fuel & Iron Co., the Colorado and Wyoming Refining Co., and the Crystal River Railroad, effective February 15th, will retain a consulting engineering engagement with the above companies and is open to any outside engagement. Mr. Hosea specializes in coal mine engineering operation, development and preparation of coal, water supply and irrigation construction, engineering reports and examinations, wood stave pipe and concrete structures, administration of water supply systems and technical reports. Mr. Hosea designed, constructed and for the past 7 years operated the $1,000,000 water supply system for the steel plant of the Colorado Fuel & Iron Co., at Pueblo, Colo., and the various dams and reservoirs in connection, and many reinforced, concrete-cased wood stave pipe lines and conduits. He designed and built most of the coal washing plants, anthracite breakers and coal mine plants previous to taking charge of water interests; located and constructed the railway lines to develop coal and iron properties; opened and developed coal mines in Iowa and Colorado as mine superintendent and has had a valuable operating experience.

CIVIL SERVICE NEWS

The Chicago Civil Service Commission announces examinations as follows:

Mechanical Designing Engineer; $1,920-$2,100; March [illegible].

Mechanical Draftsman; $1,080 - $1,320; March 10.

Foundry Pipe Inspector; $1,440-$1,620; March 11.

Assistant Foundry Pipe Inspector; $1,080-$1,440; March 12.

Bridge Designing Draftsman; $1,500-$1,740; March 12.

RAILWAYS

BIDS ASKED.

Maryland:

Baltimore, Md.—Until 11 a. m., Mar. 3, by H. K. McCay, City Engineer, for furnishing steel rails, standard joints, fastenings and special work for municipal railway on second section of Key Highway.

PROSPECTIVE WORK.

California:

San Bernardino, Cal.—San Bernardino Mountain R. R. has filed condemnation suits for right of way in vicinity of Victorville for its proposed line. H. L. Carnahan, Riverside, Cal., is attorney for railroad.

Victorville, Cal.—Carl Leonardt, contractor, Los Angeles, contemplates building railroad to site of cement plant that he proposes to erect near here.

Illinois:

Quincy, Ill.—Chicago, Peoria & Quincy Interurban Co. is reported to be planning to resume construction in April. A. B. Roth, Quincy, is Secretary.

Indiana:

Lafayette, Ind.—Surveys are under way for Lafayette & Northwestern Ry., and it is reported that construction may be started in April. It is stated that contracts are about to be closed for 250,000 ties for the line. O. L. Brown, Lafayette, Ind., is interested.

Indianapolis, Ind.—Union Ry Co. is preparing a $10,000,000 bond issue to take care of track elevation work in this city. The bonds will be guaranteed by the Big Four, Vandalia and Pennsylvania R. R. and will be sold about as follows: 1915, $1,000,000; 1917, $1,500,000; 1919, $1,500,000. The company has been getting prices on 20,000 tons of structural material for this work, and it is expected that definite announcement as to start of work will be made next month. P. J. Landers is Engineer.

Gary, Ind.—It is reported that work will be started March 1 on construction on second unit of freight yards for Michigan Central Line.

Kansas:

Baxter Springs, Kan.—St. Louis & San Francisco R. R. is reported to have completed plans for 15-mile branch from point 3 miles north of this place to Miami, Okla.

Minnesota:

St. Paul, Minn.—It is probable work will be started early this spring on changes in Mississippi River channel preparatory to erection of new union terminal. Engineering studies for the latter are under way. W. C. Armstrong, formerly Bridge Engineer of the Chicago & Northwestern Ry., has been appointed Chief Engineer of the Union Depot Co. of St. Paul and will have charge of the construction work. Offices have been opened in the Hackney Bldg., St. Paul.

Minneapolis, Minn.—Minneapolis, St. Paul & Sault Ste. Marie Ry. is reported to have negotiations under way for acquiring the Minneapolis & St. Louis R. R.

New York:

Plattsburgh, N. Y.—It is reported construction will be started soon on new railroad from Fort Ticonderoga to Lake Sanford. Line would be about 60 miles long and will open up several iron mines. No further details are available at this time.

North Carolina:

Winston-Salem, N. C.—Southern Public Utilities Co. has floated $2,600,000 bond issue to be used for improving equipment and extending street car service. Company operates in 16 cities and towns in North and South Carolina.

Ohio:

Columbus, O.—Norfolk & Western Ry. is reported to be planning to start work on its grade crossing elimination here. City's share of cost will be about $300,000.

Cleveland, O.—Cleveland Rys. Co. contemplates expenditure of $840,000. About 21 miles of track are to be renewed, 5 miles resurfaced and a $200,000 turbine installed.

Oklahoma:

Buffalo, Okla.—Alva, Buffalo & Colorado R. R. Co. has been chartered and proposes line from Rosston on W. F. & N. W. Ry. to Buffalo, 20 miles. J. H. Moran, Alva, Okla., is President.

Oregon:

Independence, Ore.—Valley & Silez R. R may let contract in May for 10-mile extension from Independence to Newport. Work will include 400,000 cu. yds. earth excavation. 20,000 cu. yds. rock excavation and 5,000 lin. ft. of trestles. R. L. Donald, 707 Northwestern Bank Bldg., Portland, Ore., is Manager.

Burns, Ore.—This town is reported as contemplating building railroad to connect with new line being built by Oregon-Washington R. R. & Navigation Co.

Texas:

Marshall, Tex.—Texas-Louisiana Traction Co. has applied for franchise here.

Washington:

Seattle, Wash.—Construction may be started in July on grade separation at Argo Station. Work includes 1,800 ft. reinforced concrete lined tunnel to cost about $450,000. Plans will be prepared by A. H. Dimock, City Engineer.

Wisconsin:

Sheboygan, Wis.—Sheboygan-Elkhart Lake Interurban Co. may start surveys in a few days for extension from Elkhart Lake to Chilton. Edward Hammett, Sheboygan, is Manager.

BIDS OPENED; CONTRACTS LET

Georgia:

Macon, Ga.—Ocilla Southern R. R. has started grading at Rochelle for an extension toward Macon. It is planned to complete 8 miles of the line within 90 days. J. A. J. Henderson, Ocilla, Ga., is President.

Illinois:

Chicago, Ill.—Illinois Central R. R. has taken bids for 6 miles of line near West Frankfort, Ill.

Tennessee:

Memphis, Tenn.—H. W. Nelson Co., 14 South Canal St., Chicago, Ill., has been awarded contract for 150,000 cu. yds. of levee for Illinois Central R. R.

Washington:

Spokane, Wash.—W. J. Hoy & Co., general contractors for grade separation work at Spokane for Northern Pacific Ry., are reported to have let all sub-contracts except those for waterproofing bridge decks and paving. Parker, Moran & Parker have sub-contract for excavation and will place two shovels at work. Van Sant, Houghton & Co. have sub-contract for concrete work.

Wisconsin:

Crandon, Wis.—Peter Nelson, Minneapolis, Minn., who has general contract for 27-mile extension of Wisconsin & Northern Ry., has opened offices at Crandon in charge of H. F. Wharton. Cox & Grabner, Minneapolis, Minn., have started work on their 2-mile sub-contract 8 miles from Crandon. Higgins & McDonald, Minneapolis, have placed a steam shovel at work on their sub-contract at the Van Ostrand end. E. G. Bradenburg, Minneapolis, who has the sub-contract for clearing and building culverts, has a camp about 6 miles from Shawano.

ROADS STREETS

BIDS ASKED.

California:

Redwood City, Cal.—Until March 15 by County Supervisors for 11 miles of macadam (2 contracts), 2 miles oil macadam and 2½ miles of gravel road.

Redwood City, Cal.—Until March 1 by County Supervisors for 6.3 miles of oil macadam under two contracts.

Colorado:

Brighton, Colo.—Until Mar. 4, by Fred O. Pearce, County Clerk, for gravel road.

Florida:

Brooksville, Fla.—Until noon, Mar. 6, by County Commissioners, M. H. Snow, Clerk, for hard surface highways in county. Jaudon Engineering Co., Engineers, Savannah, Ga.

Illinois:

Rushville, Ill.—Until 2 p. m., March 4, by Board of Local Improvements, Thomas Tyree, Secretary, for improvement of certain streets. A. E. Phillips, Engineer, Armour Institute of Technology, Chicago. Advertisement in this issue.

Champaign, Ill.—Until 5 p. m., March 2, by City Clerk for street flusher.

Springfield, Ill.—Until 11 a. m., March 10. by State Highway Commission. Wm. M Marr, Chief State Highway Engineer, for state aid work as follows: Monroe County, 1,900 ft. concrete; Union County, 3,200 ft. gravel; Bureau County, 4,000 ft. concrete; Bureau County, 3,928 ft. concrete. Advertisement in this issue.

Indiana:

Indianapolis, Ind.—Until Mar. 1, by Board of Public Works, for 500 tons asphalt for use in Municipal asphalt repair plant during 1915

Angola, Ind.—Until 1:30 p. m., Mar. 10, by Roy Hurst, City Clerk, for 8,400 sq. yds. paving. C. F. Powers, City Engineer.

Iowa:

Cedar Rapids, Ia.—Until 10 a. m., Mar. 1, by L. J. Storey, City Clerk, for paving on Second St., Third St. and Second Ave. Creosoted block, sheet asphalt, asphaltic concrete or vitrified brick.

Clinton, Ia.—Until 8 p. m., Mar. 9, by F. W. Leedham, City Clerk, for 3,700 sq. yds. of concrete pavement for 3 alleys.

West Liberty, Ia.—Until March 3 by Town Clerk (postponement of date from Feb. 16) for constructing about 40,000 sq. yds. of pavement on concrete base on Third, Fourth, Calhoun and Spencer Sts.; also about 20,000 lin. ft. of curb. Benton R. Anderson is Engineer.

Macedonia, Ia.—Until 2 p. m., March 3, by J. D. Hannan, County Auditor, Council Bluffs, Ia., for following grading on county road system: 11,767 cu. yds. excavation, estimated at 18 cts., and 99,820 cu. yds. overhaul, estimated at 1 ct. Work is located 2 miles east of Macedonia.

Davenport, Ia.—Until 2 p. m., March 3, by John W. Crowley, Commissioner Public Works, for permanent sidewalks in First, Second and Third Road Districts for year ending April 1, 1916.

Washington, Ia.—Until March 8 by J. S. McElhinney, City Clerk, for paving estimated to cost $50,000. Bids will be received on brick and reinforced concrete.

Kansas:

Holton, Kan.—Until Feb. 26, by City Clerk, for paving with vitrified brick or asphaltic concrete. Worley & Black, Engineers, Kansas City, Mo.

Maryland:

Baltimore, Md.—Until 11 a. m., Mar. 3, by R. K. Compton, Director Paving Commission, for 49,100 sq. yds. of asphalt and 6,800 sq. yds. vitrified brick pavement.

Minnesota:

Winona, Minn.—Until 2 p. m., Mar. 23, by C. W. Anding, County Auditor, for 9 state rural highways, estimated to cost $540,000; clearing, grubbing, earth and rock excavation, turnpiking, macadam and bridges and culverts. H. B. Childs, District Engineer, Winona. Advertisement in this issue.

St. Paul, Minn.—Until 10 a. m., March 1, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Ivan Way, Benson Ave., Barrett St., Orange St., Ivy St., Finn Ave., Daly St., Cleora St.

St. Paul, Minn.—Until 10 a. m., March 1, by Aug. Hohenstein, City Purchasing Agent, for furnishing 1,200 cu. yds. limestone dust, 7,000 cu. yds. crushed rock, 41 cars crushed

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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An Unwise Amendment to the Ohio Conservancy Law.

The conservancy law enacted last year in Ohio has been brought up in the present session of the state legislature for amendment. This law, as engineers will recall, was enacted to provide authority for and jurisdiction over works for flood control. The amendments proposed are several but only one of them is particularly of engineering interest and its purport is embodied in the clause, "nor shall any plan be adopted which involves the construction of detention reservoirs to hold back the flood waters upon some lands in order to prevent, or diminish the flooding of other lands." The engineer is prevented by law in Ohio, if this amendment succeeds, from considering storage reservoirs as a means of flood prevention. Specifically the storage reservoir plan chosen for flood prevention for Dayton and other towns in the Miami Valley is voided and another plan must be sought. On both counts the amendment is unwise.

The flood control plans for the Miami Valley were formulated only after very careful studies by a number of engineers of experience and high repute. Their economy and sufficiency are as certain as they can be made by engineering skill. The specific case alone is enough to counsel moderation in legislation, but the greater reason lies in the general objection had to any legislation which prohibits the use of a recognized and successfully employed means of solving a common engineering problem. The amendment cited should not be enacted and engineers should exert their influence to prevent its enactment.

Motor Buses and Passenger Transportation in Cities.

It is rather remarkable that the use of motor buses for the transportation of people in cities has not developed to any great extent up to the present time in this country. There is nothing novel in the idea. Bus lines have been in operation in Washington, D. C., for twenty years or more. In Europe motor buses are everywhere in evidence on city streets. That people are awaking to the advantages of this type of passenger transportation is evidenced by the fact that within the last six months motor bus lines have been placed in operation in a dozen or more cities of the United States.

In Washington the buses, or "herdics" as they are called there, were formerly drawn by horses, but at the present time they are motor driven. They formerly operated through the exclusive residence districts of the city and were largely used by persons in no haste to reach their destination. With the advent of the motor-driven bus, however, the speed of travel has been increased materially and compares quite favorably with street car transportation. In Los Angeles, Cal., a bus line of 22 coaches is in operation between that city and Venice, a suburban town. These coaches are double-decked and have a seating capacity of 54. In San Francisco the present bus line of one company operating 11 coaches will be increased to 50 vehicles during the Panama Exposition. Between Seattle and Bothell, in the state of Washington, a line of 20-passenger, pay-as-you-enter buses is in operation. These buses travel an average of 240 miles a day each. Many other examples of bus lines in successful operation might be cited, including the line on Fifth Avenue, New York, that has been in operation for many years.

Motor bus lines have a number of distinct advantages over other forms of transportation. The delay of one bus does not affect the vehicles behind, as in the case of street cars. They are cleaner and less noisy than street cars. They possess a flexibility of operation that permits frequent stops, widely separated terminals preventing congestion in rush hours and varied destination points to suit the requirements of a fluctuating volume and type of traffic. Both express and local buses may be operated on the same street, an impossibility on the ordinary double-track street car line.

The fare charged is ordinarily five cents, and on several lines transfer privileges are included. The use of the five-cent fare on lines operated in the West and South has given rise to the expression "jitney" bus, a "jit" being a local vulgarism for a five-cent piece. The cost of operation of motor buses, of course, varies with the type of coach and the locality. In Los Angeles about 1,000 buses are in operation, the estimated daily receipts of which are $8,500.

To the average man the advent of motor buses is an occasion of rejoicing. The great company of strap-hangers is gleeful. But from the standpoint of the street railway companies, many of which have frankly admitted that they depend upon crowded cars and strap-hangers for their profits, a serious condition is created. We are inclined to believe, however, the addition of motor bus transportation will act to increase the total number of people traveling, and, while the receipts of street car companies may be reduced slightly, the necessity of maintaining and operating extra equipment for rush hour service will be obviated. And the citizen will be able to secure a seat.

The St. Louis Ordinance Governing Quantity Surveyors.

At various times we have published discussions on the so-called "Quantity System of Estimating" and on the duties and requirements of the "Quantity Surveyor." It has generally been conceded that the proposed system has advantages over the methods of estimating now in use in this country, but designers and builders have realized that great care would need to be exercised in working out the details of a successful system. In a number of cities meetings of those interested in the subject have been held, but progress has necessarily been slow, and definite action has been lacking in most cases. It is interesting to note that, due to the activity of a committee appointed by the Engineers' Club of St. Louis, Mo., an ordinance was introduced in the Municipal Assembly creating the office of Quantity Surveyor. This ordinance was passed, and is now a law. A bill requiring that all architectural and engineering plans of public work in Missouri be accompanied by a detailed list showing the quantity of each material used in the work has also been prepared by the committee for introduction in the state legislature during the present session. The committee is now considering standard methods for use in computing the quantity of each kind of material entering into the construction of a building. The provisions of the ordinance as passed are as follows:

An ordinance to appoint certain persons as Quantity Surveyors.

Be it ordained by the City of St. Louis, as follows:

Sec. 1. The Mayor by and with the approval of the Council may appoint any number of competent persons, who shall be skilled in building construction and estimating as quantity surveyors.

Sec. 2. Each quantity surveyor so appointed shall give a good and sufficient bond to the City of St. Louis in the sum of $10,000, conditioned that he will faithfully perform the duties of quantity surveyor under said appointment, which bond must be executed by the appointee, and at least two good sureties, to be approved by the Mayor and Council, and no such bond shall be approved unless each of the sureties thereon be the owner of real property assessed at not less than one-half the amount of the bond.

Sec. 3. Any person who may employ such quantity surveyor, and who may sustain loss or damage by reason of the negligence, incompetency or misconduct of such surveyor, shall be permitted to bring an action on the bond of such surveyor in his own name in any court having jurisdiction in the premises; provided that any such action shall be brought within five years after the expiration of the commission of such surveyor.

Sec. 4. The quantity surveyors so appointed shall be commissioned and hold office for the term of four years from the respective dates of their respective commissions, and they shall charge for their services such fees as shall be agreed upon with the parties desiring their services, until such time as a joint committee from the Engineers' Club of St. Louis, the St. Louis Chapter of the American Institute of Architects and the Building Industries' Association shall recommend a definite schedule of fees for estimating different classes of structures, when the schedule of fees so recommended shall become the legal fees for quantity surveyors.

The practical workings of the ordinance will be viewed with concern by designers and builders. It will be of interest to note what measures will be taken by the mayor and city council to judge of the "competency" of those desiring to qualify as quantity surveyors. The bond requirement, we believe, is a wise one and is fair to both parties concerned, as loss or damage can be collected by an employer only by proving the quantity surveyor guilty of negligence, incompetency or misconduct. It will tend to discourage inexperienced and irresponsible applicants, but should prove no barrier to competent men. The time during which action may be brought against the bond of the quantity surveyor seems unnecessarily long. It is to be regretted that the ordinance does not specify a definite fee for service rendered, as this point should have speedy settlement if definite progress is to be made.

A Contractor as Road Engineer and His Daily Cost Record System.

Cook County, Illinois, has a former contractor as county superintendent of highways. Incidentally Mr. Quinlan is an engineer but his viewpoint with regard to construction work is practical—as becomes a contractor. Many engineers that become contractors retain the engineer's viewpoint with the result that frequently they do not remain contractors for any great length of time. On the principle that it takes a contractor to catch a contractor, Cook County should build some excellent roads in the next few years and build them economically.

The practical utility of cost records is illustrated in the system instituted in this county. Too frequently the costs kept by an engineer are of no value until the work is completed when the costs are computed and an interesting post-mortem is indulged in. While the discussion of such costs after the job is completed and the stable door locked, as might be said, is quite interesting, such discussion does not serve to reduce the cost of the work. The money has been spent and discussion does not affect matters one way or the other.

By the system outlined on another page the approximate cost of each of many small and widely separated jobs may be determined quickly and with sufficient accuracy to enable the superintendent to make cost saving changes in methods, plant or material immediately. Moreover, the system is simple and a minimum of labor is required in keeping it up. It possesses many of the earmarks of a contractor's method of daily cost keeping.

The moral of this tale is that a county road superintendent must be all that the name implies. He is more than an engineer since he must devise methods of accomplishing the work he has planned. He is more than a foreman in that work must not only be done economically but in accord with sound engineering principles. He is something of an efficiency engineer, an arbiter of disputes, and withal must present a solid resistance to any attempt to substitute political expediency for good construction.

"Going Broke" in Road Contracting.

Mr. William R. Ray, State Highway Commissioner of Washington, states in his last annual report that many contractors recently have "gone broke" in road work in that state. Unfortunately the state of Washington is not an exception in that respect. California and other states that have been engaged in extensive road building show a similar history.

The primary reason for such financial failures of contractors is ignorance of road building costs. The item of grading is almost invariably underestimated by those who have previously done little or no roadwork. Yet, if contractors were more given to reading there would be fewer mistakes on this score. Fourteen years ago the publication of Gillette's "Economics of Road Construction" made clear the fact that road grading normally costs much more per cubic yard than railway grading. Not only the smaller yardage per mile, but the large amount of trimming subgrades, ditches and slopes result in higher unit costs for roads than for railroads. Hence the railroad contractor is in grave danger of underestimating road grading unless he reads and studies the literature of the subject.

The first cost of a modern road making plant and outfit is high in relation to the total amount of work done with it each season. A $50,000 contract that must be completed in one road-building season will normally require an investment of fully $15,000 in plant and equipment. If motor trucks or traction engines and trailers are used, the plant investment will exceed this amount. A very expensive quarrying and crushing plant adds still more to the investment. The relatively short road-building season in many states, coupled with the large investment in plant, should serve to make a contractor "count the cost" with great care. Yet it often seems to the experienced road contractor that each year breeds a new crop of fools who count the cost not at all.

Publicity as to costs and as to the failure of extremely low bidders may ultimately eliminate most of the "fool bids," but the process is slow at best.

We note that Mr. Ray favors letting road contracts for a lump sum rather than by unit prices. This, he reasons, has the effect of eliminating unbalanced bids and of making bidders more careful. Of 51 lump sum contracts 90 per cent were completed at a cost to Washington state that was less than the engineer's original estimate. But of 52 unit price contracts only half were completed below the engineer's estimate.

We think that too much significance should not be attached to these results. They may simply mean that twice as many contractors "went broke" under lump sum contracts as under unit price contracts. That is usually the case. Lump sum bidding is the most risky sort of contracting. The risks are enough at best. We do not favor making them worse by asking contractors to do all the guessing as to the percentages of rock, hardpan, and the like. Except under unusual or obviously simple conditions, we should not advise a contractor to bid on a lump sum basis unless he were to estimate very liberally for contingencies.

Of course it is possible to get contractors to bid on a lump sum basis, but in the long run, it will be found an expensive plan. It will either drive conservative and careful bidders away, or it will result in higher costs than under unit price bidding.

There are but two ways in which a state can save money by securing lump sum bids: (1) Through getting contractors to assume risks without fully compensating them for the risks. (2) Through preventing skilled contractors from outguessing the engineers as to the ultimate quantities of each class of work.

As we view it, no government should desire to make money at the expense of an individual. Where there are risks, a government should assume them as far as practicable. If, therefore, there is uncertainty as to the percentage of rock excavation, the state should not attempt to make a contractor assume the risk.

An unbalanced bid can not ordinarily cause a loss to a state save under one condition, namely a wide difference between the estimated and the actual quantities, which wide difference the contractor foresaw but the engineers did not foresee. In other words, if a contractor can outguess the engineer as to the ultimate quantities, or if the engineer has actually erred in his quantity estimates, the door is open for successful unbalancing of bids. What competent engineer is ordinarily fearful of such a situation?

The common objection to unbalanced bids is entirely different. It is said that an unbalanced bid enables a contractor to put high prices on the work he does first, and thus it becomes possible for him to make an undue profit in the early part of the work. An unscrupulous contractor might thus "skim the cream" and leave his bondsmen to finish the job. If this is a justifiable fear, there is a remedy at hand. Let the contract state explicitly what unit prices will be used by the engineer in estimating the *monthly* payments to be made to the contractor, only the *final* payment being estimated at the contractor's unit prices.

The highest ethics is the best economics in the long run. Certainly it is no more than fair that risks be assumed, as far as possible, by the contracting party that is best able to stand a loss in the event of an unforeseen outcome. In the long run, the assumption of risks by a state or municipality will reduce the prices it pays for work done. If engineer's estimates are exceeded when this is the policy, so much the worse for the estimates. These very excesses proclaim the risk and roughly indicate its quantitative amount.

Highway engineers are not in a position to follow the practice of railway engineers in all their dealings with contractors, more is the pity. Railways usually endeavor to hold good contractors by giving them liberal "classification" of excavated materials whenever it is apparent that the contractors are in danger of "going broke." An engineer for a company may do this, but an engineer for the public can not do so without danger of severe criticism from those who do not perceive the underlying equity and the sound economics of this sort of liberality. But an engineer on public work is not debarred from so drawing specifications and contracts as to relieve contractors of many risks. Indeed it is the part of real wisdom to do so.

A railway engineer is more free to guess roughly as to "classification," etc., for the reason just given. A highway engineer is more bound to dig test pits, and drive rods, that his estimated "classification" may be close to the facts.

We have chosen grading as an illustrative item, but the same sort of reasoning applies to many other items. Thus, where gravel or sand are to be used in building the road pavement, it seems very desirable that the engineer determine the sources, the character and the available quantity of these constituents. This is usually left to the contractors to estimate, and introduces another element of uncertainty.

Summing up, we wish to emphasize the desirability of such a complete study of conditions, on the part of the highway engineer, that he may draw specifications and contract so as to reduce the contractor's risk to a minimum. It is also desirable to publish detailed unit costs, not only of work that is very economic but of the most expensive sorts of work as well, stating fully the conditions. We believe, too, in the wisdom of making public the engineer's detailed estimate of projected work. This is one of the most effective guides against extremes of bidding, and it saves many a contractor from "going broke."

WATER WORKS

Liquid Chlorine Sterilization of the Water Supply of St. Catharines, Ontario.

Contributed by Alexander Milne, Superintendent of Water Works, Past President American Water Works Association.

The city of St. Catharines, Ontario, situated in the Niagara Peninsula between Lakes Erie and Ontario, has since 1878 obtained its water supply from the Welland Canal (the connecting waterway between the two lakes), and up to recent years the water has been of excellent quality. However, the rapidly increasing population of the district adjoining the waterway, together with the added amount of navigation through the canal has naturally created a corresponding possible pollution. In 1912 when it was decided by the Dominion Government to proceed with the construction of the Ship Canal by enlarging portions of the existing canal to accommodate vessels of 10,000 tons, it was realized by the Water Works Commission that steps should be taken to protect the community from possible epidemics arising from the polution of the water supply, not alone from the actual operations entailed in the necessarily extensive works, but also from the large number of employes engaged, the majority of whom have little knowledge (and care less) of the laws of sanitation.

The writer in his annual report of 1913 again forcefully reminded the commission of the necessity of immediate action, the analysis showing frequent pollution, presence of B. Coli, and notice was issued advising consumers to boil all water before drinking. Action was taken by the commission on the report in January, 1914, the superintendent being directed to investigate the merits of the different methods of sterilization and report thereon, and he was authorized to visit a number of water works plants so equipped in the adjoining states.

Being quite familiar with the several types of equipments for the use of hypochlorite of lime and the results obtained therefrom, the principal consideration given to this method was the obtaining of plans and prices for an automatically operated plant suitable to the local conditions.

The ultra violet ray method was also considered carefully, all available data being obtained and studied. Owing to the fact that the local water supply is not a filtered one, and at times is slightly turbid and rather high in organic content, it was felt that although the commission has available a large block of electric power "free," the general conditions were not suitable for the ultra violet method of treatment, and bids for this type of equipment were not asked for.

Liquid chlorine was given very careful consideration, as to its qualities, cost, results, etc., and the different types of apparatus for its application and control were inspected by visiting a number of plants which were in operation and by obtaining all possible data thereon.

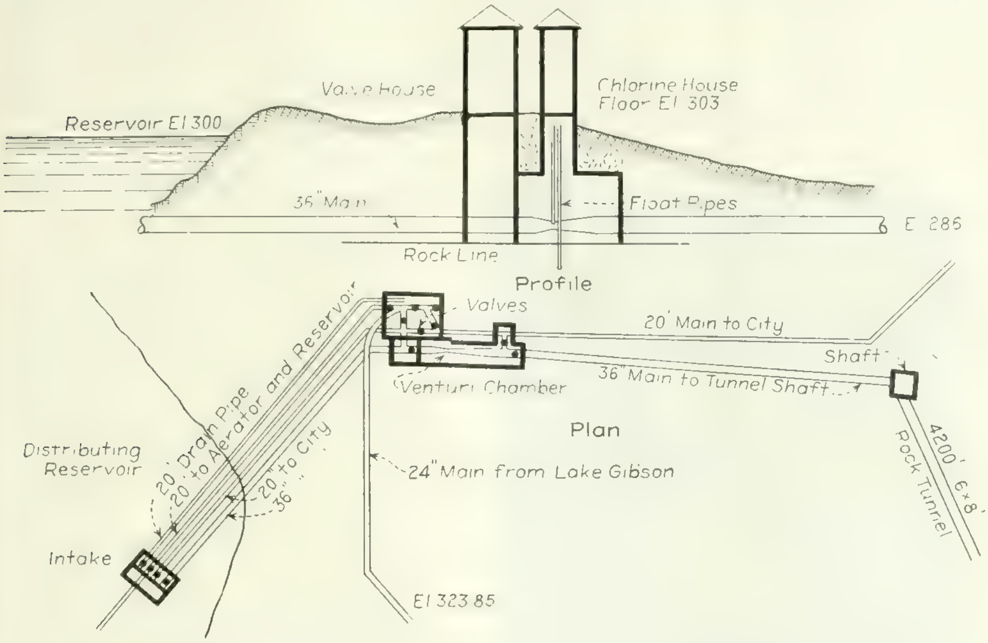


Fig. 1. Plan and Profile of Buildings and Piping for Liquid Chlorine Plant at St. Catharines, Ontario, Water Works.

Having in the meantime secured prices on the different apparatus, the writer first submitted his report to the Provincial Board of Health and received the approval of that body for the proposed installation and presented the report to the commission on March 31, 1914, recommending the installation of a liquid chlorine plant for the sterilization of the supply. He further recommended the acceptance of the proposition of the Electro Bleaching Gas Co. of New York, including a 36-in. Venturi meter and complete automatic apparatus for the control and regulation of the liquid chlorine; the company guaranteeing the efficiency and accuracy of the whole apparatus and furnishing a guarantee bond covering the agreement.

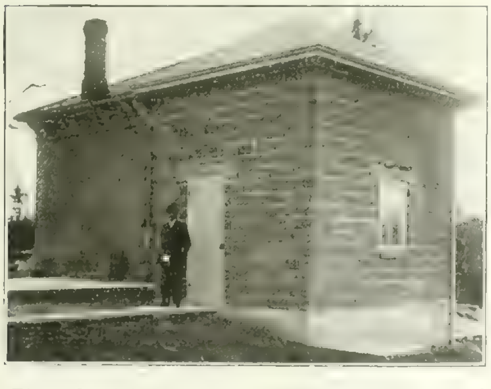


Fig. 2. View of Chemical House and Nearby Valve House, St. Catharines Chlorination Plant.

Fig. 3. View of North Portion of St. Catharines Distributing Reservoir, Showing Location of Concrete Intake Structure.

The report and recommendation was adopted by the commission and authority was given to execute a contract for the apparatus, and to proceed with the work outlined as necessary for the installation.

Active work on the excavation for the concrete meter and valve chamber was commenced on May 26, the work being done by day labor under the writer's supervision, the excavation at this point being 16 ft. to 20 ft. deep. The work of setting the 36-in. meter tube involved cutting out and removal of four lengths of 36-in. pipe, placing the 36-in. valve and providing the 36-in. x 20-in. by-pass with 20-in. valve as shown in Fig. 1, the 20-in. connection being made with an A. P. Smith No. 2 tapping machine, without interruption of the supply.

All concrete was of 1:6 mixture, using clean, sharp pit gravel, mixed wet, and liberal quantities of clean, sharp angled limestone spawls. The cross walls of the chlorine house are primarily supported on steel beams, resting on the chamber walls, the whole being continued as a unit up to elevation 303 (local datum) as shown on profile of Fig. 1. The concrete floor of the chlorine house and the roof of the chamber are reinforced with 4-in. (65-lb.) steel rails and expanded metal.

The superstructure is of double-hollow concrete blocks, strapped on the interior and lined with "Beaver Board," the whole being finished in harmonious colors. Power, light and heat for the plant is obtained from 120-volt, 66-cycle current, of which the commission has 500 HP. "free" from the Power Company whose plant adjoins the works of the commission. Figure 2 shows the chemical house, and a portion of the valve house is shown to the left of the former.

The general design of piping and valves at the intake crib and valve house is as shown in Fig. 1 and furnishes an ideal combination of feeds, which may be used combined or independently from three separate intakes if so desired, in event of trouble or the unwatering of either. Figure 3 is a view of the north section of the distribution reservoir and shows the concrete intake crib. The placing of the 36-in. and 20-in. valves at the by-pass below the Venturi meter gives the advantage of operating either or both mains without disturbing the chlorination treatment.

From this point the supply is conveyed to the city by two mains, the 20-in. shown on the plan is reduced to 16-in. at the foot of the escarpment and enters the distribution system at the extreme westerly end. The 36-in. is laid to the shaft of the tunnel as shown, the tunnel being 6x8 ft. in section for a distance of 4,200 ft. to a concrete bulkhead where it connects to a 24-in. cast iron main laid to and across the center of the distribution, a distance of 21,000 ft., thus affording ample time for complete chlorination before the supply reaches the consumer.

The 36-in. Venturi meter is the product of the Builders' Iron Foundry of Providence, R. I. It is designed especially for the rather unusual local conditions, the recording apparatus being the float-operated type "M" register, indicator-recorder, the indicator and recorder being in Imperial gallons, while the register is shown in cubic feet. Figure 4 is a view of the Venturi recorder and the chlorine controlling apparatus.

The recorder is placed directly over the float pipes thereby obtaining the best possible results in operation, not only of the meter recording apparatus but also of the chlorine regulating mechanism operated from the recorder, all possible frictional losses being eliminated.

The liquid chlorine apparatus was made and installed by The Electro Bleaching Gas Co. of New York, and is known as their Model "C," automatic type of equipment. The installation was made on a parallel center line with the meter recorder, at a distance of 3 ft. from centers, the whole unit being as shown in Fig. 4, and the operation may be described as follows:

From an aluminum sheave fitted to the shaft at the back of the meter indicator dial, a tension cord is carried at a right angle to one of a pair of sheaves bracketed on the pedestal of the chlorine controlling apparatus. This tension, or driving cord, is properly counter weighted so that it will take up and convey to the chlorine equipment the slightest movement of the meter indicator shaft.

The two sheaves on the apparatus known as "A" and "B" in the operations are mounted on the same shaft and sheave "A," which is driven by the tension cord from the meter is so proportioned in dimension that a variation in the diameter of the "B" sheave will permit of an adjustment to secure any desired rate of chlorine feed per 1,000,000 gals. of water passing through the Venturi meter tube. In other words, in order that the quantity of chlorine to be applied may be adjusted to meet the varying quality of the water, it is necessary that the amount of movement originating at the meter indicator and transmitted by the tension cord shall be increased or diminished to secure the desired action on the chlorine controlling valve. This is the purpose of the "B" sheave, and it is therefore of such design that it can readily be removed and replaced by sheaves of larger or smaller diameter as the case may warrant.

From this "B" sheave another properly balanced cord passes over a small, loose guide pulley, mounted on the electric mechanism box. This cord is connected to one part of an electric contact carriage or switch device. This entire mechanism is unique and of decidedly interesting design and correspondingly difficult to describe. The function of this switch is to make, break, and reverse the current passing to a small motor, which operates indirectly through a series of gears, the valve controlling the delivery of the chlorine gas. This switch, or contact carriage, is made of two separate parts; one part may be termed the "floating" section, being connected to the tension cord from the "B" sheave as previously mentioned, and the other part is mounted on a vertical screw shaft actuated or driven from the motor.

The operation of this switch may be briefly stated as follows: The floating portion is moved vertically a proportional fraction of the total movement originating at the meter indicator. At the inception of this movement contact is made with the second portion of the carriage, so that the circuit is closed on the motor. As the motor operates the screw shaft revolves moving the section portion of the contact carriage vertically up or down, as the case may be, until its contact with the floating portion is broken, and the power circuit opened. This, therefore, stops the motor as soon as the movement of the meter indicator ceases.

The chlorine control valve is actuated by the motor through this same vertical screw shaft by universal joint connected shaft driving bevel back gearing connected by a spur to a pinion on the spindle of the diaphragm regulating valve, this latter being the immediate control of the gas passing to the absorption tower.

As all operations and adjustments of the mechanism start from zero, the large pinion on the valve spindle has been calibrated to indicate on its face from zero the percentage of valve opening, thus enabling the operator to check the momentary flow of chlorine as given on a table furnished by the manufacturer of the equipment. An additional check is provided by the "rate of flow" gage mounted on the left which indicates the flow of chlorine in ounces per hour. At the upper right of the frame is the chlorine cylinder pressure gage, on the indicator of which is fitted a circuit closing arm, from the contact points of which are carried wires to a large alarm gong, in the caretaker's residence nearby, operated by 2 dry cells which gives a very positive alarm when the cylinder pressure reaches the low point for which it is set.

From the cylinders the chlorine passes through the controlling apparatus to the absorption tower shown in Fig. 3, discharging near its base, the tower being filled with broken pumice stone and receiving a continuous flow of water from a ¾-in. pipe fitted at its top to provide complete absorption of the chlorine, the chlorinated solution being thence carried by gravity to the 36-in. main below, discharging at the axis of the pipe. The absorption tower and all pipes and fittings in contact with the chlorine or solution being made of vulcanized rubber.

Electric current enters the building at the right of the apparatus to a switchboard, 120 volts, 66 cycle, and for the operation of the apparatus is transformed to 10 volts single phase by means of a Viking pony transformer wired through the contact carriage to the motor, the operation of the electrical apparatus being entirely automatic, on the movement of the temporary rate of flow recorder. In event of line or other electrical troubles the apparatus may be operated temporarily by a battery of six dry cells, for which provision is made. In addition to these it is the intention of the writer to install a small direct-current generator, driven by a Pelton or similar water wheel in the basement of the adjoining valve house, giving an independent triple source of power, reducing to a minimum the danger of shut-downs from power sources.

The plant was placed in operation on August 10, 1914, and with the exception of some slight adjustments to tension cords, etc., has required no attention, and has been highly satisfactory both as to mechanical operation and results produced in the sterilization of the supply the reports of the chemist indicating complete destruction of B. Coli in the treated water, while the samples untreated indicated pollution in nearly every instance.

Owing to the rather variable character of the supply it has been found necessary to keep close observation as to bacterial conditions, and to adjust the ratio of dose to meet these, but so far the maximum dose applied has been 3 lbs. of chlorine per 1,000,000 Imp. gals., which was used for a short period during October, following severe storms on the lakes. For some time and at present we are applying 1.65 lbs. per 1,000,000 gals. and are obtaining the desired results.

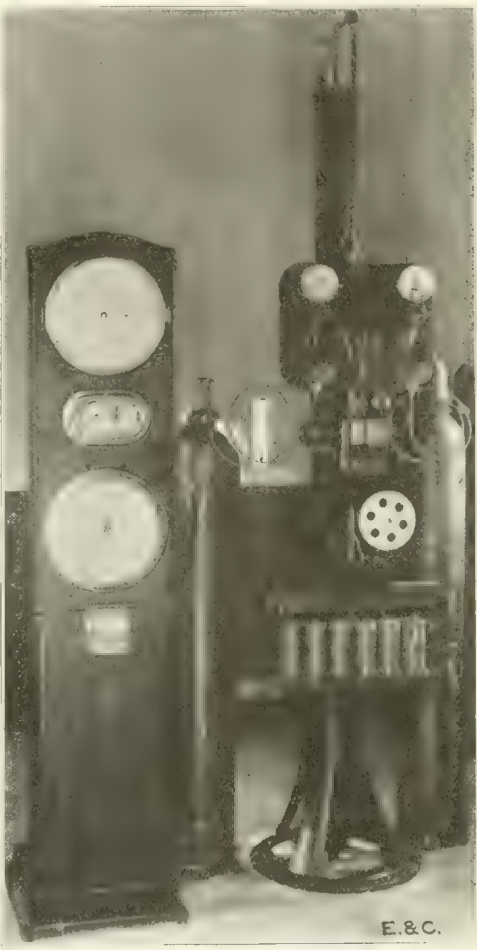


Fig. 4. View of Venturi Recorder and Chlorine Controlling Apparatus, St. Catharines, Ont.

The installation of the chlorine and meter apparatus was under the supervision of Mr. J. A. Kienle, C. E., representing The Electro Bleaching Gas Co., and all the apparatus was properly adjusted and tested by him and the writer for efficiency and accuracy when placed in operation, and again after three months operation before final acceptance. Frequent zero tests were made by the writer to ensure proper working.

Fuel Oil in Brazil.—There are several oil-burning locomotives on the Mogyana railway, which is gradually converting all its locomotives into oil burners. The Sao Paulo Railway is also experimenting with fuel oil. The oil that these railways are using is supplied by a Mexican company, with headquarters in Rio de Janeiro. There is also a market for the by-products of crude oil, such as gasoline, kerosene, and the heavy residues which are used for fuel purposes.

The population of the Ohio River basin, according to the 1910 census, was 14,401,489, or about 16 per cent of the total population of the United States.

The Results of Meterage at Columbus, Ohio, With Special Reference to Restriction of Waste in Lawn Sprinkling.

In a paper before the recent annual meeting of the Indiana Sanitary and Water Supply Association, Mr. Jerry O'Shaughnessy, superintendent of the Columbus water works, discussed lawn sprinkling regulations. He said his city had no such regulations, other than those imposed by the use of water meters, and did not expect to promulgate a set of formal regulations. He considers the use of meters the most effective lawn sprinkling regulator. In the paper some interesting data on meterage were given which are here quoted.

Some defect in a water system makes it necessary to enforce lawn sprinkling regulations. I do not say that these defects are easily overcome in many places, and they may be defects of location, of construction or operation of the plant, but nevertheless the necessity of regulations results from defects of some kind. It seems that supply and demand make it necessary to inaugurate and enforce what we call regulations, but which in reality should be called restrictions.

Supply must be conserved or enlarged and must meet the wants of demand. Demand may be wasteful and careless in satisfying its wants. Some restriction must be placed upon it. There may be a bountiful supply of water to draw from, but the pumping equipment may not be sufficient to cope with the wants of demand. There may be ample water and efficient pumping service yet supply cannot meet the wastefulness of demand. In such cases some kind of restriction must be placed on the use of water.

While Columbus grew and there became a greater demand for water, the department added to and reconstructed its supply and pumping works until we now have ample water supply and pumping equipment for some years to come and are prepared for a city much larger than its present size.

But I think the one thing that makes restriction of lawn sprinkling unnecessary in Columbus is its complete meter system. In that you will find the restriction, making regulation unnecessary. I do not think it prohibits the necessary use of water for sanitary and sprinkling purposes, but I know it makes the normal consumer careful of water. If the consumer knows he must pay for the amount of water measured out to him, he will shut off the faucet when not in use, repair bursted pipes and defective plumbing. He soon learns to be careful in the use of water as in other things.

We have in our department, a system of notification of wastage. If the meter reader detects wastage on a property, a postal card notifies the owner of the property that such wastage exists and advises him that the department is not responsible for it. Last year we mailed 2,200 of these postal cards. We also leave a slip on the premises where meter is located, showing the amount of water consumed every two months. By these slips the consumer knows whether he is using more than the normal consumption, and if wastage exists, promptly repairs the defective plumbing. Notwithstanding our efforts to cut down the wastage of water, and in face of the fact that the consumer must pay for it, we have enough wastage to lead one to the conclusion that enormous amounts of water must be wasted where people pay on the flat rate, even though the system of service inspection is thorough.

In 1890, Columbus had 6,816 taps, of which number about 7 per cent were metered. In 1901 we had 15,342 taps and 33 per cent of them were metered. We soon realized that our water supply was inadequate, and while it had been worked out in that year what would have to be done in the way of storing water and providing more efficient pumping equipment, yet it was known then this would not materialize for some time to come. Still there was the ever apparent necessity for saving water, as the wells were delivering all they could, and notwithstanding an increased usage of raw river water, we failed to meet the demand, for during long and severe dry seasons, the river would become so low it scarcely afforded any supply. In 1902 it became evident that something positive must be done, and that at once, and we began to advise the use of meters.

It was not the easiest matter in the world to convince people of the necessity for this. In order, however, to force the meter on them, we raised the flat rate exorbitantly and left the meter rate as low as possible. At the end of that year we had 16,281 taps, of which 63 per cent were metered, an increased use of meters of 30 per cent.

The people began to have their plumbing repaired and learned that it did not pay to be wasteful, and the pumpage was materially reduced. In this manner, we pulled through until the construction of the storage dam in 1905 and until the new pumping facilities were installed the same year.

Back in 1890, when only 7 per cent of the taps were metered, the daily consumption of water per tap amounted to 1,021 gals. In 1905, when 76 per cent of the taps were metered, there were 798 gals. per tap used. During the year 1914, 95 per cent of the taps were metered, and the consumption per tap was 552 gals. per day.

To drop from 1,021 gals. per tap per day to 552 gals. per tap per day, certainly shows a reduction in the waste of water. There can be no complaint as to the use of it for the people are allowed to use all they care to.

The small consumer, unless his service is metered, is usually the most prolific in the wastage of water, notwithstanding the fact that in proportion, the cost of supplying him is the greatest.

In 1914, we had 32,218 active accounts for water, metered and flat. We received for water during the year $494,000; $256,000 of this amount was paid by 2,381 consumers, and the remaining $238,000 was paid by 27,687 consumers. In April we collected from 27,000 consumers, 13,300 or nearly half, of whom used no more water in six months than 3,000 cu. ft. In October we collected from 28,000 consumers, 10,500 of whom used no more than 3,000 cu. ft., notwithstanding the sprinkling season.

We have a chart showing the average amount of water pumped at each hour of the day and night for each month of the year, and a study of this chart reveals the fact that the time for sprinkling is regulated by habit or custom of the consumers themselves; for it is done at the same hours of the day all over the city. For example, consider the months of July and November and the increased pumpage of July over that of November, a month in which sprinkling is almost uncalled for and the weather is not cold enough to necessitate opening faucets to prevent freezing.

At 1 a. m., the pumpage was about the same for each month. At 5 a. m., July showed an increase of 2,700,000 gals. over November; at 6 a. m., 3,500,000; 7 a. m., 3,900,000; 8 a. m., 3,400,000; 9 a. m., it dropped to 2,900,000, about the same as it was at 5 a. m. At 3 p. m., the increase in July over November was 3,200,000, practically the same as at 8 a. m.; at 4 p. m., 5,400,000; at 5 p. m., 7,100,000; at 6 p. m., 10,200,000; and at 7 p. m., 12,000,000. At 8 p. m., it dropped to 5,800,000 and by 9 p. m., was back to 2,500,000.

From this it will be seen that a small amount of sprinkling is done between the hours of 6 and 8 in the morning, while the heaviest sprinkling of all begins at 5 p. m., and at 7 p. m., the maximum amount was being done. Then at 8 p. m., it fell off and by 9 p. m., had almost entirely stopped.

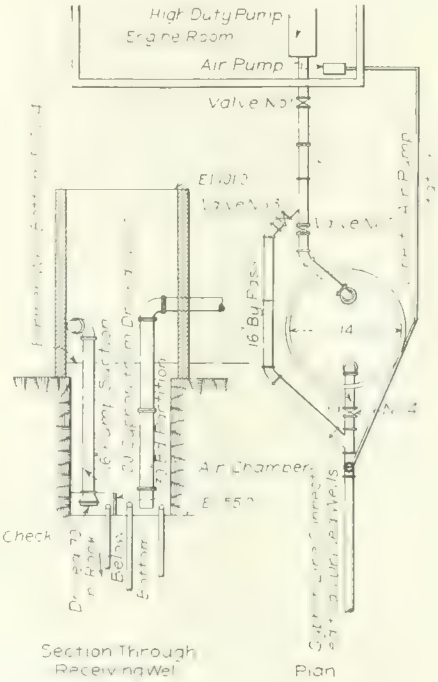
The privilege of sprinkling cannot be denied and if regulated no more can be done than to set certain hours for it; and our records show that people have their own notion of what time to sprinkle and it accords very much with the hours of the day to which sprinkling is confined where there is lawn sprinkling regulations. The foregoing explains why Columbus, Ohio, has no lawn sprinkling regulations and why none are needed.

In conclusion, I would say, whether or not a plant is well equipped in the way of supply and pumping facilities, or whether or not there is a shortage of water during sprinkling seasons, the use of meters is the best lawn sprinkling regulation that could be adopted.

Syphoning Water from Series of Drilled Wells to a Common Pump Well at Kokomo, Ind.

Contributed by Omar O. Jones, Superintendent of Kokomo Water Works, Kokomo, Ind.

The problem of securing more water from deep wells has claimed the attention of the best hydraulic engineers and practical water works managers for many years. It is shown by government surveys in all sections of the United States that the water level is slowly but surely receding and that our trouble from this cause has only begun. In nearly all sections the ground water table has been lowered until ordinary suction pumps at the surface are obsolete. This condition was the incentive that gave us the air lift and the screw, as well as several other deep well pumps. All of them are more or less efficient, but not sufficient or economical enough to be practical in the supply of well water for a city.



Plan and Section of Receiving Well and Syphon Line to Series of Drilled Wells at Kokomo, Ind.

We are all familiar with the syphon principle, and in the light of our experience it is surprising that more of them are not in use.

The same system was used at Muncie, Ind.; Jamestown, N. Y.; Sioux Falls, S. Dak., and Wichita, Kans., all American Water Works and Guarantee Co. plants.

Originally the supply for this city was obtained from four 6-in. drilled wells. These were located in the bottom of two receiving wells, 14 ft. in diameter and 25 ft. deep, which served as reservoirs for the flowing wells. The receiving wells were curbed with stone and protected by substantial houses. For ten years these wells had a flowing capacity ample for fire and domestic consumption. The water level in the receiving wells gradually receded, and two more wells were drilled. These gave only temporary relief, for it was soon apparent the well field must be extended, as the wells flowed no longer, or at best but intermittently.

Five additional wells were drilled within a radius of 2,000 ft. and connection was made with compound pumps erected in a pit 10 ft. deep, the discharge being connected with receiving wells. This plan was effective, but the double pumping proved very expensive. The continued decline in the water level and the increased consumption made our position again untenable. It was then decided to install our present syphon system, a description of which is the object of this contribution.

Plans and specifications were made by Mr. J. N. Chester of Pittsburgh, Pa., at that time chief engineer of the American Water Works and Guarantee Co., for deepening one of the receiving wells sufficiently for the outlet of the syphon line to be connected to all of the deep wells. The problem of blasting out the bottom of the well to an additional depth of 25 ft. and at the same time to continue the supply to the city was the most embarrassing encountered.

A "pulsating" deep well pump was secured from the Emmerson Pump Co., Alexandria, Va., which consisted of two 12-in. cylinders, 6 ft. long. The pump occupied very little space, being suspended from the top of the well by a ⅜-in. chain and lowered as the excavation progressed. The suction of this pump was inserted in one of the drilled wells in the bottom of the receiving well, thus keeping the water below the drilling and explosives. The discharge from this small pump into the other receiving well supplied the city for 60 days, or till the excavating was complete.

Steam for this pump was supplied from a portable boiler at nominal expense. The drilling was by hand and the stone was hoisted by horse and rope. Drillers left the pit by ladder and the shots were fired by battery at the surface of the ground. The work was done in January and February under unfavorable conditions, adding quite a sum to the cost.

A 20-in. cast iron pipe was laid to the farthest well and all the intervening wells were connected. A 20-in. air chamber was placed on the syphon line entering the receiving well and it was connected to an air pump in the station. The drop pipe extended to 2 ft. above the bottom of the well and 12 ft. below the natural elevation of the water in the deep wells.

The syphon line is 20 ins. in diameter and that part in the well is flanged. A gate is placed between the air chamber and the well; it is to be closed when the bypass is used. As shown in the accompanying drawing, this 16-in. bypass is connected with the pump suction and thus makes it possible to pump direct from the deep wells should repairs to the receiving wells become necessary.

Previous to making this improvement, which included a new and more economical pump, our coal consumed was 50 to 60 tons per week, which was reduced by the improvements here described to 20 to 30 tons.

Our syphon has been in use 9½ years, with absolutely no cost of operation or maintenance. The air pump is little additional expense. The cost of labor for the improvement was $1,033; for material, including rent of boiler, fuel, tools, boots, drayage, explosives and wiring, $1,546, giving a total cost of $2,579. The auxiliary pump was sold and the deep well pump returned to the makers at a fair price. The salvage reduced the cost to a very satisfactory investment.

Suggestions for the Making of Water Meter Rate Schedules.

In the preliminary report of the committee on meter rates of the New England Water Works Association, made late last year, a procedure was outlined to govern the making of water meter rate schedules. The portion of the report here presented in substance has to do with the form of the schedule. The actual rates should ever be determined with direct reference to all the pertinent conditions in the locality for which the rates are intended. This suggested schedule is believed to be adapted to general use. In this schedule the sliding scale of rates is recognized and three classes of rates in a given schedule are provided. As stated, the actual rates are for local determination to produce the required revenue. The quantities of water per annum, per quarter or per month to which the three rates are applicable are defined and made uniform by the schedule. A service charge is also provided. In event of local objection to a service charge the committee proposed an alternate arrangement under which the amount of the service charge is applied as a loading to the price for a small amount of water first sold from each service, thus making in effect a fourth and higher rate, for use only where no service charge is made.

DIVISIONS OF THE SLIDING SCALE.

It was proposed to make only three divisions of the sliding scale. At the present time there are many schedules in effect, with more and even with several times this number of divisions. The committee believed that in general more than three divisions are unnecessary and undesirable. Too many rates add to the complexity of the schedule, to the labor of applying it and to the difficulty of understanding and comparing rates.

The committee proposed that all water up to 300,000 gals. per annum (equal to 822 gals. per day, or to 40,000 cu. ft. per annum, or 10,000 cu. ft. per quarter) shall be charged for at the first or highest rate. This rate for convenience will be called the Domestic Rate. The quantities of water covered by it will include substantially all water used by private residences, and also much of the water used by small hotels and smaller commercial and industrial establishments.

The second or Intermediate Rate will apply to quantities in excess of 300,000 gals. per annum up to 3,000,000 gals, per annum.

The third and lowest rate will be called the Manufacturing Rate and will apply to all water in excess of 3,000,000 gals. per annum from any service (equal to 8,220 gals. per day, or to 400,000 cu. ft. per annum, or 100,000 cu. ft. per quarter).

It was recommended that the price per 1,000 gals. or per 100 cu. ft. be, in most cases, an even number of cents, omitting fractions, and that the intermediate price for water be to the nearest cent midway between the average and the mean proportional of the domestic rate and the manufacturing rate. By this rule the intermediate rate is definitely fixed at an amount midway or a little below midway between the domestic and manufacturing rates. There is, therefore, no need of discussing the amount of this rate. Consideration may be concentrated on the two main points in the schedule, the domestic rate and the manufacturing rate; and with these fixed, the intermediate rate will follow by fixed rule, and will be certain to be appropriate in connection with the others.

THE AMOUNT OF SLIDE IN THE SCALE.

There are many scales of meter rates in effect at the present time in which the highest rate charged for the first water is unduly large in comparison with the lowest rate charged for the largest quantities. It sometimes happens that there is a ratio of ten to one or more between these rates. The committee disparaged so great an amount of slide, and recommended that the lowest price for water shall rarely be less than half of the domestic rate.

Where the price for manufacturing water is 75 per cent or more of the domestic rate, it was suggested that the intermediate rate may be omitted and that the manufacturing rate then apply also to the water that would otherwise be sold at the intermediate rate. If the rate for manufacturing water is 100 per cent of the domestic rate, both limits disappear and one flat rate will apply to all quantities.

Many works now make a flat meter rate for water. A flat rate can only be fairly applied in connection with a proper service charge. With an adequate service charge, the reason for the sliding scale is greatly reduced, and there is much to be said in favor of the flat rate. The committee did not wish to urge the sliding scale in preference to flat rates where such are now used, and the proposed scale lends itself to use either with or without the sliding scale.

The principal reason for the sliding scale is that it costs more to distribute water to many small takers than to a few large ones. From the standpoint of cost only, the best way to take care of this excess cost is by means of the service charge. But to do this adequately would mean the adoption of a service charge so large as to be burdensome to the smallest takers. These smallest takers are not profitable to the system at low rates even with such service charges as the committee now proposes. Nevertheless they must be supplied, and it seems to be a wise policy to supply them at low rates, making the larger takers carry a proportion of the excess cost of supplying small consumers. The sliding scale affords a means and perhaps the best means of effecting this adjustment.

In view of the general use of the sliding scale at the present time, and in view also of some strong arguments in favor of a moderate amount of slide in the scale, the committee did not see its way clear to recommend giving up the sliding scale, and only recommended that the amount of slide be limited to moderate proportions and that the points where change in rate takes place be made definite and uniform.

SERVICE CHARGE.

The committee believed that it was essential to make a substantial service charge in order to secure equitable rates for all. The service charge may be naturally made up of several parts. It suggested that the procedure to be followed in determining the amount of the service charge be as follows:

First, that the average amount of money invested by the works in the service pipe and meter be ascertained. Where the works furnish the service pipe to the curb line, and the meter, the normal cost seems to be about $25 per service. Where the taker pays for the service pipe and the works furnish the meter, the normal cost seems to be about $10 for a ⅝-in. meter in position. The committee suggested that 10 per cent of this cost be taken as the first part of the service charge. That is to say, that $2.50 per annum be used where both service and meter are paid for by the works; $1.00 per annum where the meter only is furnished by the works, and that this part of the charge disappear where both pipe and meter are paid for by the taker. The committee believed that on the whole 10 per cent is a fair allowance for the depreciation in the service pipe and meter, and for the interest on the money invested in them. The structures are not long-lived, and occasional repairs are needed. A reasonably approximate figure is sufficiently close, and 10 per cent is used in this way.

The figures mentioned for cost of service and meter are believed to be representative, but they should be increased or decrased according to the ascertained average costs under local conditions. Round figures should be used in all cases as a matter of convenience, and because precision is unnecessary, and because it cannot be reached in most cases. For meters larger than the ⅝-in. domestic size, correspondingly larger figures should be used.

Second, a sum per annum representing approximately the cost of reading the meters, keeping the meter records, making bills, and collecting the money. The amount of this item depends upon the frequency upon which meters are read, and upon local conditions; for ordinary domestic services where meters are read once a quarter, $1 per annum may be a sufficient allowance. This figure may also be used without substantial injustice for services of all sizes, because when meters are read monthly the quantities are usually larger and the cost of meter reading becomes an inappreciable fraction of the bill.

Third, an amount which will represent the approximate average value to the works of the water that passes a domestic meter without being registered. The normal service of a domestic meter for one day may be assumed to consist of passing 200 gals. of water, more or less, in about two hours, the whole time being made up of many short intervals during the day. During the remaining 22 hours no water will ordinarily be flowing. If the service pipe and plumbing are perfectly tight, no water will pass during those 22 hours; if there is a leak of such size that the water lost by it will turn the meter, then the meter will register the flow throughout the 24 hours, and all the water passing will be recorded, except that there may be some slip in the meter at a low rate. If there is a leak in the service or plumbing which allows water to escape, but in amount so small that it does not serve to move the disk or piston of the meter, then the amount of water lost by such leakage in the 22 hours when the piston or disk is not moving will be entirely unrecorded. Probably no meter in ordinary service will register a flow of less than 100 gals. in 22 hours. Many meters in actual service will allow much larger quantities to pass without registering. It is probable that the plumbing in every house has leaks at times, through defective washers in the faucets or automatic valves which permit the loss of water in amounts too small to be recorded. In some houses such loss is always taking place. In the aggregate the amount of this unrecorded leakage from plumbing is large. It probably furnishes the greatest single reason why the amount of water registered by meters never approximates closely the total quantity of water furnished by the system.

Water lost in this way is running at a steady rate throughout the 24 hours, and increases but slightly the peak load of the plant. It can, therefore, be supplied at the lowest relative cost, and for the purpose of this estimate should be reckoned at the lowest rate charged for any water that is sold.

The amount lost per service will range from nothing to 100 gals. per day, and occasionally to much larger quantities. Assuming an average of 50 gals. per day per service at a minimum price of 10 cts. per 1,000 gals., the value of water so lost amounts to $1.82 per service per annum.

There are no adequate data upon which this loss can be computed, and the committee saw no way of securing such data. Nevertheless it believed that the matter is an important one and that a substantial allowance should be made for such losses. It suggested for the present the use of $2 per annum for this item.

Upon this basis the service charge will amount to the sum of these parts, namely, first, 10 per cent of the average investment of the works in service pipe and meter; second, $1 per annum for reading meters, billing, and collecting; third, $2 per annum for the probable value of unregistered water. For a domestic service with ⅝-in. meter, the ordinary service charge may properly be $3, where service and meter are paid for by the taker; $4 where the meter is furnished by the works; and $5 or $6 where both meter and service pipe are paid for by the works, the lower figure being used where the average cost of a service pipe is under $15, the higher where it is greater than $15.

The figures used in the above paragraphs should be considered only as general approximations, to be modified to meet established local conditions, or upon more complete data. The committee suggested that the method is of first importance and should be first discussed and settled, and that the values to be then used under it should always be selected with reference to the conditions in each plant for which a service charge is to be established.

The charges for larger services will readily be reached by the application of the same methods, and the committee did not suggest any values for them.

AS TO THE MANNER OF APPLYING THE SERVICE CHARGE.

The committee recommended that the amount determined by the use of these methods, raised or lowered to a convenient round figure, should be charged for each service; that this charge should be made in all cases whether water is drawn or not; and that all water drawn from the service should be charged at current rates in addition thereto.

Many works at the present time make a charge for meter rent. In such cases, and otherwise if desired, the service charge may be called "meter rent," the amount being taken as the amount determined for the service charge.

The method of making a service charge separate from and in addition to the charge for water registered is the most convenient and equitable way of distributing the costs considered in the above paragraphs where they belong, and the committee recommended it for use in all cases.

ALTERNATE PROCEDURE

Where there is local objection to making a service charge (even though called meter rent), the following alternate and less desirable procedure may be used.

The amount that would be a fair service charge is computed as above. This amount is divided by 60 and the result to the nearest even cent is added to the domestic rate, and this new rate (which may be called a loaded or maximum rate) is applied to the first 60,000 gals. of water per annum drawn from each service. If cubic feet are used, the amount is divided by 80, and the result to the nearest even cent is added to the domestic rate per 100 cu. ft., and the increased rate is applied to the first 8,000 cu. ft. per annum used from each service. In connection therewith, a minimum rate must be established. The minimum rate may be about $3 more than the computed service charge. This double procedure of loading the rate for the first quantity of water sold from each service and of establishing a minimum rate will accomplish in a rough way the general purpose of the service charge. It is less satisfactory because it is less fair as between the various small consumers drawing quantities of water that will be affected by it. It is as fair to the works and to the larger consumers because the loading of the first quantity of water sold by the method described will produce a sum nearly equal in the aggregate to that which would otherwise be directly charged for the services.

GALLONS OR CUBIC FEET.

It is most unfortunate that two units of measurement are in common use. It would be much better if one could be discarded. It is absurd that two units should continue in general use. The advantages of adopting either one would be vastly greater than any possible advantage in either. It would seem that the Association could determine which it prefers and throw its influence toward its universal adoption. The committee felt that this should be done by action of the whole Association and not by a committee.

In the interest of economy of labor, it is obviously desirable that the same unit should be used in any system for both meter registers and schedules. Thus the use of meters reading in cubic feet, with a schedule of rates in gallons, is undesirable and should be avoided by changing as rapidly as is possible so that both are on the same basis.

FORMS OF SCHEDULE.

The committee proposed the following form for a schedule for meter rates:

For each service supplied by ⅝-in. meter there shall be a charge for the service and meter per annum of ..$.

In addition thereto, for all water drawn there shall be charged:

Cents per 1,000 gals.

For the first 200,000 gals of water per annum, or any part thereof, the domestic rate of..........................$........

For water in excess of 300,000 gals. and under 3,000,000 gals. per annum, the intermediate rate of................. ....

For water in excess of 3,000,000 gals. of water per annum, the manufacturing rate of . ...

The prices to be written in the schedule should be fixed in each case by the local authorities to meet local conditions, and to produce the required revenue, and the committee made no suggestion as to how great they should be. It is further the intention that cubic feet shall be substituted for gallons if desired, the numbers being divided by 7.5, so that the actual quantities paid for under each rate will not be changed; also that the rates may be stated as semi-annual, the numbers being divided by 2; or as quarterly, the numbers being divided by 4; or as monthly, the numbers being divided by 12.

It is to be recognized that a monthly rate with one twelfth the quantities, with varying rates of monthly use, will produce in some cases slightly different annual results from the corresponding annual rate, but it is recommended that such difference be disregarded, that the rates be made for whatever period meters are read, and that each record period be considered by itself in computing the charge.

A schedule under the alternative and less desirable arrangement, avoiding the term "service charge" or "meter rent," would read as follows:

Minimum charge for service with ⅝-in. meter, per annum. ....$ .....

Cents per 1,000 gals.

For the first 60,000 gals. of water per annum, or any part thereof, at the maximum rate of...... ....$ ....

For all water in excess of 60,000 gals. and under 300,000 gals. per annum, the domestic rate of.................. ....

For all water in excess of 300,000 gals. and under 3,000,000 gals. per annum, the intermediate rate of............. ....

For all water in excess of 3,000,000 gals. per annum, the manufacturing rate of ....

ACKNOWLEDGMENT

The committee's preliminary report in full, including the matter here given, data on actual rates in force and showing a meter rate sheet for plotting rates for comparison, is published in the Journal of the Association for September, 1914. The members of the committee are: Allen Hazen (chairman), Charles R. Bettes, A. E. Blackmer, A. W. Cuddeback, James L. Tighe and Philander Betts.

BUILDINGS

Preliminary Report of Committee on Edison Fire.

In our issue of Feb. 17, 1915, we gave the preliminary findings of the "Committee on Edison Fire," appointed by the American Concrete Institute. This committee consisted of Cass Gilbert (chairman), Walter Cook, W. H. Ham, Richard L. Humphrey, Rudolph P. Miller, C. L. Norton, J. Knox Taylor, and E. J. Moore (secretary). The following data, which were abstracted from the preliminary report of the committee, will be found of value to engineers and builders:

GENERAL DATA ON THE REINFORCED CONCRETE BUILDINGS.

The reinforced concrete buildings within the burned area were constructed during 1905, 1906 and 1907, in the following order: Nos. 7, 15, 25, 13, 24, 12 and 11 (see Fig. 1). These buildings are of the beam-and-girder type; the columns are square or rectangular in section, with the exception of those in the first and second stories of building No. 7, which are circular; the walls have the usual window openings extending from column to column (the wall beams being cast with the floors and the curtain walls afterwards). The interior partitions were constructed of 3-in. and 4-in. plaster of Paris cinder block, plastered with Portland cement mortar. All window frames and sash were of wood, except those in the monitors of buildings Nos. 11 and 24, which were of metal; no wire glass was used. The interior metal covered wood doors did not fulfill the present requirements for proper fire doors.

Figure 2 shows typical floor plans of buildings Nos. 7, 11, 12, 13, 15, 24 and 25, and indicates the location of broken columns. Figure 3 shows typical floor, wall, girder and column details of building No. 11.

ORIGIN AND PROGRESS OF THE FIRE.

The fire started in one of the film inspection booths in the one-story wood frame building, No. 14 (Fig. 1), at about 5:25 p. m. At this time the wind was blowing from a point a little east of south, so that the fire quickly gained headway through the film stock and on the wood frame of the building, and spread to the lumber piles on the north and the three-story frame, box and cabinet making building on the west. There was a large stock of unfinished cabinets, bundles of wood veneer, etc., in building No. 18 and the lower stories of building No. 15, so that the fire by 6 or 6:30 p. m. had reached serious proportions. The brick walls of buildings Nos. 19 and 21 and the concrete walls of building No. 12 seem to have checked the fire for a time in the region of building No. 18. The exterior and interior walls and partitions in the first and second stories of buildings Nos. 13 and 15 were at first effective in resisting the progress of the fire, but it spread rapidly through windows to the third, fourth and fifth stories of these buildings, which presented an undivided area, and traveled east against the wind through the Lakeside Ave. ends of these buildings. At 7 o'clock the fire had entered the Lakeside Ave. end of building No. 11 in the three upper stories and continued through to the east end of building No. 11 and then north through this building. A section of three upper stories of this building, which seems to have been subjected to fire not more than 1½ hours, collapsed at 8:30. At 9 o'clock the fire reached its height in the three upper stories of the main portion of building No. 11. In the meantime the finished cabinet stock in the first story of the same building had caught fire from the adjoining buildings on the west, and the fire spread through to building No. 10 and thence up the wood enclosure at the north end of building No. 11. By 9 o'clock the two northerly bays of this building were burning brightly in all stories and a section near the center was being attacked by the fire from both directions. At this time the roof of building No. 10 had collapsed and the fire was traveling against the wind along the roof of building No. 8, on Alden St., towards building No. 6. The fire did not reach building No. 7 until between 9 and 10 o'clock, and the roof of building No. 6 did not fall until after 10 o'clock. At about 9 o'clock the fire had started in the second floor of the Lakeside Ave. end of building No. 11, adjacent to building No. 13. The fire in the first story of building No. 11, in the Lakeside Ave. end, did not start until after 10 o'clock; the indications are that the damage in this story was due to the exceedingly hot fire from the burning of the adjacent portion of building No. 6, which had a wood frame in the second story, and was used for film manufacture. This was connected to third story of building No. 7 by an inclined passageway.

Mr. Edison gave the committee the following explanation of the collapse of the east end of building No. 11: On the fourth floor of building No. 11 were large wooden plating vats containing nitric, hydrochloric and sulphuric acids; as these vats were consumed by the fire the acids were released, combining to form aqua regia, and attacked the concrete of the columns below, causing their collapse.

At the other end of the burned area the progress of the fire was at first more rapid; by 7 o'clock it was general in buildings Nos. 19 and 20; by 8 o'clock it had destroyed these buildings, and was at its height in the top story of building No. 24, but was being held at the east end in the lower stories of this building. After reaching the west end of the top story of this building the fire traveled to the lower stories down the temporary wooden enclosure and worked back to the fire coming through the lower stories of the building. By 9:30 the temporary west end enclosure had burned, and by 10:30 there was comparatively little fire in this building except in the second story and at the extreme west end of first story. The office building (No. 25) caught fire at the extreme east end about 7 o'clock, and was not extinguished until 11 o'clock. The principal efforts by the fire department were directed to this building in order to prevent the fire spreading to the laboratory, on the west and the storage battery buildings on the opposite side of Lakeside Ave.

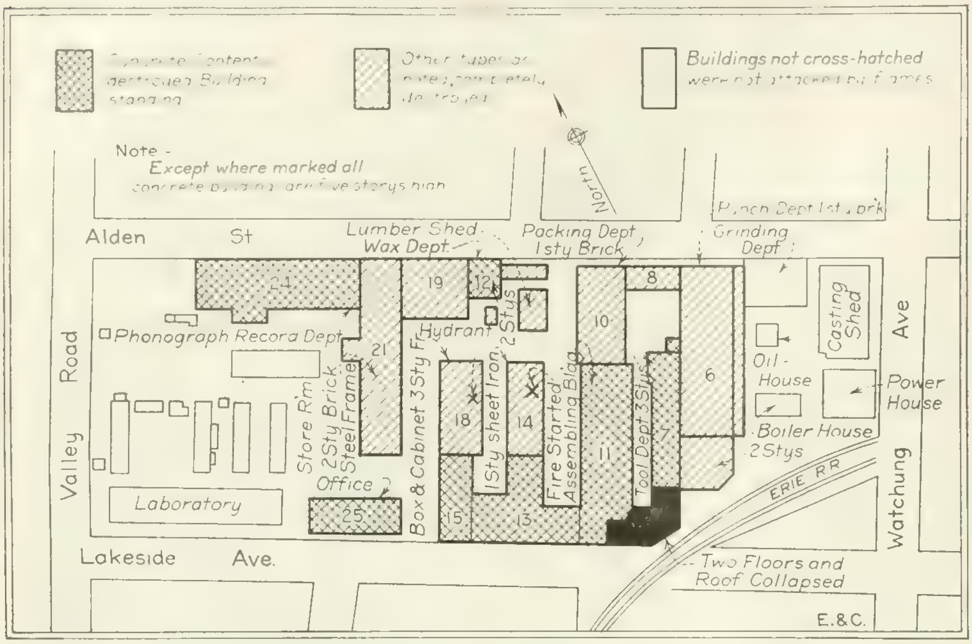


Fig. 1. Layout of Plant of Thomas A. Edison, Inc., West Orange, N. J., Showing Location of Burned Area and Types of Buildings Affected.

SEVERITY OF FIRE.

Melted copper and brass were found in nearly all of the buildings reached by the fire, and several pieces of fused iron were also found. In nearly all of the concrete buildings melted glass was found on the window sills. The concrete in the wall columns was less damaged by spalling than that in the interior columns and the ceiling beams, which would indicate that the heat in the interior of different stories was much greater than near the walls. The hottest fire and the highest temperature were apparently reached in the three-story frame building (No. 18), where the top of the iron hydrant, near the east side, was melted. During the burning of this building the critical point in the progress of the fire was reached, and it got beyond control. The highest temperatures in the concrete buildings were reached in the west end on the third floor of building No. 24, where was stored a very large quantity of highly combustible material. In this building whereever a wood top floor was used it was in all cases entirely consumed, together with the wood sleepers embedded in cinder concrete. In the lower floor of building No. 11, in which the interior columns showed the greatest damage, it is evident that extraordinarily high temperatures were obtained; in this portion of the building where the damage was greatest the finished cabinet stock, piled to the ceiling, was entirely consumed.

The slagging of concrete during the fire in building No. 12 was unquestionably due to the materials used in the process of manufacture at this point, and this is still under investigation.

The fused metal found in different parts of reinforced concrete buildings would seem to indicate that the fire reached an intensity of 1,000° F. in all these buildings, and in many cases as high as 2,000° F. In the third story of building No. 24, the second and third stories of building No. 15, and the first story of building No. 11, temperatures in excess of 2,500° F. were reached.

BEHAVIOR OF CONCRETE IN THE FIRE.

In general, under ordinary conditions of fire exposure, the concrete, although cracked, was not damaged to any great extent. Where the fire was intense and of considerable duration, the damage to the concrete was very much greater. The variable effect of heat is shown very distinctly on the interior columns in the following way:

The columns in the office building where a small amount of combustible material was stored are little damaged. The same effect is found in the machine shop, where non-combustible occupancy caused lower temperatures. Where the fire was most intense, the interior column corners were spalled as described below. The damage to the concrete forming the columns (square in section) was very general in these stories where intense fire occurred. The concrete at the corners either spalled or cracked away from the center core of the column, which, with two exceptions, maintained its structural integrity. This spalling or cracking at the corners varied in amount from 1 to 3 to 4 ins., which generally left a column approximating an octagonal or circular section. In many cases the separation of the concrete at the corners of the column was along the line of the vertical reinforcement, but in very many cases the reinforcement was not exposed. In this connection, it should be noted that the piers supporting the carpenter shop, which were not reinforced, were similarly spalled at the corners. The end walls in the three upper floors of buildings Nos. 13 and 15 were of reinforced concrete 8 ins. thick and extended above the roofs of the adjoining buildings, which were completely destroyed; while this was in the hottest part of the fire, these walls were practically undamaged and are an admirable demonstration of the value of concrete walls as a fire barrier.

The behavior of the concrete under the unusual conditions of this fire fully demonstrated that it is an admirable material for fireproofing purposes, because of its very low heat conductivity and its toughness.

The intensity of the fire and the rapidity with which it traveled through the buildings subjected the concrete to extremely rapid expansion. Building stone, under similar conditions of rapid expansion, splinters and spalls, and while concrete is much tougher, it is subject to the same action. This action is proportional to the brittleness of the material. Under the conditions prevailing in a fire of usual severity there is an opportunity for concrete to adjust itself to increase in temperature and the danger of spalling is, therefore, greatly reduced.

There seems to be a general feeling that the damage to wall columns was the result of the application of water to the heated concrete. The evidence available does not confirm this as a primary cause, as it is known that no water was played on some of the wall columns which were damaged.

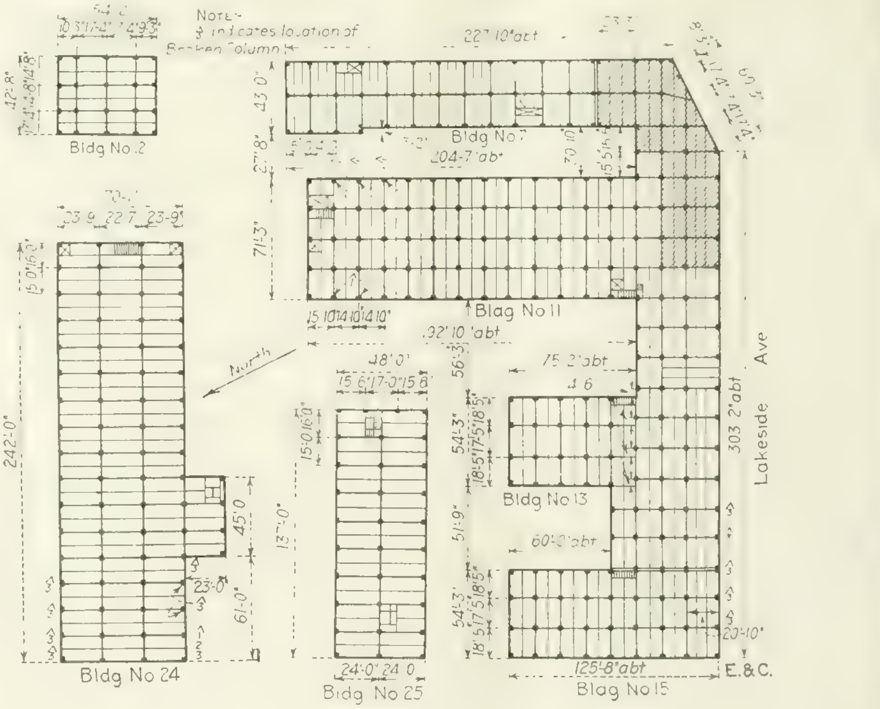


Fig. 2. Typical Floor Plans of Buildings Nos. 7, 11, 12, 13, 15, 24 and 25—Plant of Thomas A. Edison, Inc.

The question of the expansion of structures from intense heat applied over large areas is one that deserves most careful consideration, and is a matter upon which very little information is available. Careful study is being made for the purpose of contributing information on this subject. The San Francisco fire showed, to a limited extent, the effect of expansion on structures, but most of the available information applies to relatively small units; the Edison fire is one of the first cases where an opportunity has been afforded to study the effect in long buildings under conditions of a conflagration in which extreme temperatures have developed. In a study of the character it is unfortunate that comparison with some other type of construction could not have been included, but it is believed that concrete stood these unusual conditions at least as well as could reasonably have been expected of any other material.

Many statements have been made as to the depth of calcination of the concrete, but no one is competent to say whether the damage from this heat action extended any considerable distance below the surface of the concrete. At local points—for example, building No. 12, where extraordinary conditions prevailed—the slagging of the concrete, which also carried with it the destruction of other materials, is not considered in this analysis. It will further be recognized that the large area of concrete buildings standing permitted rather an unusual opportunity for securing a number of examples where the damage had been apparently great, and in a fair analysis, due consideration should be given to the fact that in the greatest portion of these buildings the concrete remained firm and hard and intact after this severe heat treatment.

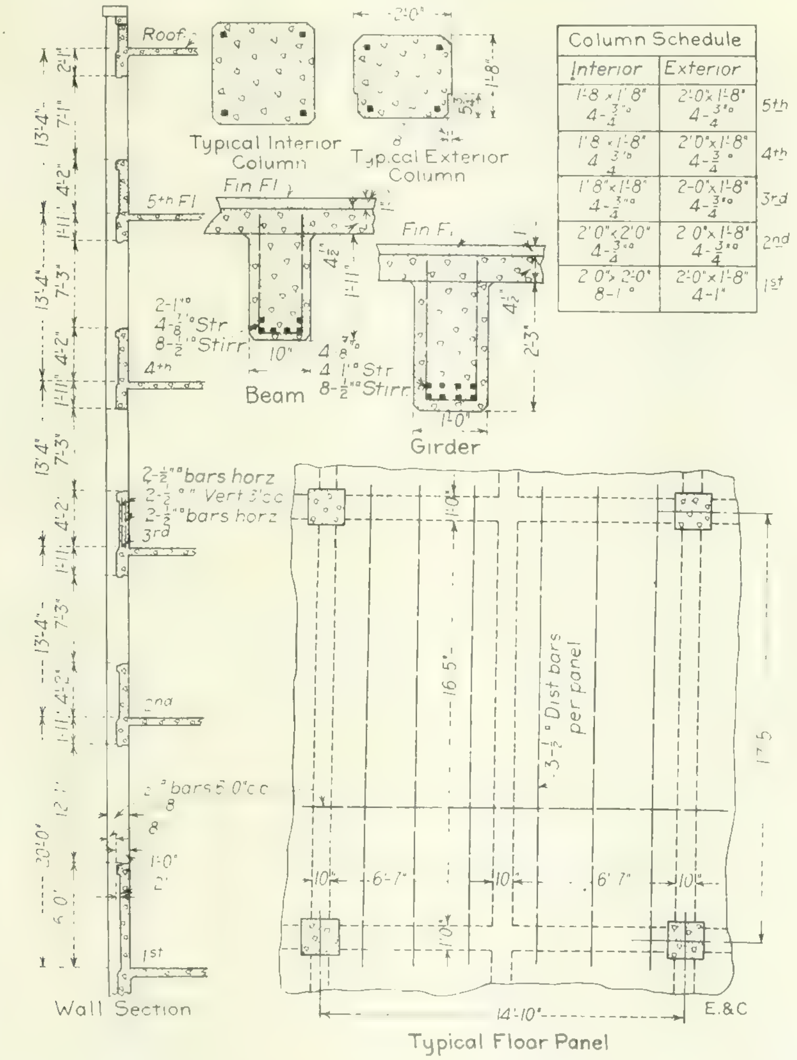


Fig. 3. Typical Floor, Wall, Column and Girder Details of Building No. 11.

BEHAVIOR OF OTHER PARTS OF CONCRETE BUILDINGS.

The 3 and 4-in. plaster of Paris cinder blocks which were used in the interior partitions and for stair and elevator enclosures were all damaged, and under severe exposure were completely destroyed. Such tin-clad doors as had been installed were 1 to 1½-in. thick, and did not conform to the present requirements for proper fire doors, and in no case did they offer substantial resistance to the fire. The windows with wood frames and sash, glazed with plain glass, which were used throughout (with the exception of the monitors in building No. 24 where metal frames and sash were used with plain ribbed glass), gave little resistance to the fire, the wood frames and sash being quickly consumed. The metal frames and sash in buildings Nos. 11 and 24 were badly damaged, while the glass was, in nearly every instance, melted out of the sash. The wood topping on concrete floors, including the sleepers, was entirely consumed.

DAMAGE TO CONCRETE IN EACH BUILDING.

The cracking of the concrete at the corners of interior columns was quite general and to a very limited extent occurred also at the underside of beams and girders. Table I gives a summary of the extent of the damage to the concrete, the data being taken from the report of the fire made by the National Fire Protection Association. Floor slabs were in general not damaged by the fire other than that small cracks were to be noted on the underside along the lines of the reinforcement; the concrete, however, seemed to be sound and there was practically no spalling. The roof slabs generally expanded from the beams and girders along the ridge of the roof.

The damage to beams and girders was at the bottom and was most severe along the edges, being quite general in the line of the reinforcement; the concrete usually remained in place and afforded protection to the reinforcement; on the sides it was practically undamaged.

It was noted that in the beams and girders, and frequently in the columns, expansion bolts or other metallic connections for attaching piping, shafting, etc., to the structure had been embedded in the concrete in such a manner as to form a direct heat connection to the reinforcement; and it is apparent that it is not good practice to embed metallic connections in such a way that they may become mediums for the transmission of heat into the interior.

The most serious damage to the reinforced concrete work was in the wall columns near the ends of the buildings. This is especially true on the Lakeside Ave. fronts of buildings Nos. 11 and 15; first story of the north end of building No. 11; and the third story of both sides of building No. 24. The broken portions of all these fractured wall columns indicate that there was a movement of the portion of the building above the fracture in a horizontal direction from the center of the building toward the ends, and the data obtained, showing the progress of the fire, indicates that the portion of the building above the fracture was heated prior to that below. A witness of the failure of a section of building No. 11 noted that first two wall columns failed, followed by failure of interior columns and general collapse of three upper floors. Further evidence of the horizontal movement of the portion of the building above the broken columns was the V-shaped space where the curtain walls joined the wall columns, which was very pronounced near the ends of the buildings. Measurements, taken after the concrete had cooled, from plumb lines dropped from the corners of the buildings indicated that the corner columns had returned nearly to their former position. The several wall columns which failed indicated that this was primarily due to the fact that the expansion of the building above was greater than that below the fracture; and since in all cases the distance from the center of the building to the point near which the columns were broken was greater than 100 ft. and the free expansion for this distance for a difference in temperature of 1,000° would be over 6 ins., it would seem likely that this expansion was a factor in the failure of these wall columns. Failure of the wall columns (vertically over each other in the first, second, and third floors) occurred in the south side near the west end of building No. 24. From the record of the progress of the fire the main failure probably occurred first in the third floor, followed by failure in the second floor, and later by failure in the first floor. The most remarkable feature, to be observed after the fire, was that the monolithic construction was such as to transfer the load which these fractured wall columns had carried either to adjacent interior columns or adjacent wall columns,

TABLE I DATA GIVING NUMBER AND PERCENTAGE OF DAMAGED COLUMNS

Building and floor	Total No. of cols.	No. intact	Cols. badly spalled.	Spalled to reinforcement	Failed	Per cent seriously injured, including failures	Per cent of failures
No 21—							
1st	73	66	3	2	2	9.6	2.7
2nd	73	58	9	3	3	20.5	4.1
3rd	73	43	13	7	10	41.1	13.7
4th	73	63	6	0	4	13.7	5.5
5th	73	1[illegible]		—	—*—	—	
No. 11, 13, 15—							
1st	199	120	17	56	6	39.7	3.0
2nd	199	160	18	18	3	19.6	1.5
3rd	199	116	16	39	28	41.7	14.07
4th	199	120	42	13	24	39.7	12.06
5th	199	159	16		24	20.1	12.06

*Interior columns on this floor were 3 16 x 8 in. pipe, concrete filled. All except two were deflected 1 to 3 ins.

Columns noted as intact include those having surface cracks not of a serious nature.

Columns noted as spalled include those where concrete is so separated from body of column by cracks as to be of no structural value, even if the material has not actually fallen off.

Per cent seriously injured does not include those that failed.

Columns classed as failed are those which have lost their ability to carry load.

probably the former. In the former case the floor construction, with stiff connections to columns, acted as a cantilever above the broken columns to transmit the load back to the interior columns. In the latter case the wall construction acted as an arch or truss in transferring the load to the wall columns on either side of those broken. Where the wall columns had failed it was noted that generally the adjacent end columns had not. This is probably due to the lesser load on the end column and the absence of restraint by the curtain wall.

Interior columns of the reinforced concrete buildings were all square in section with the exception of those in building No. 7, which are circular in the first and second stories. Damage to the concrete at the corners of square columns was very general in those stories where fire occurred. Only two interior columns failed,—one in the first story of building No. 11 near the south end of building No. 7; this column is in line with the inside court wall of the Lakeside Ave. wings of buildings Nos. 11 and 13, and the primary cause of failure was probably similar to that for the other wall columns. The second interior column which failed is in the third story of building No. 24, at which point there was an extremely hot fire, and in addition this column was overloaded by additional loads thrown upon it by failure of the adjacent wall columns. The general damage to the interior columns seems to have been primarily due to the fact that the surface of the concrete expanded much more rapidly than that in the interior of the column. This expansion along the longitudinal surface of the column, in addition to the lateral expansion developed by the extremely rapid heating of the two faces at each corner, caused the spalling noted. Damage of the same character, although to a lesser degree, to the edges and the bottom of beams and girders also resulted under these conditions; although it should be noted that in the case of the beams and girders the concrete was not at the time in compression but in tension, and this probably explains the lesser damage.

There were two types of round columns in these buildings: The first was the "Lally" column, which supported the roof of building No. 24. This column consists of a wrought iron pipe forming an outer shell which is filled with concrete. The intense heat in the floor of this building expanded the outer shell so rapidly that it blistered and flowed so as to form an annular bulge. The utility of this shell for structural purposes was destroyed, and the concrete core in most cases carried the load; in some cases the column buckled as a result of the heat and failed.

The other type of column having a circular section was that in use in the two lower stories of building No. 7. This column consists of an outer shell of punched metal lath covered with 1 in. of Portland cement plaster and of a core of reinforced concrete. While the actual strength of the column after the fire can only be determined from tests, it is evident that these columns maintained their structural integrity and successfully performed the function as supports for these floors, and further, gave evidence which indicates that a column of circular form is preferable to one of square section. While the fire in this building was not as severe as in some of the other reinforced concrete buildings, it was noted that at the elevator shaft, where the fire conditions were alike in the two lower stories with circular columns and in the top story square columns, the corners of the square columns were damaged (similar to the damage to square columns in other buildings), while there was very little damage to the circular columns. The damage to circular columns consisted in the pitting and spalling of surface of the cement plaster.

There was an apparent lack of stiffness in the floors, which was undoubtedly due largely to the casting of the slabs and beams and girders separately, which was probably a contributing cause to the sagging in some of the floors. Reinforced concrete is most efficient as monolithic construction, and buildings of this character require, in order to develop the full strength of the structure, a positive bond between the slab and the floor frame.

EFFECT OF DESIGN ON PORTIONS DAMAGED BY THE FIRE.

There seems to be a general tendency to criticize the design of these reinforced concrete buildings, but it does not appear that this was a serious factor in the damage to the concrete; and it should be noted that most of the details which characterize this design were those in use at the time these buildings were constructed; that is, this design should not be criticized from the viewpoint of current practice, but rather from the practice at the time the buildings were designed. Comment is here made on the following points usually the subject of this criticism:

(1) The stirrups used in the beams and girders consisted of two "L" sections lapped under the main reinforcement instead of the usual "U" section. This detail is not objectionable on account of its strength, because it gives a stronger anchorage at the bottom of the beam or girder than is usually obtained; but better anchorage to the slab should have been provided.

(2) The vertical reinforcements in all columns was not provided with the usual metallic ties. If such ties had been used they probably would have held the concrete together, but would not have prevented the damage to the exterior shell of the column. After the heat reached the reinforcement it was absorbed faster than by the surrounding concrete, and the swelling of this metal, while not a primary cause of the damage to the concrete at the corners of columns, did result in serious stripping of the concrete from the columns in many places.

ESTIMATE OF COST TO RESTORE ALL REINFORCED CONCRETE WORK.

In view of the uncertainty as to the damage done and the repairs necessary, which can only be determined after load tests and a more complete investigation, it is impossible to state the exact cost of the restoration. The officials of the Thomas A. Edison, Inc., state that the salvage in machinery in the reinforced concrete buildings will be at least 94 per cent; of the buildings, 87 per cent; and the cost for the restoration of these buildings from 10 to 15 per cent.

Results of Some Tests to Determine the Effect of Normal and Low Temperatures on the Strength of Cement Mortar.

(Contributed.)

We are indebted to the Aberthaw Construction Co., Boston, Mass., for the accompanying data on the results of tests planned by them to determine the action of normal and low temperatures on the strength of cement mortar briquettes. The tests were in charge of Herbert L. Sherman, who was engaged by that company. The series of tests was intended to parallel, as closely as possible, the conditions existing on building construction carried on in winter weather.

It was desired to learn what heating was necessary to make concrete sufficiently strong so that forms might be drawn, and to determine the strength of concrete under different treatments. It was considered of particular value to learn whether concrete, which had been heated for several days and then allowed to cool to the temperature of the winter air, increased in strength; and if so how fast and how much. This parallels the common practice of heating a concrete building for some days, and then leaving it unheated. If the tests indicated that concrete does not increase in strength after the heat is removed, or if it increases only very gradually, then there would be little reason for leaving the forms in place beyond the period of heating. For example, if the concrete does not increase in strength after five days of heating, then the strength of the concrete would be that of six-day-old heated concrete, even if the forms are left in place during cold weather for three or four weeks. Leaving the forms in place would mean a waste of money if conditions are entirely safe at the end of six days.

No claim is made that this series of tests is complete, or that it proves anything definitely. It simply shows the strength of this particular set of briquettes, made in the way described.

It is to be noted that the interior of a mass of concrete is protected by the exterior, and that the effect of cold upon a small briquette is more sudden and more thorough than it would be on a large mass of concrete. It must be recognized that concrete throws off heat in setting, and that this setting heat helps force the set of the concrete. It is desirable to study the matter further with full-size sections of concrete. It is probably fair to reason that a full-size section is less seriously affected than the small briquette.

It is to be remembered that, in heating a concrete structure, the ceiling and upper sections of the columns are kept very much hotter than the lower sections of the columns, particularly the lower part of the wall columns. And it is very common to design the wall columns with reference to architectural treatment, very often making them much larger than is necessary to carry their loads. This feature has probably saved many failures.

DETAILS OF TESTS.

In all the tests there was used a mixture of several brands of "Lehigh Valley" cement and standard "Ottawa" sand. All briquettes were mixed at the same time by the same man, in a room in which the temperature was approximately 72°. All briquettes which were held between 40° and 70° were kept moist. The briquettes were tested in a standard machine. The frozen briquettes were allowed to thaw out before testing. All temperatures are Fahrenheit.

TEST NO. 1.

For purposes of comparison the briquettes were made of 1 part cement and 2 parts sand, gaged with water. The materials were approximately at 72° F. when mixed, and after molding, the briquettes were kept at a nearly constant temperature of 72°. Table I gives the results of these tests.

TABLE I.—RESULTS OF TEST NO. 1.

Age, days	Strength of individual briquettes, lbs.			Av. strength, lbs.
4	450	422	452	441
7	463	436	435	445
14	504	536	532	524
21	506	494	522	507
28	502	496	522	507
42	532	515	557	535
56	...	...	...	...
84	564	587	542	564

TEST NO. 2.

The mortar and materials were the same, and were mixed under the same conditions, as for test No. 1. The briquettes were kept at 72° for four days, and were then placed in cold storage at a uniform temperature of 29° until the time of breaking.

TABLE II.—RESULTS OF TEST NO. 2.

Age, days.	Strength of individual briquettes, lbs.			Av. strength lbs.
4	450	422	452	441
7	404	425	427	419
14	467	492	492	484
21	437	450	464	450
28	436	412	394	414
42	430	473	465	456
56	501	522	533	519
84	543	541	538	541

TEST NO. 3.

The mortar and materials were the same, and were mixed under the same conditions, as for test No. 1. The briquettes were molded at 72°, they were kept at 40° for four days, and were then placed in cold storage at a temperature of 14° up to the time of breaking.

TABLE III.—RESULTS OF TEST NO. 3.

Age, days.	Strength of individual briquettes, lbs.			Av. strength. lbs.
4	328	333	354	338
7	305	336	334	325
14	315	326	335	325
21	304	335	348	329
28	304	315	298	306
42	378	362	385	375
56	367	382	407	385
84	463	410	426	433

TEST NOS. 4, 5 AND 6.

With the exception that a 5 per cent salt solution was used in the mortar instead of clear water, and that the tests were not continued beyond 28 days, tests Nos. 4, 5 and 6 parallel tests Nos. 1, 2 and 3, respectively. From the results of tests Nos. 4, 5 and 6 it was hoped to determine whether or not the presence of salt was any aid to the hardening of concrete at temperatures below the freezing point.

TABLE IV.—RESULTS OF TEST NO. 4.

Age, days.	Strength of individual briquettes, lbs.			Av. strength, lbs.
4	425	433	417	425
7	412	425	436	425
14	506	518	523	516
21	506	472	493	490
28	496	493	462	484

TABLE V.—RESULTS OF TEST NO. 5.

Age, days.	Strength of individual briquettes, lbs.			Av. strength, lbs.
4	425	433	417	425
7	386	367	360	371
14	458	442	437	446
21	456	486	455	466
28	442	415	424	427

TABLE VI.—RESULTS OF TEST NO. 6.

Age, days.	Strength of individual briquettes, lbs.			Av. strength, lbs.
4	325	304	311	313
7	360	356	344	353
14	346	355	364	355
21	412	414	426	417
28	374	394	375	381

TEST NO. 7.

Nine briquettes were made of the same materials, and under the same conditions, as for test No. 2, except that three of the briquettes were removed from the 29° temperature at the age of 7 days, three at the age of 14 days and three at the age of 21 days. All briquettes, after being removed from the 29° temperature, were kept at 72° until they reached the age of 28 days, when they were broken at the same time. Table VII gives the results of this test. From tests Nos. 7 and 8 it was hoped to determine whether or not concrete, which was first subjected for a limited period to warm weather, then frozen, then thawed out, would recover promptly and would become as hard as concrete subjected to summer conditions.

TABLE VII.—RESULTS OF TEST NO. 7.

Age, days.	Strength of individual briquettes, lbs.			Av. strength, lbs.
7—28	527	515	534	525
14—28	516	522	538	525
21—28	512	483	504	500

TEST NO 8.

Nine briquettes were made under the same conditions as for test No. 3, except that three of the briquettes were removed from the 14° temperature at the age of 7 days, three at the age of 14 days, and three at the age of 21 days. After being removed from the 14° temperature all of the briquettes were held at a temperature of 72° until they reached the age of 28 days, when they were broken at the same time. Table VIII gives the results of these tests.

TABLE VIII.—RESULTS OF TEST NO. 8.

Age, days.	Strength of individual briquettes, lbs.			Av. strength, lbs.
7—28	491	512	521	510
14—28	505	486	495	495
21—28	452	474	483	470

COMPARISON OF VARIOUS TESTS.

To facilitate a comparison of the various tests, Table IX, which records the average strength of the briquettes in each test, is given.

TABLE IX. COMPARISON OF RESULTS OF VARIOUS TESTS.

Age, days.	Test No. 1	2	3	4	5	6	7	8
	Average strength of briquettes.							
4	441	441	338	425	425	313		
7	445	419	325	425	371	353		
14	524	484	325	516	446	355		
21	507	450	329	490	466	417		
28	507	414	306	484	427	381		
42	535	456	375	...				
56	...	519	385					
84	564	541	433					
7—28							525	510
14—28							525	495
21—28							500	470

Data on the Operation of Ventilating Fans.

The extensive and increasing use of fans for ventilating purposes has created a demand for specific data on the use and operation of fans. The two types of fans in common use are known as the "centrifugal" and "propeller" fans, each type having its particular field, although they may overlap in some cases. The following data on ventilating fans, which were taken from a paper by C. L. Hubbard, in The Engineering Magazine, will be found of value.

TYPES OF FANS.

Centrifugal Fans.—The centrifugal type of fan includes the regular paddle-wheel blower or exhaust fan, the multivane fan, and the cone fan.

The first of these is the standard type, and it is used more widely than any other, although the multivane fan is rapidly coming into general use owing to its smaller size for a given capacity and to its higher efficiency.

Both of these types are positive in their action, and easily give the pressures required to force the air through long ducts at high velocities. They are used almost exclusively for air supply in all classes of large buildings and also for exhaust ventilation in shops, factories, office and municipal buildings, or wherever the vent flues and ducts offer considerable frictional resistance.

Cone fans are often used in schools and churches where large volumes of air are moved under comparatively low pressures. They are usually made to discharge into a large chamber from which distributing ducts lead to different parts of the building.

Propeller Fans.—Propeller fans are adapted to conditions where the air is drawn from large gathering chambers and is discharged directly outboard against a low resistance, as in the case of churches, schools, and hospitals. The smaller sizes are extensively used for local ventilation in rooms of various kinds. Propeller fans are light in construction, as compared with the centrifugal type, and are capable of handling large volumes of air with a small expenditure of power when operated under conditions for which they are designed.

FAN DRIVES.

Ventilating fans may be driven either by steam engines, turbines, or electric motors, according to circumstances. When the exhaust can be utilized in the heater, engines and turbines are usually more economical to operate where it is necessary to vary the fan speed to any great extent during different periods of the day. Where electricity is generated on the premises motors are usually employed for all fan work, especially where ventilation is provided throughout the year regardless of heating, and where the exhaust from the engine would be wasted during the summer. Again, considerations of convenience and quietness of action often lead to the use of motors even at an increased cost of operation.

MOTORS FOR VENTILATING WORK.

As it is usually desirable to provide a certain range of speed in the case of ventilating fans it is best to employ direct current motors when possible to obtain the best results, and machines of this type must always be used when direct connected to the fan shaft, on account of the low speed required.

Shunt motors on constant potential circuits are best adapted to fan work, being self-regulating and running at a sufficiently constant speed for all practical purposes.

CAPACITY OF CENTRIFUGAL FANS.

The capacity of a centrifugal fan depends upon the diameter and width, the speed, and the resistance against which it operates.

The following formulas are derived from an extended series of tests upon a standard blower of the paddle-wheel type, and give results corresponding very closely with those obtained in practice.

$$V = 2DNAB. \tag{1}$$

and

$$N = \frac{V}{2DAB}. \tag{2}$$

in which

V = cubic feet of air discharged per minute,
D = diameter of fan wheel, in feet,
N = revolutions per minute,
A = a factor, depending upon diameter of fan (see Table I),
B = a factor, depending upon resistance operated against (see Table II).

The values of A given in Table I are based upon the assumption that the width of the fan at the periphery is 0.5 of the diameter. If the width is greater than this, increase A in the same proportion. For example, if the width is 0.6 of the diameter for the make of fan used, multiply the tabulated value of A by $0.6 \div 0.5 = 1.2$.

TABLE I.—VALUES OF A IN FORMULAS 1 AND 2.

Diameter of fan, in feet.	Values of A.
3	2.9
3½	3.9
4	5.0
4½	6.2
5	7.6
6	10.7
7	14.1
8	18.6
9	23.4
10	28.7

The resistance against which a fan operates varies with the friction in the ducts, which in turn depends upon the length of run, the number of bends, and the velocity of air flow.

In assuming the factor B the following buildings are given as illustrating types in which the flue velocities and resulting resistances are similar. These factors are based on experience, and will vary with the depth of heater, velocity of air flow, length of ducts, and number of bends:

The lowest value (0.6) is for shops employing deep heaters from 20 to 28 pipes in depth, with high air velocities of 1,800 to 2,000 ft. per minute. The highest (0.9) applies to schools and churches with shallow heaters of open pattern and comparatively short ducts of large size. Between these extremes there is a wide variety of conditions where the factor for resistance must be estimated from experience.

TABLE II.—VALUES OF B IN FORMULAS 1 AND 2.

Type of building.	Value of B.
Shops, foundries, factories, etc.	0.6 to 0.7
Office and municipal buildings, hotels	0.7 to 0.8
Schools, churches and halls	0.8 to 0.9

The maximum speed at which a fan should run will depend, within certain limits, upon the quietness of action it is desired to maintain.

For ordinary conditions the limiting speeds given in Table III may be taken as corresponding well with practice, although with

TABLE III.—MAXIMUM SPEEDS FOR VARIOUS SIZES OF FANS.

Diameter of fan, in feet.	Maximum revolutions per minute. Shops and factories, approx. peripheral vel. [illegible] ft. per min.	Offices and municipal buildings, approx. peripheral vel. 1,50[illegible] ft. per min.	Schools and churches, approx. peripheral vel. [illegible] ft. per min.
3	600	490	380
3½	500	420	320
4	450	360	280
4½	400	320	250
5	360	280	220
6	300	260	200
7	270	220	170
8	240	190	150
9	210	170	130
10	190	150	120

well balanced fans, properly supported, the speeds given in the table may be slightly exceeded without undue vibration.

Table IV gives the cubic feet of air, in round numbers, delivered by fans of different diameters for the speeds given in Table III and for the values of B stated in Table II.

TABLE IV.—CAPACITIES OF VARIOUS SIZES OF FANS.

Diameter of fan, in feet.	Cubic feet of air per minute for speeds given in Table III.		
	Shops and factories, B = 0.6	Office and municipal buildings, B = 0.7	Schools and churches, B
3	6,200	5,900	5,300
3½	8,200	8,000	7,000
4	10,800	10,000	9,000
4½	13,400	12,500	11,200
5	16,400	14,900	13,400
6	24,600	23,300	20,500
7	32,700	31,000	27,400
8	42,800	39,600	35,700
9	53,000	50,000	43,800
10	65,100	60,000	55,000

Example 1.—What volume of air will be delivered by an 8-ft. fan at 200 r.p.m. when used for the ventilation of an office building?

In this case, $D = 8$, $N = 200$, $A = 18.6$, $B = 0.7$, from which, $V = 2 \times 8 \times 200 \times 18.6 \times 0.7 = 41{,}600$ cu. ft. per minute.

Example 2.—A shop building is to be supplied with 22,000 cu. ft. of air per minute. What should be the diameter and speed of fan?

Looking in the column for "Shops and Factories" in Table IV, it is found that this quantity comes between the limiting volumes given for 5-ft. and 6-ft. fans. As it is nearer the latter the larger size will be chosen. The next step is to compute the required speed. Here we have $V = 22{,}000$, $D = 6$, $A = 10.7$, and $B = 0.6$, from which,

$$N = \frac{22{,}000}{2 \times 6 \times 10.7 \times 0.6} = 286 \text{ r.p.m.}$$

In both of these examples the width of fan at the periphery has been assumed equal to 0.5 the diameter, which corresponds closely to the average fan of standard make.

POWER FOR DRIVING FANS.

The power required for driving a fan varies with a number of governing conditions; hence formulas applying with any degree of accuracy are somewhat cumbersome to use.

The curves given in Fig. 1 have been plotted from tables of horse powers and include the effects of speed, air volume, efficiency, etc. They are to be used in connection with the tables and formulas already given for capacity at different speeds.

Horse powers taken from the curves should be multiplied by the factors given in Table V to offset the effect of resistance.

TABLE V.—RESISTANCE FACTORS FOR USE IN CONNECTION WITH CURVES IN FIG. I.

Value of B.	HP. factor.
0.60	0.70
0.65	0.75
0.70	0.80
0.75	0.85
0.80	0.90
0.85	0.95
0.90	1.00

Example 3.—A factory requires a 7-ft. fan running at a speed of 260 r.p.m., to deliver the required volume of air based on a resistance factor of 0.65. What power of engine or motor should be provided?

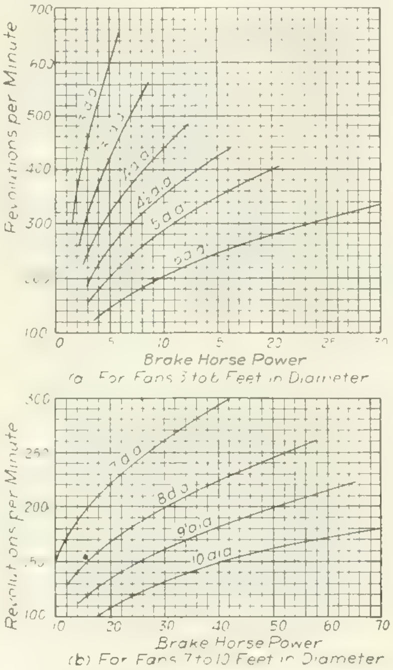
Figure 1 (b) shows that an 8-ft. fan requires 30 HP. at this speed, which, corrected for the effect of resistance, actually calls for 30 × 0.75 = 22.5 HP.

The effect of closing off the discharge outlet from a fan, or what is equivalent, increasing the resistance, is to reduce both the volume of air moved and the power required for maintaining a given speed. This holds good until the outlet is entirely closed, and the only power consumed is that used in churning the air within the fan casing.

THE ACTION OF MULTIVANE FANS.

As fans of this type vary considerably in form and general proportions, it is not possible to give working data which will apply to all makes with any degree of accuracy comparable to that which applies in the case of the paddle-wheel type.

In a general way the cubic space required for a multivane fan will be approximately one-half to two-thirds that required by the older type of the same capacity. Also, a multivane fan having the same outlet area as a paddle-wheel fan will deliver the same volume of air against a given resistance when running at about 65 per cent of the peripheral speed, and will require approximately 80 per cent as much power. While fans of this type run more quietly at higher speeds, they are actually operated in practice at lower peripheral velocities than the paddle-wheel fan, varying from 2,600 to 3,000 ft. per minute in the case of schoolhouses and churches, and 3,600 to 4,000 ft. in factory work. Under ordinary conditions static pressures of 1, 1½, and 2 ins. of water column may be assumed in schools, office buildings and factories, respectively, when determining size, speed, and power of fan from manufacturers' tables. Moreover, the best results are obtained with corresponding outlet velocities of about 1,600, 1,800, and 2,000 ft. per minute.



(a) For Fans 3 to 6 Feet in Diameter

(b) For Fans 7 to 10 Feet in Diameter

Fig. 1. **Curves Showing Horse Power Required to Operate Fans From 3 to 10 ft. in Diameter at Various Speeds—See Table V.**

TABLE VI.—STATIC PRESSURES, IN INCHES OF WATER COLUMN, FOR PIPES 100 FT. LONG, AT VARIOUS VELOCITIES.

Dia. of pipe, in ins.	Static pressures for pipes 100 ft. long at—			
	800 ft. per min.	1,200 ft. per min.	1,600 ft. per min.	2,000 ft. per min.
10	0.120	0.27	0.46	0.73
12	0.095	0.22	0.39	0.60
14	0.085	0.19	0.33	0.52
16	0.075	0.17	0.30	0.46
18	0.065	0.15	0.25	0.40
20	0.058	0.13	0.23	0.36
24	0.049	0.115	0.19	0.32
28	0.043	0.095	0.17	0.26
34	0.035	0.075	0.14	0.21
40	0.029	0.065	0.12	0.18
45	0.026	0.060	0.11	0.16
50	0.024	0.055	0.095	0.15
55	0.022	0.051	0.085	0.14
60	0.020	0.046	0.076	0.13
65	0.018	0.041	0.070	0.12
70	0.017	0.037	0.065	0.11
75	0.016	0.034	0.061	0.095
80	0.015	0.032	0.058	0.090

In specifying fans with which the engineer is not perfectly familiar it is usually best to state the volume of air to be moved per minute, the static pressure against which the fan is to operate, and the limiting peripheral velocity, rather than to give the size and speed. The static pressure in any given case may be approximately determined from Table VI, which gives the static pressure or resistance for round pipes 100 ft. in length for different velocities of air flow. For other lengths the resistance will vary in direct proportion, that is, for a pipe 200 ft. long the resistance will be twice as great, etc.

For velocities not given in Table VI values may be interpolated with sufficient accuracy.

When the duct is rectangular in section it may be reduced to a circular form having the same frictional area by the formula,

$$D = \frac{4AB}{2(A+B)},$$

in which D = diameter of the equivalent round duct, and A and B are the sides of the given rectangular duct.

The resistance offered by a 90° elbow will depend upon the radius of the inner curve, or throat, and may be taken as shown in Table VII.

TABLE VII.—RESISTANCES OFFERED BY 90° ELBOWS.

Radius, in diameters of pipe.	Length of straight pipe, in diameters, having same resistance.
¼	67
½	30
¾	16
1	10
1½	6
2	4.3

The resistances produced by standard pipe heaters of different depths are given in Table VIII, and for "Vento" cast-iron heaters in Table IX.

TABLE VIII.—RESISTANCE, IN INCHES OF WATER COLUMN, FOR PIPE HEATERS OF VARIOUS DEPTHS.

Air velocity in ft. per min.	Four rows.	Eight rows.	Twelve rows.	Sixteen rows.	Twenty rows.	Twenty-four rows.
800	0.05	0.09	0.13	0.18	0.22	0.26
1,000	0.08	0.15	0.21	0.28	0.35	0.41
1,200	0.12	0.21	0.30	0.40	0.50	0.59

TABLE IX. — RESISTANCE, IN INCHES OF WATER COLUMN, FOR VENTO HEATERS OF VARIOUS DEPTHS.

Air velocity, in ft. per min.	One stack.	Two stacks.	Three stacks.	Four stacks.	Five stacks.	Six stacks.
800	0.37	0.70	0.103	0.135	0.167	0.200
1,000	0.59	0.109	0.160	0.221	0.262	0.313
1,200	0.84	0.157	0.230	0.303	0.376	0.449

In determining the pressure to be overcome in any given system the resistance is computed for the longest duct, including bends, and to this is added the resistance due to the heater. If an air washer is used, or the inlet duct is of any considerable length, the effect of these should also be included. When the main duct or trunk-line is reduced at intervals, it may be assumed that the smallest or extreme section of the duct is carried back to the fan independently, and the resistance computed on this basis.

Example 4.—The last section of an air duct is 18 × 24 ins., the extreme length of run 350 ft., and the air velocity through duct and heater 1,000 ft. per minute. There are four elbows with radii equal to one-half the diameter, and a pipe heater is employed, 16 rows in depth. What will be the total resistance against which the fan must operate?

Diameter of equivalent round pipe =

$$\frac{4 \times 18 \times 24}{2(18 + 24)} = 20.5 \text{ ins., which may be taken}$$

as 20 ins. Resistance for 100 ft. of straight pipe at 1,000 ft. per minute velocity, =

$$\frac{0.058 + 0.13}{2} = 0.094 \text{ ins. of water.}$$

Effective length of run =

$$350 + \frac{4 \times 30 \times 20}{12} = 550 \text{ ft.}$$

Resistance due to pipe, = 0.094 × 5.5 = 0.517 ins.; resistance due to heater (Table VIII) = 0.280 ins.; and total resistance = 0.517 + 0.280 = 0.797 ins. of water column.

In some fan tables the pressure is expressed in ounces per square inch instead of inches of water. This change may be made by multiplying inches of water by 0.58, which, in the above case, gives a pressure of approximately 0.8 × 0.58 = 0.464 ounces per square inch.

PROPELLER FANS

Tests show that when operated under the usual conditions of discharge ventilation, that is, connected with a system of ducts in which the velocity does not exceed about 700 ft. per minute, a propeller fan of good type will move the air a distance parallel to the shaft equal to about 0.7 the diameter of the fan per revolution. Moreover, the best results are obtained with a linear velocity through the fan of approximately 1,000 ft. per minute, which corresponds with the number of revolutions per minute, for fans of different size, given in Table X.

The above rule expressed as a formula is:

$V = 0.55 D^3 R$,

in which,

V = cubic feet of air moved per minute,
D = diameter of fan, in feet, and
R = revolutions per minute.

The power required for driving propeller fans under these conditions will run from 0.15 to 0.2 HP. per 1,000 cu. ft. of air moved per minute.

TABLE X. — REVOLUTIONS OF FAN PER MINUTE FOR AIR VELOCITY OF 1,000 FT. PER MINUTE.

Diameter of fan, in ft.	Approximate r.p.m. for lin. vel. of 1,000 ft. per min.
2	700
2½	575
3	475
3½	400
4	350
5	275
6	225
7	200
8	175

Example 5.—What volume of air will be discharged per minute by a 5-ft. fan at 270 r.p.m., and what horse power will be required to drive it?

Volume of air per minute = 0.55 × 5^3 × 270 = 18.562 cu. ft.

Horse power for driving the fan = 18.56 × 0.2 = 3.7.

Arbitration Provision for Building Contracts.

To the Editors: The need for an arbitration provision in all building contracts should by this time be universally recognized, for, apart entirely from considerations of relative intelligence, ability or responsibility of architect and contractor, one does ont need to be reminded that omniscience is not a human attribute. In view of the limitations of the human mind it would not be extreme to say that no building contract can reasonably promise the fair and equitable accomplishment of the purposes for which it is written without having a provision therein for arbitration of disputes arising between the parties thereto; and except in the case of public contracts where, for lack of definite provision in the statutes, there may be some question as to the right of public officials to delegate their powers of final decision or acceptance of work to other parties, it is rare nowadays that arbitration in some form is not provided in every contract. It is a matter of frequent observation, however, that arbitration clauses do not effectively accomplish that for which they are designed. For instance, a loose wording often admits to the board of arbitration men inexperienced in the work they are called upon to judge; but the principal cause of dissatisfaction with attempts at arbitration arises from delay either in getting the arbitration under way or in bringing it to a definite conclusion. It may be said that most arbitrations are requested on the part of the contractor, and it may likewise be stated that in a majority of cases he meets with reluctance, upon the part of the architect, acting as the agent of the owner, to recognize the necessity for arbitration. The resulting delays are generally far more expensive to the contractor than to the owner. The more insistent for arbitration the contractor becomes, against the architect's opposition, the wider opens the chasm between them, and the more thoroughly they distrust each other. Finding arbitration unavoidable under such circumstances, the affair becomes a battle of wits, with the architect in the sustained role of obstructionist; and if everything else fails he may yet secure delay without limit by appointing as his representative on the board of arbitration a man under instructions to delay negotiations as long as possible. Such tactics, because of the fact that arbitrators generally act out of friendship for the respective parties represented and therefore are not prone to spend more of their time on the matter than is absolutely necessary, are generally quite effective. The decision often drags until in desperation the contractor proceeds with his work and the controversy is deferred until, with the building complete and his bills to pay, he faces the alternative of a settlement on the architect's terms or a protracted lawsuit, which, while it may secure him justice, must to some extent damage his reputation with architects and owners.

These considerations emphasize the necessity for providing that the arbitrators shall be properly qualified judges of building operations; that the party making demand for arbitration shall in some positive way show his good faith; that the other party shall in turn be required to show his good faith by responding promptly; and that the board of arbitration shall be required to proceed expeditiously to the solution of the problems involved.

To meet these requirements the subjoined arbitration provision is suggested for insertion in building contracts, in the consideration of which let it be noted that the party making the demand must name his representative *at the time he makes the demand*, and that thereafter the time, within which the organization of the arbitrators must be effected and their deliberations concluded and decision rendered, is strictly limited. The provision is as follows:

> Should any dispute arise between the owner and contractor, or between the contractor and architect, as to the true meaning of the plans and specifications, or respecting the manner or sufficiency of the performance of any work thereunder, or respecting the character or value of extra work or work omitted, the questions in dispute shall, in the first instance, be decided by the architect; but should either party be dissatisfied with such decision the questions shall, on written demand of either party, delivered to the other or at his place of business, be submitted for decision to a board of arbitration consisting of three men experienced in the business of building, one to be named in the demand by the party making the demand, one by the other party within five days thereafter, and the third by these two within three days thereafter; these arbitrators to have plenary power and the decision of any two of them to be conclusive and binding on both parties to this contract. No dispute shall interfere with the progress of the general construction, but necessary work shall proceed under the direction of the architect and the decision of the arbitrators shall award adequate compensation therefor to the contractor. Neglect of either party to such dispute to appoint an arbitrator within five days after such demand for arbitration has been delivered shall operate as a waiver on his part of the right to have other arbitrators appointed, and the question shall thereupon be decided by the arbitrator named in the demand for arbitration, whose decision shall be conclusive and binding on both parties to this contract. The life of any board of arbitration shall be limited to fifteen (15) calendar days after the appointment of the second member thereof, unless extended by consent of both parties, and no person shall be qualified to sit on more than one board of arbitration to consider the same question. Each party shall pay the expense of the arbitrator appointed by him; all other expenses of arbitration to be paid by the losing party, except as may be otherwise determined by the board, which shall have discretion in this matter.

With the exception of the clause limiting the life of the board of arbitration and disqualifying the members of one board for service on another board to consider the same question, the foregoing provision in substantially the form given was about a year ago, at the instance of the writer, incorporated in the standard builders' contract of the General Contractors' Association of San Francisco and has met with general approval. The additional clause referred to appears quite necessary to round out the provision and render it "torpedo proof."

Very truly yours,
E. T. Thurston,
Manager, Thurston & Co.,
Constructing Engineers.

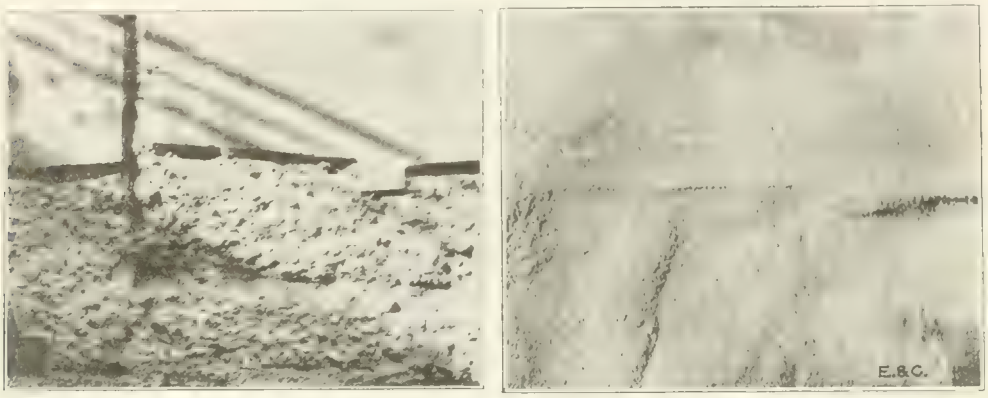
San Francisco, Cal., Feb. 4, 1915.

GENERAL

Mixing, Curing and Placing Concrete With High Pressure Steam.

A description of a machine for mixing and placing concrete by steam ejections was published in our issue of Nov. 25, 1914. At the convention of the American Concrete Institute further data on the work of this machine were given in a paper by Harold P. Brown and from this paper we take the following excerpts:

The process consists in thoroughly mixing measured amounts of cement, sand, broken stone and water in a cylinder, which is then filled with a hot gas or vapor under high pressure. Perfect hydration is thus secured and a most effective chemical action is set up which gives the product entirely new qualities. When the proper pressure and temperature have been reached and the curing process is completed, the outlet valve is opened and the plastic concrete is dropped into a superheated stream of rapidly-moving gas or vapor. The wet particles are separated from each other and can be carried several hundred feet in a rubber-lined hose to the point of deposit, which may be many feet above the mixer. The stream is projected through an expansible nozzle and strikes the work at high speed, thus tamping it and securing unusual density and strength. The blow jars out part of the water, and the high temperature and the sudden reduction of pressure cause rapid evaporation of the remaining moisture, so that quick setting is obtained. At first the stones or pebbles bound off, but when a layer of ½ in. or more has been deposited they imbed themselves and further tamp the work, making it adhere strongly to brick, stone, reinforcing steel or cold concrete. A thin slab made in this way has an almost metallic ring and is waterproof at heavy pressure. When the proper amount of water is used very little concrete falls away, and layers over 1 ft. thick have been placed at one time on vertical walls. More water is used in the final coat, which is thus made plastic enough for easy finishing. During each period of mixing a stream of superheated steam is kept flowing at low pressure through the outlet to keep the hose and the destination of the new work warm and moist. With careful handling excellent work can be done in freezing weather.



Figs. 1 and 2. Views Showing Cavity in Concrete Wall and the Same Cavity After Filling With Concrete Atomizer.

Figure 1 shows one of the many holes in a concrete retaining wall on the Lackawanna railway in Newark, N. J., where the deepest portion was 15 ins. Figure 2 shows the same place before screeding; this was filled in a single operation. Figure 3 is another view of the same work, showing the manner in which the stream was obtained from the locomotive of a work train. The picture shows two men at the nozzle, but the duty of the extra man was merely to keep an eye on the watchman who announced the approach of trains.

The machine which was used on this work was rented for several months by the Lackawanna railway and used in repairing defective and honeycombed work subject to tidewater at the Hoboken Terminal. Here compressed air was used, but in the repair work along the road steam was taken direct from the locomotive, thus saving the trouble and great expense of the cumbersome air compressor with its motor, receiver, regulator, water pump and tank. The road has recently purchased the apparatus for further extensive repairs and construction work.

One of the early experimental machines was used about two years ago on the New York Central and over 6,000 sq. ft. of structural steel was covered with from 2 to 6 ins. of concrete, applied with compressed air and with steam. All of this work has proved as hard as flint and not a single crack or fault has developed in it. This is true of all the work of my other larger machines.

When the atomizer was operated with air at another plant, a 60-HP. boiler was used to supply steam for the compressor, and it consumed about 400 lbs. of No. 3 buckwheat coal per hour, using forced draught and producing about 1 cu. ft. of concrete per minute. When steam was used direct instead of air, the same amount of work was done with natural draught and less than 100 lbs. of coal per hour used. The cost of the fuel for mixing, curing and placing 1 cu. yd. of concrete with this machine did not exceed 10 cts., and a boiler of 30 HP. would have been large enough for it.

When steam is used the mixing is done at a pressure of 75 to 80 lbs. with sufficient superheat to prevent condensation, thus maintaining the proper amount of water in the concrete. By increasing the amount of superheat to the proper degree, the steam issuing from the nozzle is kept in gaseous form so that the work deposited can easily be seen by the operator. The superheater can be located in the stack of the boiler if the work is nearby, or over a salamander if distant. Or when the boiler is operated at 180 to 200 lbs. pressure, a reducing valve is placed close to the machine and set for 85 lbs. pressure supply to the mixer, thus obtaining the required superheat.

A special grade of rubber is used for the hose lining and this is worn but very slightly by the concrete, since wet cement to quite an extent lubricates the surface. The writer has many feet of hose which is still in good condition after severe service for more than a year; it shows very little wear. Special couplings are used with no metal parts exposed to the concrete stream. To avoid delay through clogging of the hose, an expansible rubber nozzle is used whose size of opening is controlled by a lever in the hand of the operator. In case a pebble blocks the flow, a slight movement of the lever opens the passage to the full diameter of the hose and the obstruction is blown out. The pressure at the nozzle is about 45 lbs. and the stream of mingled vapor and concrete shields the operator from rebounding pebbles, while wooden ferrules on the nozzle levers protect his hands from the heat of the steam. A skillful operator can apply a thin, even layer of concrete almost as smooth as the scratch finish on plaster, or he can produce a surface lightly or heavily pebbled as may be desired. A glass finish can be given to the work by projecting it against an oiled sheet of planished metal.

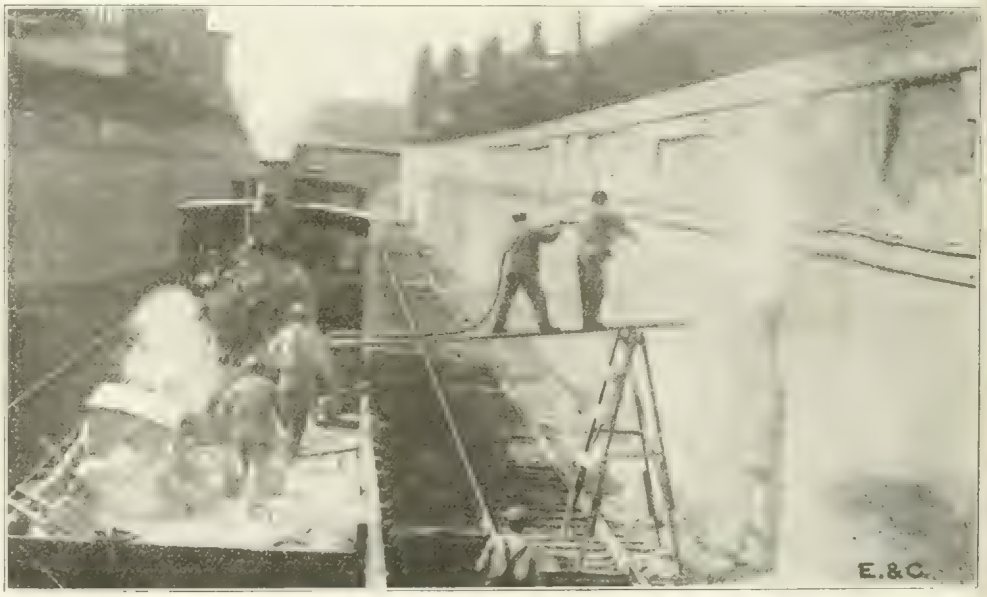


Fig. 3. View Showing Concrete Atomizer Repairing Concrete Wall.

The No. 2 Concrete Atomizer has a charging door either at one end or in a dome on the top. The driving shaft is square in section and carries a series of mixing paddles and scraping devices for keeping the surfaces clear. Ample clearance is given between the paddles and shell so that stones up to ¾ in. size can be used. In operation the rapid motion of the rotating parts keeps the air filled with flying particles of concrete. These particles are driven through the outlet valve and discharged into the hose, which is 1¾ ins. inside diameter. The speed of the engine automatically increases as the load grows less, so that the rate of discharge can be kept uniform. When the cylinder is nearly empty the tank pressure falls and its steam supply is shut off; the rest of the work is done by the expansion of the steam through the hose. The piston of the outlet valve is made to clear all material from its path when closing so that no dead passages are left in which concrete can set and block the pipes.

The No. 3 Concrete Atomizer is similar in construction and has a mixing tank 5 ft. long and 3 ft. inside diameter. It is designed to mix about 20 cu. ft. of loose materials with an output of 150 to 180 cu. ft. per hour; it will handle 1-in. stones. An engine of special design is used with this machine as the requirements of the service are unusual. The engine has a splash lubrication and is self-contained and powerful. It can be operated with compressed air when the machine is to be worked in tunnels or caissons where steam cannot be used. Even in this case the air can, if necessary, be superheated and the advantages secured of combined heat and pressure.

A prominent engineer is at present making careful records of the costs of curing and placing large masses of concrete with this machine and his report will in due time be submitted with full details of the tensile and crushing strength of the product. It must be remembered that the only additional cost of the product beyond the cost of ordinary power mixing, is the fuel required to heat the materials to about 350° and to convey the concrete through the hose to its place in the work. Operating with steam the cost of fuel and labor in mixing, treating and placing concrete with the small machine has been less than 80 cts. per cubic yard. With the larger machine the cost will be about 50 cents. It is often objected that the 15 per cent to 20 per cent greater density obtained by the process causes a correspondingly greater cost per cubic foot for materials. This is true, but as the strength of the product is multiplied by 2½ to 3, the section can be reduced at least 25 per cent and the cost of materials put on the same basis as ordinary work with a greatly increased factor of safety. The same result can be obtained by using less cement in the mix. The Concrete Atomizer can be used to replace the ordinary mixer, engine, hoisting apparatus, tower, chutes and runways in all kinds of light construction.

The Illinois Waterway — Proposed Eight Foot Channel from Lockport to Utica.

Passage of an act providing for an 8-ft. waterway from Lockport, Ill., to Utica, Ill., is urged in the message of Governor Dunne to the Illinois Legislature. The waterway called for is one recommended in a report by Lyman G. Cooley, Consulting Engineer; E. J. Kelley, Assistant Chief Engineer, Sanitary District of Chicago; Walter A. Shaw, C. E., member Illinois Public Utilities Commission, and Le Roy K. Sherman, C. E., member Illinois Rivers and Lakes Commission. This report follows:

At the present time a navigable depth of over 7 ft. exists normally for a distance of 262 miles of a total of 327 miles between Chicago and the Mississippi River. This distance of 65 miles between the Illinois River at La Salle and the Chicago Drainage Canal at Joliet is now limited to a draft of 4½ ft. through the Illinois and Michigan Canal.

Various projects following the Des Plaines and Illinois Rivers have been presented during the past 14 years, providing an adequate depth for navigation from the southern terminus of the Drainage Canal at Joliet to the Illinois River at La Salle. These projects have not matured. This has been due not so much to inherent defects in the projects or to lack of appreciation of the economic worth of the undertaking, but rather it has been due to undetermined legal factors affecting the available flow of water from the Drainage Canal and to opposition by water power claimants.

Your Board of Engineers has based its investigations upon the following premises: (a) That the proposed waterway be available for immediate construction and use. (b) That the construction now contemplated be in harmony with possible future developments, permitting an increase in size at such time as existing obstacles may be removed and as commerce may demand.

The Illinois and Michigan Canal may be utilized for this waterway in part or as a whole by deepening the channel and by enlarging the locks. Some of the existing locks may be dispensed with by constructing new locks of greater lift. The channel thus formed, however, is poorly adapted to future enlargements both as to increase in width and in depth, and the relative frequency of the locks limits the speed of water transportation by this route.

The Illinois River may be utilized in part for this waterway by raising the stage and by deepening its bed. The river waterway possesses advantages over the canal type in that it gives a greater present width and depth, is readily adapted to any desired future enlargement and creates a channel requiring a minimum for maintenance and operation and affording a maximum in waterway facilities. The greater speed of transportation in a river waterway of ample channel and unobstructed by frequent locks results in cheaper freight costs and consequent benefit to the public.

Three projects are presented herewith, each of which provides a navigable depth of at least 8 ft. from Joliet to La Salle.

Project I involves the deepening of the Illinois and Michigan Canal from Joliet to La Salle; the construction of new locks throughout and the construction of a new lock at the Sanitary District Power House at Lockport. The plan contemplates dispensing with some of the existing locks, namely, locks number 8, 10, 12, 13 and 15, while the remaining ones are replaced by locks of greater lift.

Project II involves the deepening of the Illinois River from La Salle to Starved Rock; the construction of a lock and dam in the Illinois River at Starved Rock; the construction of a connecting channel and lock between the Illinois River and the Illinois and Michigan Canal at Walbridge Creek, just below Marseilles; the improvement of the Illinois and Michigan Canal by deepening and constructing new locks from Marseilles to the southern terminus of the Drainage Canal at Joliet; and the construction of a new lock at the Sanitary District Power House at Lockport. This project utilizes the Illinois River as a waterway for 22 miles of the total distance of 65 miles from Joliet to La Salle.

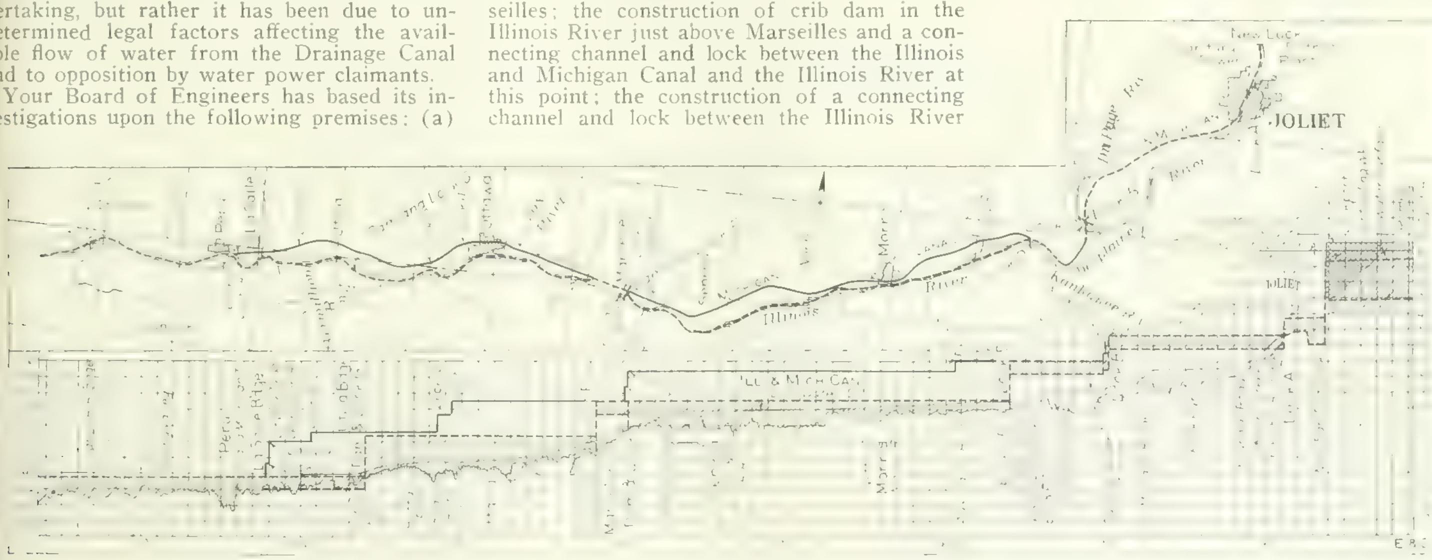
Project III involves the deepening of the Illinois River from La Salle to Starved Rock: the construction of lock and dam in the Illinois River at Starved Rock; the construction of a connecting channel and lock between the Illinois River and the Illinois and Michigan Canal at Walbridge Creek, just below Marseilles; the construction of crib dam in the Illinois River just above Marseilles and a connecting channel and lock between the Illinois and Michigan Canal and the Illinois River at this point; the construction of a connecting channel and lock between the Illinois River and the Illinois and Michigan Canal at a point just below Dresden; the improvement of the Illinois and Michigan Canal by deepening the bed and constructing new locks from Dresden to the southern terminus of the Drainage Canal at Joliet; and the construction of a new lock at the Sanitary District Power House at Lockport. This project utilizes the Illinois River as a waterway for 45 miles of the total distance of 65 miles from Joliet to La Salle.

In these projects, the channel of the Illinois and Michigan Canal is to remain 60 ft. in width at the water surface, is to be 36 ft. in width at the bottom and is to have a uniform depth of 8 ft. of water. The minimum width of the channel in the Illinois River is to be 150 ft. and the minimum depth of water 8 ft.

The locks contemplated in the Illinois River at Starved Rock and at the Sanitary District Power House at Lockport are to have a width of 55 ft., a length of 250 ft., and a depth of 8 ft., while the locks in the Illinois and Michigan Canal are to have a width of 45 ft., a length of 250 ft. and a depth of 8 ft. Locks of the dimensions adopted for the Illinois and Michigan Canal with a 12-ft. lift will cost approximately $90,000, while locks of the same lift and depth, but having a width of 35 ft. and a length of 170 ft., the size of those on the Hennepin Canal, would cost approximately $60,000.

The construction of the larger locks will permit employment upon the contemplated work and upon subsequent work on the waterway or large dredge boats in the Illinois and Mississippi Rivers as well as of those in the Great Lakes and will insure competition upon dredging contracts in the waterway unrestricted to one locality or to any one combination of contractors. Your Board of Engineers is, therefore, of the opinion that foresight and ultimate economy warrant the increased expenditure for the larger size locks even in the Illinois and Michigan Canal. The comparative estimated costs of the project follow:

Project I—	
Excavation, I. & M. Canal, Joliet to La Salle	$ 540,700
Locks in I. & M. Canal	766,200
Miscellaneous, I. & M. Canal.........	75,000
New lock at Sanitary District Power House, Lockport	300,000
Total estimated cost, say	$1,682,000
Project II—	
I. & M. Canal, Joliet to Walbridge Creek	$1,060,000
Dam, lock, etc., at Starved Rock....	1,583,000
New lock at Sanitary District Power House, Lockport	300,000
Total estimated cost, say..........	$2,944,000
Project III—	
I. & M. Canal, Joliet to Dresden	$ 509,480
Locks and river connections at Marseilles	682,130
Dam, lock, etc., at Starved Rock.....	1,583,000
New lock at Sanitary District Power House, Lockport	300,000
Total estimated cost, say..........	$3,075,000



Route of Proposed 8-ft. Waterway from Lockport to Utica, Ill.

The relative amounts in the foregoing estimates which are chargeable to rehabilitation in the Illinois and Michigan Canal and those which are chargeable to the Illinois Waterway under the Constitutional Amendment permitting the $20,000,000 bond issue, may be placed as follows:

	Chargeable to I. & M. Canal rehabilitation.	Chargeable to waterway.	Total cost.
Project I	$1,382,000	$ 300,000	$1,682,000
Project II	1,061,000	1,883,000	2,944,000
Project III	817,000	2,258,000	3,075,000

By modification in the design of the dam and at somewhat increased cost, electrical power may be generated at Starved Rock. The energy of the stream under the proposed conditions with a flow of 10,000 cu. ft. per second is 23,600 hp. on the turbine shaft. The cost of this power plant is not included in the foregoing estimates.

Your Board of Engineers recommends the adoption of the project herein outlined as Project III, since, at slightly increased cost, it provides a channel not only of greatest present efficiency, but one which best lends itself to future progressive development for future commercial needs. This project requires least for maintenance and operation, allows the highest speed of transportation and results in consequent lowest freight costs. The adoption of this project puts under immediate development the major portion of the ultimate Illinois Waterway.

Cost of Drilling With Well Drilling Machines in Ore Prospecting.

The data following are from two records of well drilling or churn drilling in prospecting for ore. While wages and prices are unusual, the data are so given that they can be used generally by substituting other figures. Both records are from the "Engineering and Mining Journal" but the data have been considerably rearranged.

Pacific Mines Corporation.—The figures here presented were compiled by C. H. Palmer, Jr., mining engineer, Los Angeles, Cal., from drilling operations recently completed at the property of the Pacific Mines Corporation, seven miles south of Ludlow, Cal., at which point the company's standard-gage railroad connects with the main line of the Atchison, Topeka & Santa Fe Railroad.

Twenty-four holes having an average depth of 258 ft. were drilled within a radius of 1,100 ft. to prospect the extension of the present orebodies, which dip gently to the north. A Star rig No. 23 was used, and holes were drilled with an 8¼-in. bit and 2½-in. manila drill cable. When casing was required the hole was continued with a 6-in. bit. The work was done by two drilling crews, each consisting of a driller and a helper. On days when it was necessary to move the rig, both crews assisted. The driller received $6 a day and his helper $4.80.

An average of the formation passed through consisted of:

Wash formation, ft.	21
Trachyte porphyry, ft.	210
Kaolinized hanging wall, ft.	4
Ore zone, ft.	18
Quartz-monzonite foot wall, ft.	5
	258

No difficulty was encountered in drilling these formations, although the hanging-wall material was sticky and the hard-ore zone necessitated sharpening the bit about every 5 feet.

The topography is mild within the radius drilled. The weather is hot in summer and the country arid, the water-supply being obtained at Ludlow for $1.50 per 1,000 gals. Coal costs $8.15 per ton delivered at the mine.

These holes required 45 lbs. of coal and 21.6 gals. of water per foot drilled. The costs do not include those for moving the rig for drill-hole set-ups, which amounted to $215 for coal and water and $263 for labor. The accompanying table gives the distribution of time in the drilling operations:

Total possible drilling hours—3,092

	Hr.	%.
Actual drilling	2,626	84.93
Casing	59	1.91
Removing casing	34	1.10
Repairing drilling machine and rope	141	4.56
Fishing for tools	19	0.61
Unforeseen delays	213	6.89
	3,092	100.00

(Moving the rig for set-ups took in all 527 hrs.)

The cost of drilling the 24 holes was divided as follows:

Item	Per ft	Pct. total.
Fuel, coal	$0.183	17.55
Oil and grease	0.007	0.66
Firebrick	0.007	0.66
Labor	0.598	57.31
Cable	0.111	10.62
Water	0.054	5.20
Coke	0.016	1.59
Repair parts and tools	0.042	3.99
Unclassified	0.025	2.42
Totals	$1.043	100.00

Wells Nos. 1 and 2, total footage drilled 811, having an average depth of 405 ft., were drilled for a water-supply for milling and domestic purposes, and were located about 5.5 miles east of the mine. The formation passed through consisted of wash, fine sand and clays. The costs and time distribution were as shown

Total possible drilling hours—703.

	Hr.	%.
Actual drilling	444	63.16
Casing	78	11.10
Repairing drilling machine and rope	81	11.52
Fishing for tools	58	8.25
Unforeseen delays	42	5.97
	703	100.00

(Moving the rig for set-ups took in all 149 hrs.)

These holes required 61 lb. of coal and 22.5 gal. of water per foot drilled. Moving the rig for drill-hole set-ups cost $51 for coal and water and $192 for labor in addition to the above figures.

The higher per-foot cost, in comparison with holes Nos. 1-24, was due to the necessity of casing both the wells, while the distance from supplies and shops added to the cost in the form of teaming and repairs, respectively.

The cost of drilling wells 1 and 2 was divided as follows:

Item.	Per ft.	Pct. total.
Fuel coal	$0.250	11.94
Oil and grease	0.013	0.61
Teaming	0.505	24.14
Labor	0.952	45.47
Cable	0.194	9.28
Water	0.057	2.71
Coke	0.016	0.77
Repair parts and tools	0.084	4.01
Unclassified	0.022	1.06
Totals	$2.093	100.00

Well No. 3, total footage drilled 572, was drilled on the southern edge of a dry lake 7.8 miles north of Ludlow, Cal., and a short distance west of the Tonopah & Tidewater R. R. Drilling was carried on under difficult conditions. The excessive heat, accompanied by high winds, partly accounts for the high labor charges noted below. One drilling crew was used. Eight-inch pipe was used to case the hole, which was necessitated by caving, caused by the encountering of salt water flows in the dark clays.

The material drilled consisted of:

Wash formation, ft.	70
Yellow clay, ft.	180
Dark, sticky clays, ft.	322
	572

The sticky clays made the progress slow and added to the water costs. Boulders also caused troubles and delays. Water was delivered to a point near the well by the T. & T. R. R. for $2.50 per 1,000 gallons. This hole required 100 lb. of coal and 61 gal. of water per foot drilled, the latter including the water used for the domestic purposes of two drillers for 95 days. The pipe was not recovered.

The cost of drilling well 3 was divided as follows:

Item.	Per ft.	Pct. total.
Fuel, coal	$0.407	9.26
Oil and grease	0.005	0.11
Firebrick	0.011	0.24
Labor	1.998	45.41
Cable	0.386	8.81
Water	0.174	3.95
Coke	0.023	0.55
Repair parts and tools	0.065	1.48
Teaming	0.294	6.71
Pipe	1.030	23.43
Unclassified	0.002	0.05
Totals	$4.395	100.00

While the preceding costs seem high, Mr. Palmer reports that they may be taken as a fair average by those contemplating drilling similar footages under the trying conditions of an arid country. Sand storms greatly hindered work on well No. 3 and excessive heat at night made sleep difficult. This decreased the efficiency of the drillers and is partly responsible for the high labor charges. An unavoidable loss of time resulted from these circumstances which had a corresponding effect of increasing the water and fuel costs. Wells Nos. 1 and 2 were drilled under more suitable conditions than well No. 3, although far from satisfactory for efficient labor returns. As all drill and domestic supplies had to be carried a distance of 5.5 miles over heavy roads, teaming charges were high. Conditions were more satisfactory for low costs while drilling holes Nos. 1 to 24 inc. Repair shops were at hand and living conditions were excellent. Boulders encountered in the wash formation retarded, however, the work; also drilling the hard-ore zone and monzonite, and often portions of the trachyte was very slow, which especially increased the fuel and labor charges.

Miami Copper Co.—Records of this Arizona mine for some five years as given by H. P. Bowen include about 44,500 ft. of churn drilling, consisting of 73 holes of an average depth of 605 ft. In this work two No. 23 Star traction machines, equipped with No. 24 boilers and derricks, were used. All holes were started with a 10-in. bit and in a few cases it was necessary to use the 4¼-in. tools to reach the desired depth. Two-inch manila rope was used in starting and this was replaced by ¾-in. steel drilling cable when water was encountered, which occurred usually at from 300 to 400 ft. One-half of the holes were drilled at the corners of 200-ft. squares and the others on 400-ft. squares. The drilling was divided into two 18-month periods, in each of which a nearly equal footage was drilled and the following scales of wages paid:

	1st period.	2nd period.
	12-hr. shift.	8-hr. shift.
Foreman, per month	$200.00	$200 00
Samplers, per month	100.00	100.00
Drillers, per shift	6.00	5.00
Helpers, per shift	4.80	4.00
	9-hr. shift.	8-hr. shift.
Laborers, per shift	$2.00	$2.15
Machinists, per shift	4.25	4.25
Carpenters, per shift	4.25	4.25
Blacksmiths, per shift	4.25	4.25

After the completion of the second drilling period, all tools, casing and repair parts were collected, repaired and stored. The drills were taken down and rebuilt on new frames, new parts being used where necessary, new tubes were placed in the boilers and the engines lined up. The machines were then housed-in, giving practically two new machines. Besides ordinary running expenses, the accompanying statements include the original cost of the machines and the cost of rebuilding them, the cost of all repair parts, tools, and casing charged out to churn drilling, whether actually used or not, the cost of two buildings, one for churn-drill supplies and the other in which the drills were stored. No credit has been allowed for the value of the rebuilt machines nor for the still serviceable tools, casing and supplies. The drilling cost of the two periods differed but slightly, the most noticeable variance being in the cost of repair parts which changed from 1c per ft. for the first period to over 5c. per ft. for the second.

COSTS OF DRILLING.

Item.	Per ft.
Churn drills	$0.849
Churn drill tools	0.2037
Wire drilling cable	0 0336
Sand line	0.0080
Manila rope	0.0658
Belting	0.0045
Casing and drive shoes	0.0872
Repair parts	0.0316
Coal and coke	0.2835
Lubricating oil and grease	0.0094
Iron and steel	0.0049
Galvanized and corrugated iron	0.0064
Bolts, nuts, washers, and rivets	0.0010
Timber and lumber	0.0136
Coal oil and gasoline	0.0059
Small tools	0 0019
Packing and waste	0.0019
Miscellaneous	0.0086
Pipe and fittings	0.0015
Sample sacks	0.0203
Sampler's supplies	0.0051
Engineering supplies	0.0037
Churn drill roads	0.4382
Water supply expense	0.0415
Foreman	0.1289
Engineers and draftsmen	0.0689
Samplers	0.1505
Drillers and helpers	0.6460
Tin and plate shop	0.0131
Blacksmiths	0.0130
Machinists	0.0165
Carpenters	0.0035
Miscellaneous labor	0.0135
Grinding and assaying samples	0.0394
Teaming	0.2376
	$2.6976
Supply warehouse	0.0097
Churn drill storehouse	0.0067
Casing racks	0.0028
Rebuilding machines, etc.	0.0379
	$2.7547

CHURN DRILL ROADS

Item	Per ft. of hole drilled
Explosives	$0.0321
Tools and drill steel	0.0063
Miscellaneous supplies	0.0017
Labor	0.3981
	$0.4382

WATER SUPPLY.

Item.	Per ft. of hole drilled.
Galvanized iron	$0.0032
Pipe and fittings	0.0256
Miscellaneous supplies	0.0013
Labor	0.0114
	$0.0415

REBUILDING AND REPAIRING.

Item.	
Foreman	$ 157.58
Drillers and helpers	498.50
Tinners and plate shop	53.81
Blacksmiths	24.78
Machinists	145.00
Carpenters	83.62
Miscellaneous labor	41.65
Teaming	199.96
Repair parts	415.20
Iron and steel	6.72
Bolts, nuts, washers, and rivets	8.46
Coal oil and gasoline	17.75
Small tools	3.07
Packing and waste	14.27
Miscellaneous supplies	9.77
	$1,680.14

Comparative Tests of Mud Capping and Block-Holing for Breaking Boulders.

Tests made by the Bureau of Mines give data of interest to contractors respecting boulder-breaking by the familiar method of adobe-shots and by block-holing.

Adobe shots were made on two high-grade limestone blocks cut from the same large block and weighing 215 and 203 lbs. Each block was approximately a cube, measuring 12½x12½x13 ins. The heavier block was selected for tests in the air. It was laid on two 6x6-in. timbers, and on the center of the top side a 50-gram 1¼-in. cartridge of the 40 per cent strength low-freezing dynamite was placed. A No. 6 electric detonator was inserted in the cartridge and laid parallel to the vertical bedding planes of the block. The charge was then covered with a 35-lb. mud cap consisting of 30 lbs. of dry fire clay mixed with 5 lbs. of water and fired. The block was not shattered on top, but pieces were split off around the sides. The other block was then immersed in a barrel of water having a temperature of 70° F. The water was 32 ins. deep, there being 13¼ ins. of water above the block. The charge was the same as in the previous trial except that no mud cap was used, and the charge was coated with paraffin in order to protect it from absorbing water. On firing no apparent damage was done to the block and no cracks were visible. This trial was then repeated on the same block immersed in water with a charge of 100 grams. This greater charge did not break up the block as much as did the 50-gram charge when the block was in air only.

Other similar tests confirming in every particular these tests, and again the confining effect of the surrounding material was shown. The above experimental proof is presented as a confirmation of practical experience that submarine blasting requires larger charges to disrupt a given amount of material than open work on similar materials.

Block-hole tests were made on two similar high-grade limestone blocks cut from the same large block and weighing 198 and 205 lbs. A hole 1 in. in diameter and 6 ins. deep was drilled from the center of one side to the center of the block. Each was charged with 5 grams of the 40 per cent strength low-freezing dynamite. A No. 6 electric detonator was used. The bore hole was filled with water in each case. The 198-lb. block was fired in air and the 205-lb. block was suspended in a barrel of water in the same manner as in the previous tests. Both blocks were broken. The following tabulation shows comparative results:

COMPARATIVE RESULTS OF ADOBE SHOTS ON LIMESTONE BLOCKS.

Condition of block.	Quantity of explosive used	Weight of block	Weight of largest piece	No. of pieces over 3 ins. in diameter.	Average weight of these pieces.	Total weight of small pieces.
	Grams.	Lbs.	Lbs.		Lbs.	Lbs.
In air	50	215	82	13	15.5	11
In water	*100	203	104	8	24.6	5

*After firing a 50-gram charge.

COMPARATIVE RESULTS OF BLOCK-HOLE TESTS WITH LIMESTONE BLOCKS.

	Grams.	Lbs.	Lbs.		Lbs.	Lbs.
In air	5	198	52	15	12.7	7
In water	5	205	59	11	18.2	5

ROADS AND STREETS

Methods and Cost of Constructing a Rolled Concrete Road in Washington.

This article discusses the methods and cost of constructing 9.5 miles of the Pacific Highway in Jackson County, Washington. In building the road an improved type of concrete roller was used, hydrated lime added to the concrete to increase the density of the pavement and facilitate handling and careful provision was made to check up the movement of the pavement under temperature changes and frost action. The road connects the towns of Central Point, Medford, Phoenix and Talent. The construction between each town is separately described. We are indebted to Henry L. Bowlby, state highway engineer of Washington, and his last published report for the data given in the article.

GRADING.

The road from Central Point to Medford was a wornout macadam, 2½ years old. The macadam had not been laid to a regular grade and numerous humps had to be removed and depressions filled. The loosening of the old surface had to be done with a traction engine and scarifier. The haul was long in many places. As it was necessary in sections to scarify only the crown, the use of the scarifier was not always practical, and hand picks were used for a large part of the work. On the three right-angle curves the new roadway left the old alignment entirely in easing off to a 200-ft. radius. Throughout the entire distance, the old road had been graded up quite high, leaving ditches on each side, but the roadbed was not of sufficient width. It was necessary to borrow dirt wherever it could be obtained to widen the shoulders to make a total width of roadway of 24 ft.

On the Medford-Talent section, the road had been graded and a strip of crushed rock laid most of the distance varying in width from 8 to 12 ft. There had been no attempt to make an even grade. In many places the crown was high and narrow and had to be graded down. The shoulders had to be widened the entire distance. In all places, except where the fills were large, the shoulders were made 8 ft. wide on each side, to allow teams to travel on an earth road if desired. This provides a 32-ft. roadway.

The cost of grading from Central Point to Talent, 16,581 cu. yds., was $14,324.00, or 86 cts. per cubic yard, or $1,510.00 per mile.

The high cost of the grading was due to the fact that the amount taken off from the surface of the road was very light and exceedingly hard.

CONSTRUCTION METHODS ON CENTRAL POINT-MEDFORD SECTION.

The first pavement laid was that between Central Point city limits and Medford, a distance of three miles. This road had been macadamized three years before at a cost of $12,000.00 per mile, and had completely gone to pieces. However, it was desired to make use of the old macadam base as much as possible. This required a large amount of hand work in scarifying the old surface.

The pavement is 16 ft. wide, and the depth of concrete where the sub-base was solid, is nowhere less than 4 ins. at edges, and 5 ins. at center, and generally it is 4½ and 5½ ins. thick at edge and center, respectively. It was laid in two courses, granite screenings being used as aggregate in the top course.

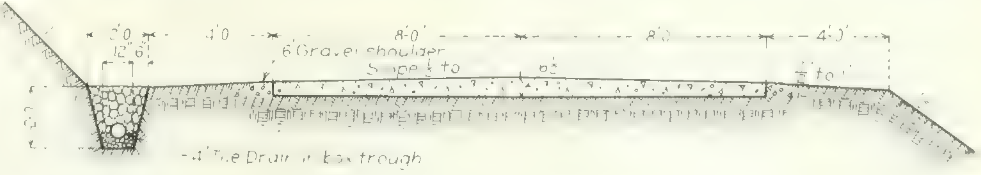


Fig. 1. Standard Cross Section for Concrete Roads.

Note.—This cross section was modified as described in the text

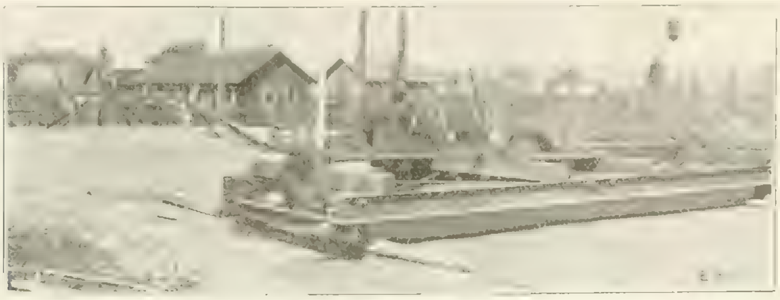
The sub-base was graded to a level section, water-soaked and rolled. The 4x4-in. form timbers were laid and fastened with 14-in. iron pins.

The sand and granite was hauled and dumped in piles upon the sub-base and the cement piled alongside. On this 3-mile section, the base consisted of granite passing a 1½-in. screen, crushed creek gravel and sand. The crushed gravel and sand were purchased from the Medford Concrete Construction Company, and hauled in wagons a maximum distance of three miles. The granite was shipped via the Southern Pacific Railway from Tolo to Crater Lake Junction, then switched to a spur on the Pacific & Eastern Railway. The spur, built by the county forces, was graded up so that flat cars with built-up sides and sliding gates, could be unloaded into the traction cars by gravity. All granite was hauled, the maximum haul being 2½ miles, by a Buffalo-Pitts 30-hp. traction engine, pulling six to seven cars, containing an average of 5 cu. yds. each.

The mixing was done with a standard Austin Cube ⅓-cu. yd. concrete paving mixer, requiring all the material to be shoveled from the ground into wheelbarrows and wheeled to the skip. An inspector was kept constantly at the skip to see that the right number of wheelbarrow loads, of the right size, of each kind of material were dumped into the skip, with the correct amount of cement and hydrated lime to form each batch. Each batch was mixed one minute, or 16 complete revolutions of the drum, and then deposited in a turnover bucket which ran out on a 20-ft. boom, and dumped in place on the road bed. The batches were given a rather dry mix, and when deposited, spread with hoes having a blade 14 ins. long and 2½ ins. deep. When the base had been deposited for a distance of 20 ft., the Bowlby roller made one trip over it, forward and back. The skip was then loaded with the top mixture, made slightly wetter than the base but not wet enough to bring water to the surface when floated lightly with a wooden float. The top layer, 1½ ins. thick, was deposited on the base concrete and rolled at once. The time of exposure of base concrete before the wearing surface covered it never exceeded ten minutes.

CONCRETE ROLLER.

The roller used was designed by H. L. Bowlby for the purpose of combining a strike-off board and uniform tamper. On its forward trip the roller carried a light wave of concrete in front of the roll, and since the roll covers the full width of the pavement and weighs approximately 1½ tons, it gave a heavy compression to the soft concrete, which proved to be much more uniform and more effective in removing voids and making a dense concrete than the ordinary tamping method. The crown of the pavement is in the roll. The roller weighs 2 tons and is driven by a 12 hp. gasoline engine. The roll makes 50 r.p.m. to 800 r.p.m. of the engine and is 12 ins. in diameter at the ends and 16 ft. long.


(a) Details of Roller

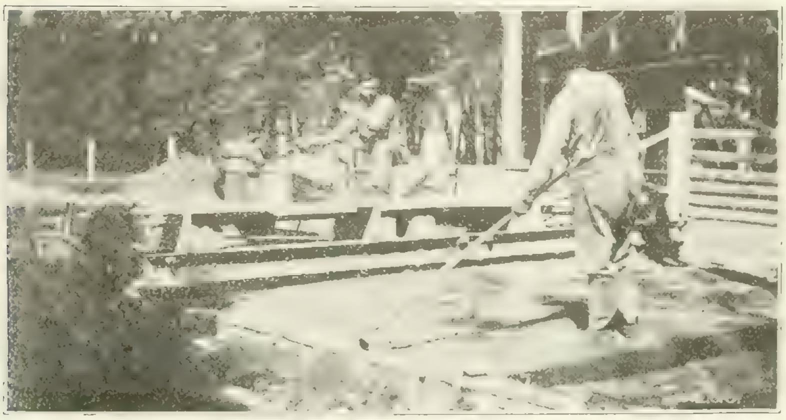

(b) Passing a Joint

Fig. 2. The Bowlby Concrete Roller in Operation.

PROPORTIONING INGREDIENTS OF THE CONCRETE FOR DENSITY.

In laying this pavement, an absolutely dense mix was considered imperative. The roller does its part effectively after the concrete is poured, but the more important feature is to so proportion the mix as to obtain maximum density. To get this density, samples of each of the different materials were shipped to Edwards & Lazell, chemical engineers of Portland, for testing. Tests were constantly made in the field by the inspector, to insure proper density. The sand was likewise tested at intervals, and the tests showed results better than standard Ottawa sand.

Fig. 3. Method of Piling Aggregate and Cement.

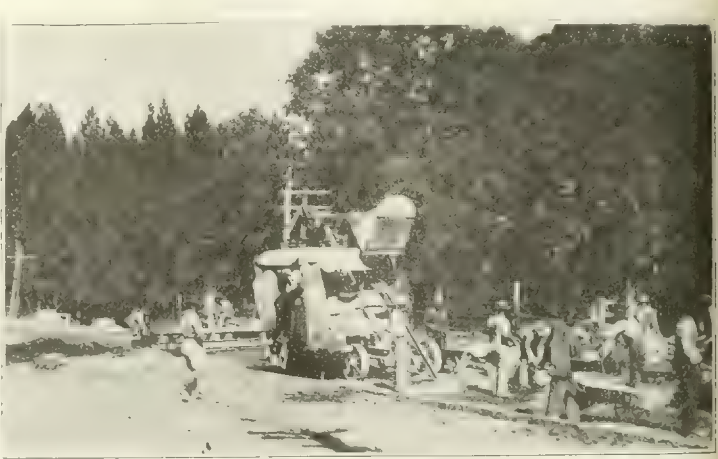


Fig. 4. View Showing General Method of Construction.

Hydrated Lime.—Hydrated lime was added to each batch in quantities varying from 5 to 10 per cent of the weight of cement. A part of the concrete was laid without adding the lime. The value of the lime lies, to a small extent, in the fineness of the particles serving as a filler, but the main value lies in its lubricating properties. It is a very noticeable fact that concrete containing hydrated lime slips and flows into place much easier and forms a denser mix with less tamping than that which does not contain lime. When lime is added, a less amount of water gives a greater plasticity, and therefore less danger of separation of the aggregates. Moveover, it is thought that the lime tends to hold moisture in the concrete until the setting has passed that stage where loss of its water due to absorption from the ground below can affect it.

Necessity of Wet Sub-Base.—In connection with the loss of water-content, it may be well to note that the presence of much moisture in the sub-base proved to be absolutely essential. The sub-base was soaked before placing the concrete in every case, but there seemed to be different results when deposited upon different soils. For example, a number of long stretches were laid without any expansion joints, and upon those soils which retain moisture fewer natural contraction cracks are found than where the soils are more porous. This was noticeable on another section.

TABLE I. — TYPICAL MONTHLY SEGREGATION SHEET FOR COST KEEPING.

SECTION "C"—MIXER NO. 1, SEPTEMBER, 1914.

Items and Amount.		Cost.
Sand and gravel (from Bear Creek), 1,213 yds.	$ 121.30	
Handling and hauling	1,155.00	
		$ 1,276.30
Sand (from Phoenix plant), 4 yds.	5.44	
No. 0 gravel (from Phoenix plant), 266 yds.	361.49	
Hauling	90.00	
		456.93
Granite—		
Quarry, 790 yds.	1,433.00	
Per cent of getting plant in shape	380.84	
Royalty	197.50	
Freight and demurrage	311.00	
Hauling and handling (cars to work)	299.49	
		2,621.83
Cement		
15,571 sacks used, 50 spoiled	8,059.83	
Hauling	422.70	
Hydrate, 103 sacks	75.32	
Hauling	2.58	
Handling	96.56	
Hauling forward	3.20	
		8,660.19
Pavement—		
Setting forms	96.63	
Mixing and placing	844.99	
Finishing	128.52	
Removing forms	52.52	
Watching pavement	172.36	
Covering and sprinkling	175.88	
Fencing pavement	54.11	
Pumping water	272.49	
Placing and removing water pipe	61.40	
Hauling coal	11.25	
Coal for mixer	93.47	
		1,963.62
Sub-grade	1,042.60	
Rolling labor	85.75	
Rolling fuel	37.50	
Blacksmithing	43.33	
Shoulder	195.05	
Cleaning pavement	38.25	
Side roads and bridges	36.00	
Per cent of Phoenix spur	56.40	
		1,534.88
Total		$16,513.75

Pavement laid, 7,167 lin. ft., or 12,741.4 sq. yds. Cost, $1.29 per sq. yd.

CONCRETE MIXTURES.

On the Central Point-Medford section, the proportions of different sized materials were quite varied. The base ranged from a 1:3:1:2 mix (1-cement: 3-sand: 1-granite passing a ⅝-screen: 2-granite passing a 1½-in. screen and retained on ⅝-screen), a 1:1:3:2; 1:2½:1:3; 1:2:1:4; and a 1:2:1:2:2 mix, in which creek gravel was used making up the fifth part in this proportion. Creek gravel was the cheapest rock available.

CONSTRUCTION METHODS MEDFORD-TALENT SECTION.

The Medford-Phoenix section was laid with Mixer No. 1, and was similar to the Central Point-Medford section, except that crushed creek gravel was used in the base instead of granite, due to its lower cost. It also was impossible to furnish, for both top and base,

TABLE II.—SEGREGATION OF COST OF CONCRETE PAVEMENT FROM CENTRAL POINT TO TALENT, JACKSON COUNTY, WASHINGTON.

Items and amount.	Cost.	Sub-totals.	Cost per sq. yd.	Pct. of paving cost.
Granite (f. o. b. Tolo), 8,010.2 cu. yds.	$22,357.91			
Freight on granite	3,576.00			
Hauling and handling granite	4,811.14			
		$30,745.05	$0.350	23.4
Cement (f. o. b. railroad spurs), 24,856½ bbls	53,059.86			
Hydrate (f. o. b. railroad spurs), 210 tons	3,545.63			
Handling and hauling	3,289.69			
		59,895.18	.681	45.5
Sand and gravel, 10,646 cu. yds.	6,924.03			
	7,724.03			
		14,648.06	.166	11.1
Paving (labor), 87,951.8 sq. yds.	15,292.67			
Superintendence	1,020.97			
		16,313.64	.185	12.4
Warehouse (on P. & E.)	344.07			
		344.07	.004	0.3
Phoenix spur (railroad)	351.70			
		351.70	.004	0.3
Depreciation on all machinery, at 13.1 per cent	2,802.50			
Road machinery maintenance and paving supplies	2,580.00			
Tools and implements	851.53			
		6,234.03	.071	4.7
Storing machinery	144.44			
		144.44	.002	0.1
Telephone and telegraph	70.84		.001	0.1
		70.84	.001	0.1
		$128,747.01	$1.473	
Construction overhead	2,752.38			
		2,752.38	.031	2.1
Totals		$131,499.39	$1.504	100.0

This amount, $131,499.39, is 80.7 per cent of the total expenditure on the Central Point to Talent Section, and also includes the cost of all bridges and culverts from Talent to Ashland Hill.

Note.—The item "depreciation on all machinery, 13.1 per cent," is obtained by dividing the total cost of non-expendable equipment ($21,402.31) by the amount which has been paid and charged in above cost data, out of this amount ($2,802.50). See page 44 for statement of cost of non-expendable equipment.

Note.—Cost per mile, $13,842.00, 9.5 miles constructed. 87,951.8 sq. yds.

granite from the Tolo quarry after the first 1½ miles. From this point the base consisted of uncrushed gravel, but the tests proportioning for density were taken often and rigidly. A number of good sand and gravel beds were found along the creek with short hauls.

Central Material Yard Plan.—The Phoenix-Talent section was built by an entirely different method. To avoid dumping the material on the ground, and then having to pick it up again, the central material yard plan was adopted. In accordance with this plan, a gravel and sand bar on the creek was selected at a point convenient to the road. The gravel bar and a 5-acre lot lying between the creek and the road was rented. A Bagley scraper 1⅓ cu. yds. capacity, with 500 ft. of 1-in. cable, a No. 10 Western jaw crusher, rotary screen, and 50-hp. motor were installed. The sand and two sizes of crushed gravel were screened into bins of 10 cu. yds. capacity each. From these bins the material was hauled by road train to piles 300 ft. distant, located about the hoist. Besides the outfit mentioned, a cement warehouse, capacity 1,500 barrels, was built, and a set of loading bunkers of 10 cu. yds. capacity each were placed against the warehouse. Trap doors were made in the bottoms, and placed high enough so that the dump cars could run under the bunkers and be loaded by gravity. The Brown hoist 30-ft. boom, and ½-yd. clamshell bucket, kept the bins full from the piles surrounding it. The granite for the wearing surface and cement was hauled to the warehouse from the railway ½ mile distant.

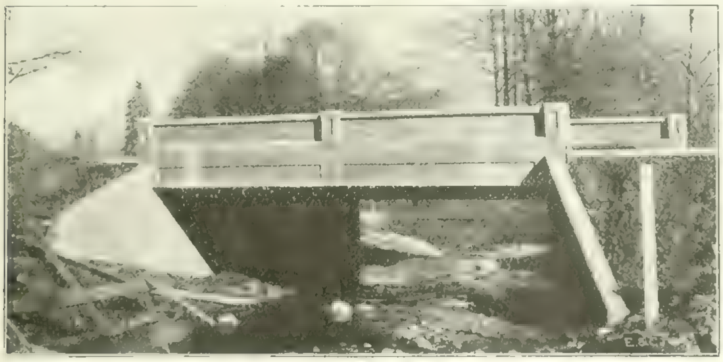


Fig. 5. A Type of Concrete Bridge Constructed—Span 24 Ft.

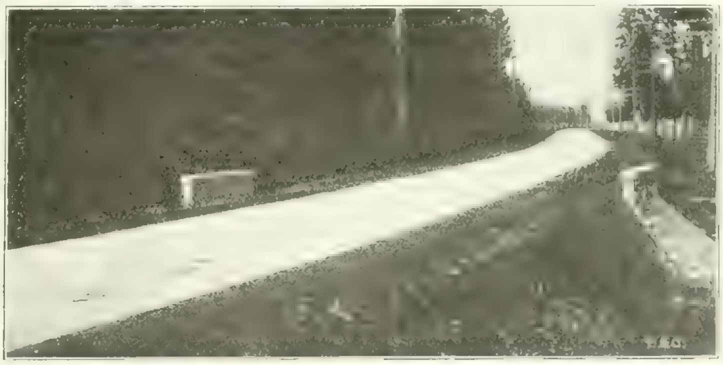


Fig. 6. Finished Surface, Shoulders and Culvert Near Phoenix.

Industrial Railway.—The aggregates, proportioned in batch quantities, were hauled from the material yard to the mixer on the road, by the trainload, consisting of special Koppel cars 24-in. gage, running on 16-lb., 24-in. gage portable track, made up in 15-ft. sections. Each car carried three hoppers of 12 cu. ft. capacity each, and each hopper was loaded with one complete batch for the mixer. Three trains of four cars each (12 hoppers) were employed, one at the mixer being unloaded, another enroute, and the third being loaded. One 20-hp. gasoline Milwaukee locomotive furnished the traction power. The cars were run alongside the mixer, the hopper picked up by the automatic traveling crane on the mixer and dumped into the charging hopper above the cube.

The mixing and placing on this section was similar to that on previously described work. All pavement was covered with canvas and kept wet by the liberal use of water until it became sufficiently set to allow earth or sand to be spread upon it without sticking. This interval of time varied with the temperature, and the movement of air. Great care was taken to prevent the pavement from drying on the surface for even the shortest time, and with the extreme heat of July and August it required constant watching. It was kept wet day and night for eight days, and the earth cover left on for approximately 30 days, when the road was thrown open to traffic.

Quarrying.—The Ray quarry at Tolo was leased to secure stone. This plant was in extremely poor condition, and poorly designed, which caused a great deal of preliminary work before crushing started. For the granite wearing surface it was decided to crush the rock to pass a ⅝-in. screen, and it was impossible to obtain a large enough proportion of ⅝-in. to sand material with the old crushers. The plant consisted of two Gates gyratory crushers, a 7½ K and a No. 6. There was not quarry face available to keep even one crusher running steadily and the product from both was too large. Crushing rolls were installed to re-crush the oversize, and by numerous changes and constant repairing, the plant furnished enough material for the topping to keep the mixers working. This required a large amount of two-shift work. The repair work was done after hours whenever possible.

The quarry itself was decidedly run down. The over-burden to be removed was a large item. These difficulties, coupled with the inherent poor crushing qualities of granite, help to account for the high cost of the granite chips used in the wearing surface.

KEEPING ROAD CLOSED.

Great difficulty was experienced at the beginning, especially on the Medford to Central Point section, in keeping traffic off the road. It became necessary to build a smooth-wire fence along both sides of the pavement for the entire distance, and maintain it until the pavement was opened to traffic. Also, watchmen had to be posted at the ends of the pavement to prevent the fence from being broken down. The great majority of the people were law-abiding, and in sympathy with the efforts made to protect the pavement.

CAPACITY OF MIXERS.

The economical capacity of the central material yard outfit was approximately 340 ft. of 16-ft. pavement 6 ins. thick, or 600 sq. yds. per

TABLE III.—SEGREGATION OF ALL COST OTHER THAN PAVING COST ON THE CENTRAL POINT-TALENT ROAD.

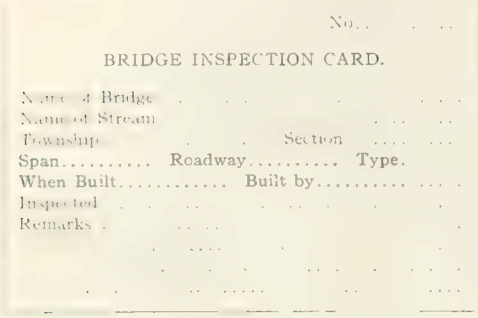
Items.	Cost.	Sub-totals.	Cost per sq. yd.	Pct. of total cost.
Culverts, labor and material	$ 4,424.79			
Wagner Creek bridge, labor and material	1,944.27			
		$ 6,369.06		3.9
*Grading (labor), 16,581 cu. yds.	9,611.26			
Grading, tools and implements	500.00			
Grading, supplies	1,048.38			
		11,159.64	$0.86	6.8
Sub-grade (labor)	6,572.91			
		6,572.91		4.0
Shoulders (labor)	3,164.36			
		3,164.36		1.9
Engineering, preliminary and location, paid by county warrants	407.94			
Engineering location	180.98			
Engineering construction	1,952.99			
Inspection	1,818.37			
		4,360.28		2.7
Total		$ 31,626.25		

*The cost of grading and subgrade together was $1,579 a mile, or 86 cts. a cu. yd.

8-hr. day, while that for Mixer No. 1 was approximately 400 lin. ft. of 16-ft. pavement 6 ins. thick, or 710 sq. yds. per 8-hr. day. A smaller crew was required to run the outfit on the central material yard plan.

RECORDS AND COST DATA.

Throughout this entire work exact records were kept of the amount done per day, where done, composed of what material, and under what conditions the work was done. The following is a copy of a page of the record.



No. . . . . .

BRIDGE INSPECTION CARD.

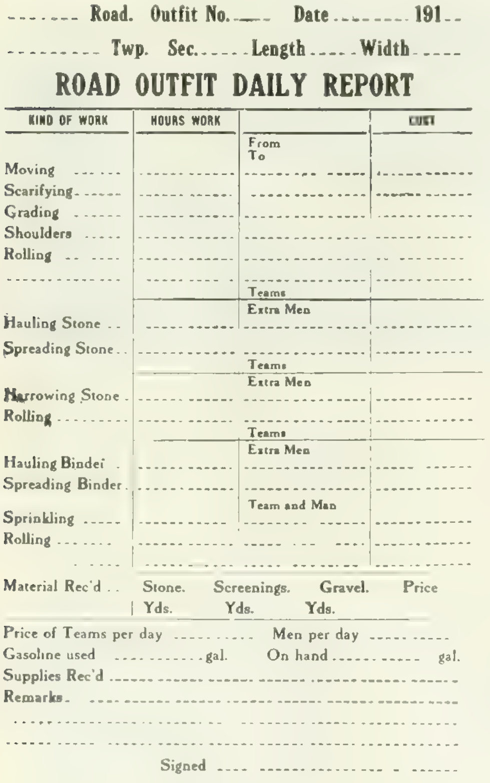
Name of Bridge . . . .
Name of Stream . . . . . .
Township . . . . Section . . . .
Span. . . . . Roadway. . . . . Type. .
When Built. . . . . Built by. . . . .
Inspected . . . .
Remarks . . . . . .

Fig. 1. Bridge Inspection Card.

SECTION C—MIXER NO. 1—JULY 14, 1914.

Mixtures used—
Surface, 1:1:2.
Base, 1:2:2:4.
Cement used, 650 sacks.
Hydrates used, 43 sacks.
Feet laid, 345, Station 568 plus 23 to 564 plus 78.
Total feet laid to date, 1,128, on Section C. Cover good; with sand, 7-15-14.
Expansion joints, 30 feet rubberized felt.
Temperature:
8:00 o'clock a. m., 66, minimum.
12:00 o'clock m., 84.
5:00 o'clock p. m., 90, maximum.

Remarks—
Colt tracks on pavement at Station 566 plus 00 to 566 plus 10.
Four sacks cement saved by shaking the empty bags.
River gravel varied today more than usual.



-------- **Road. Outfit No.** ---- **Date** -------- **191**--

---------- **Twp. Sec.** ----- **Length** ----- **Width** ----

ROAD OUTFIT DAILY REPORT

KIND OF WORK	HOURS WORK		COST
		From To	
Moving			
Scarifying			
Grading			
Shoulders			
Rolling			
		Teams	
		Extra Men	
Hauling Stone			
Spreading Stone			
		Teams	
		Extra Men	
Harrowing Stone			
Rolling			
		Teams	
		Extra Men	
Hauling Binder			
Spreading Binder			
		Team and Man	
Sprinkling			
Rolling			

Material Rec'd	Stone. Yds.	Screenings. Yds.	Gravel. Yds.	Price

Price of Teams per day ---------- Men per day ----------
Gasoline used ----------gal. On hand ---------- gal.
Supplies Rec'd ----------
Remarks ----------

Signed ----------

Fig. 3. Daily Report Postcard for a Road Gang.

Monthly segregation of costs were kept, showing in detail the items of expense covering all branches of the work entering into the cost of the pavement. Table I is a sample page of a monthly segregation sheet.

The segregation of the cost data in Table II covers the total expenditure in connection with the pavement. The items segregated so as to show the cost of each item, the cost per square yard, and the percentage of the total cost.

Study of Wear and Contraction. Concrete bench marks have been set near the edge of the right-of-way at different places along the highway where conditions or materials were changed. For example, where the wearing surface changed from 1:2 mix to a 1:1:2 mix, a bench mark was set near the edge of the right of way and elevation stamped upon it. On the pavement at points ten feet each side of the expansion joints, a soft copper wire is set 6 ins. from the edge of the pavement. Measuring from this wire exact elevations, read to thousandths, have been taken every foot across the pavement. The object of the wire is to locate definitely a point which can be found at any future time for reference with respect both to longitudinal and transverse measurements. In the years to come it will be possible and very easy to check the amount of wear on the pavement to within a thousandth of an inch. Having the two measuring points so close together and under the same working and traffic conditions, but with different materials, will make it possible to determine the merits of the materials, mixes, and cements used.

Exact records of every contraction crack on the entire road have been kept. The shape, dimensions and notable features are all drawn to scale. Where expansion joints were used, the sheets show little besides the straight lines, but on those sections of roadway where no expansion joints were used, each natural crack is drawn showing all of its features. These records will be gone over and additions made in the future to show the yearly behavior of the pavement.

COST OF NON-EXPENDABLE EQUIPMENT.

Motorcycle	$ 115.00
Brown hoist	4,600.00
Engine, concrete roller No. 2	206.00
Track and cars	6,769.20
Locomotive	2,768.47
Plant hoist	1,004.16
Concrete roller No. 2	600.00
Mixer No. 2	2,302.60
Locomotive clutches	10.00
Per cent of auto	222.05
Per cent mixer No. 1	1,142.77
Per cent concrete roller and engine No. 1	338.63
Per cent steam pump	45.60
Water pipe	876.28
Screen for Phoenix plant	181.50
Belt (not used) and pulleys	220.05
Total	$21,402.51

Note.—For depreciation charges, see Table II.

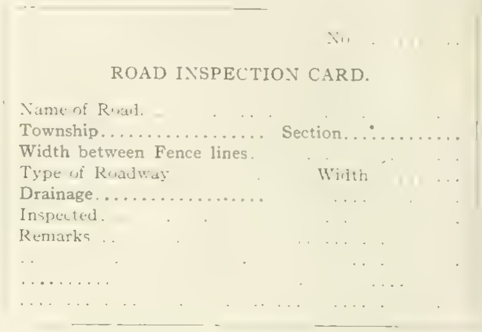
COMPLETION OF WORK.

Work was begun in February, 1914, and completed in November. The pavement was in perfect condition in December, 1914, there being no more contraction cracks than were expected, and absolutely no pot holes or failures of the concrete. All construction was accomplished by day labor under the supervision of the state highway department. F. A. Kittredge was the district engineer in direct charge of construction.

Inspection and Cost Record System Used on Road Work in Cook County, Illinois.

(Staff Article.)

Within the past year the office of county superintendent of highway for each of the counties in the State of Illinois was instituted. This officer is an engineer appointed by the State Highway Commission from a list of eligibles certified by the county board. The superintendent is appointed for a term of six years and is subject to removal for cause by the county board. His powers and duties are as follows: (1) Prepare plans, specifications and estimates for all bridges built by the county and submit them for approval to the State Highway Commission before adoption. (2) Supervise the construction and maintenance of bridges and roads on which the entire expense is met by the county or the county and township jointly. (3) Inspect, report upon and advise township officials with regard to all bridges and roads at least once a year. (4) Supervise the repair of state aid roads under the direction of the State Highway Commission. (5) Keep a record of all contracts and purchases of material or apparatus approved by him in excess of $200. (6) To serve as a deputy to the State Highway Commission when called upon by the Commission. State aid roads are built, inspected and maintained by the State Highway Commission, and the county superintendent has no jurisdiction over them.



No. . . . . .

ROAD INSPECTION CARD.

Name of Road. . . . .
Township. . . . . Section. . . . .
Width between Fence lines. . . . . .
Type of Roadway . Width . . .
Drainage. . . . .
Inspected. . . . . .
Remarks . . . .

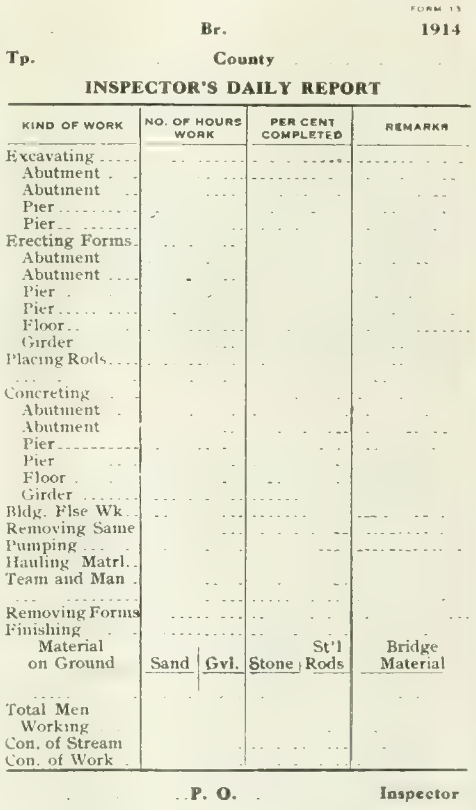
Fig. 2. Road Inspection Card.

The office of Geo. A. Quinlan, superintendent of highways for Cook County, as at present organized consists of a senior assistant engineer and a junior assistant engineer, draftsmen, inspectors and clerical employes. Draftsmen and inspectors are employed as the work in hand demands.

METHOD OF INSPECTION TO SECURE OFFICE DATA.

Under the system of county and township road construction in vogue in Cook County prior to the appointment of the county superintendent of highways each township or the county, as the case might be, employed an engineer only when his services were needed. The same engineer was seldom employed many times and records of the location, design and construction of roads and bridges were not made by the county and were scattered among many engineers in private practice. Not even an accurate map of the roads in the county existed.

It was found necessary to go into the field and inspect and measure up existing roads,



FORM 13

Br. 1914

Tp. County

INSPECTOR'S DAILY REPORT

KIND OF WORK	NO. OF HOURS WORK		PER CENT COMPLETED		REMARKS
Excavating					
Abutment					
Abutment					
Pier					
Pier					
Erecting Forms					
Abutment					
Abutment					
Pier					
Pier					
Floor					
Girder					
Placing Rods					
Concreting					
Abutment					
Abutment					
Pier					
Pier					
Floor					
Girder					
Bldg. Flse Wk					
Removing Same					
Pumping					
Hauling Matrl.					
Team and Man					
Removing Forms					
Finishing					
Material on Ground	Sand	Gvl.	Stone	St'l Rods	Bridge Material
Total Men Working					
Con. of Stream					
Con. of Work					

P. O. Inspector

Fig. 4. Daily Report Postcard for a Bridge or Culvert Gang.

culverts and bridges to obtain these records. This work is being accomplished as rapidly as more important work will permit. To facilitate this work and provide a convenient means of recording the information records are made on 4x6-in. cards, Figs. 1 and 2, that are filed in vertical cabinet files.

A decimal system of numbering was adopted. Townships were numbered alphabetically, 1 standing for the township beginning with A, etc. Point one (.1) was used to designate bridges and culverts and point two (.2) to designate roads. The actual U. S. Land Survey section number was used for the section and letters A, B, C, etc., for the structure or road. For example, 1.110C appearing as a card number designated the township beginning with A and means bridge C in section 10 of that township.

Bridges and Culverts.—A dimensioned sketch of the structure, in the case of a culvert or bridge, is made upon the reverse side of the card. The condition of the structure is reported as "no good" (N. G.), "poor," or "good"; "no good" meaning immediate replacement is necessary, "poor" that frequent close inspection is necessary, and "good" that the structure does not need close watching. A photograph is usually taken and the print pasted to the end of the card.

FORM 14 1M 12 14 JJC

______Road Outfit No. ______ Started______ Finished______

______Twp. ______Sec. Length______Depth______Width______

DISTRIBUTION OF LABOR

OPERATIONS	Total Hrs	RATE	AMOUNT
Moving			
Scarifying			
Plowing			
Grading			
Shoulders			
Sprinkling			
Rolling			
Teaming Stone			
Extra Men			
Spreading Stone			
Harrowing Stone			
Delays			
Repairs			

Front of Card, Labor Distribution.

MATERIAL

	Quantity	Unit Price	TOTAL
Stone Yds			
Screenings Yds.			
Gravel Yds.			
Water, Gals			
Gasoline, Gals.			
Supplies			
GRAND TOTAL			

Reverse of Card, Material.

Fig. 5. Monthly Distribution Card.

Roads.—Road inspections are made to secure data for mapping and reference purposes and to secure some record of the present condition of existing roads and the pavements upon them, where such pavements exist. Existing widths between fence lines, the type and width of surfacing and pertinent data as to drainage and general conditions are recorded.

INSPECTION OF ROAD CONSTRUCTION AND REPAIR

Upon the undertaking of construction or repair work by either the township or county that is done in accordance with plans prepared or approved by the county superintendent, whether on contract or day labor work, an inspector is immediately placed upon the job. This inspector makes daily reports upon post-card forms. Figure 3 shows the type used on road work and Fig. 4 that used on culvert and bridge work. (The bridge form is the same as that used by the State Highway Commission). These cards serve the double purpose of enabling the superintendent to keep track of the movements of various gangs and the progress of the work and also furnish data from which variations in daily cost of various items are secured immediately so that checks or improvements may be applied. The inspector also keeps a cost record diary of the standard forms used by the Illinois Highway Commission on state aid roads and from this cost record the final costs on the job are computed since the data kept in the diary is much more complete than that sent to the superintendent's office on the daily progress cards.

The inspectors remain with the construction gangs at all times and act under the direction of the superintendent or his engineers. The same system of reporting is used on all work whether large or small, maintenance, repair or new construction. The dairy cost record, however, is only kept on work that warrants the keeping of cost data of great accuracy and refinement such as a large concrete road construction job and on work of a type dissimilar to routine work concerning which [illegible] accurate data are desired.

DAILY COST SYSTEM

Data given on the daily post cards is transferred immediately to a monthly distribution card, Fig. 5. This card is 5x8 in. in size and is a filing card. Labor distribution is made on one side and materials on the other side. At any time should the superintendent desire to know how the cost of any particular section of work is running a summary is quickly made and recorded on the card shown in Fig. 6.

We are indebted to Geo. A. Quinlan, superintendent of highways for Cook County, Illinois, for the data from which this article was prepared.

Estimating the Cost of Concrete Roads in Milwaukee County, Wisconsin, and Methods and Cost of Maintenance.

[See Engineering and Contracting, May 13, 1914, and December 16, 1914.]

The method of preparing estimates for concrete road construction in Milwaukee County, Wis., was discussed by H. J. Kuelling, engineer for that county, in a paper before the Eleventh Annual Convention of the American Concrete Institute. Methods and cost of maintenance were also discussed.

CONSTRUCTION.

The question, "What is the cost per square yard or per mile of concrete?" is as easily answered as, "What is the cost of a house?" One is as definite as the other for there are almost as many kinds of concrete roads as there are houses, and for each kind there is a different answer. Even after the quality and thickness of concrete to be built has been determined there are naturally many local conditions that will have a marked bearing on the results; such as lengths and kind of roads available to haul material over, facilities for unloading and hauling aggregates and cement; amount of labor available; the necessity for camps; the distance and elevation that water must be carried and also its source; the availability of suitable aggregates, whether they must be washed, or crushed or shipped by rail; the weather conditions that are liable

800 12-14 JJC FORM 15

COST RECORD

Road Outfit No.______

Road______Twp.______Sec______

Depth______Length______Width______

MATERIAL COST

				Amount
Stone	Yds.		per Yd	
Screenings	Yds.		per Yd	
Gravel	Yds		per Yd	
Water	Gals.		per Gal	
Gasoline	Gals.		per Gal	
Supplies				
			TOTAL	

LABOR COST

	Total Hrs	Rate	Amount
Moving			
Scarifying			
Grading			
Plowing			
Spreading			
Delays			
Repairs			
		TOTAL	

Total Material Cost

Cost per Sq. Yd.______ Total Labor Cost

Cost per 100 ft. Grand Total

Fig. 6. Card Used in Segregating Daily, Weekly or Monthly Costs.

to exist. Any or several of these conditions may have a marked effect on the cost of construction. Given answers to these questions or conditions the problem of figuring the cost becomes much simplified.

Assuming the standard Wisconsin state specifications which call for a 1:2:3½ mix and assuming a pavement with an average thickness of 7 ins., I will attempt to show you in as simple language as possible how we arrive at our estimates of costs.

With an average thickness of 7 ins. we allow only 5 sq. yds. per cubic yard of concrete allowing the extra inch as a factor of safety. With a 1:2:3½ mix we need approximately ½ cu. yd. of sand and about 0.84 cu. yds. of aggregate or a total in all of about 1⅓ cu. yds. of material for a cubic yard of concrete. No suitable material is available without shipping in by rail and we find that washed sand and gravel can be laid down at almost any siding in the county for $1 per cubic yard of sand or gravel, the sand to weigh 3,000 lbs. per cubic yard and the aggregate a little less, depending upon the idea of the dealer. This brings our sand and gravel for a cubic yard of concrete to about $1.33, or about 27 cts. per square yard of road.

The next problem encountered is unloading this material into the hauling vehicle. In our case nearly all has been done by hand. Allowing for lost time due to rain, switching of cars and waiting for teams and figuring labor at from $2.25 to $2.50 per day of ten hours, we have a cost of 5 cts. per square yard for unloading. This may be reduced a little, but have found it safer to not expect too much from shovellers especially in hot weather.

The item of hauling is the most variable of any, perhaps, in the entire cost. The length of haul, the method of hauling and the kind of roads to haul over all have a marked bearing on the result. Also, possible weather conditions must be taken into account for after a rain the size of load and number of trips must be materially reduced. Where steep grades are encountered, extra teams must be figured upon. Assuming an average haul of 2½ miles, a team would average about 3½ trips per day under our conditions, or about 17 miles per 10-hour day during the various kinds of weather. At $6 per day, which we often are forced to pay, and assuming an average of 1¾ cu. yds. per load we arrive at a cost of $1.35 per cubic yard of concrete or 27 cts. per square yard of road.

The mixing and placing, under which we include all labor connected with the job such as watchmen, pumpmen, smoothing grade, etc., will with our labor conditions and allowing for lost time and overhead expenses come to about $1 per cubic yard or 20 cts. per square yard.

In case steel joints are placed these will come to about 2½ cts. for the steel and ½ ct. for the felt when placed 50 ft. apart and ¼ in. in thickness of felt.

The cost of furnishing water is rather uncertain for the amount of pipe necessary may vary from one to three, or even more, miles per job. Assuming two miles of pipe at a rental of 2 cts. per foot for use in placing a road one mile long we have a water cost of about 2 cts. per square yard.

For carrying liability insurance a contractor must add about 1½ cts. in our state. The depreciation on machinery we have found to be about 1¼ cts. per square yard. Trimming up the shoulders will require an additional expenditure of about 1 ct.

The items as enumerated bring us to a total of 87¾ cts., to which we add a reasonable profit when figuring what a contractor should bid.

Since we furnish cement in all cases we add our cement cost only after the profit percentage has been included. With cement at $1.14 per barrel on cars and 20 cts. per barrel for cartage, we arrive at a cost of about $2.25 per cu. yd. of concrete for cement or 45 cts. per square yard. This gives us a total of $1.32 without a contractor's profit, under the conditions existing in 1913. Work done in 1913 by force account varied from $1.30 to $1.61, and that done by contract varied from $1.24 to $1.72, the variations depending entirely upon the local conditions. In 1914 with cement slightly higher but with labor and teams considerably cheaper, but other conditions about as in 1913, the costs in Milwaukee county varied from $1.10 to $1.45.

An engineer should thus be able to compute the cost of the various items in his community and separate the labor and material into fairly definite per cents for each job. He will find that cement will vary the least while hauling labor will vary the most.

[Editor's Note: In the discussion of this paper in reply to a question as to the proper percentage to allow for contractor's profit Mr. Kuelling stated that he allowed 15 per cent on labor and a little less on material. Contingencies were allowed for by estimating the output of labor, such as the number of miles traveled per day by a team, somewhat below the average.]

In conclusion, the cost of construction, I repeat, is merely a guess unless all the local conditions are considered.

MAINTENANCE.

The amount of maintenance will vary with the quality of concrete in the road. In other words, concrete that is of uniform texture will wear in a manner similar to sandstone blocks and therefore demand very little maintenance whether the aggregate be of hard or fairly soft material; the harder and tougher the sand and stone, the longer the life of the pavement. Where the mortar and the aggregate are allowed to become separated when the concrete is being placed, there is certain to be an uneven wearing of the surface which naturally becomes more and more pronounced as the traffic pounds, in falling into or climbing out of the depression.

It would, therefore, seem that the first maintenance required in a concrete road is to get as uniform and tough an aggregate as possible and then to be sure that the concrete is properly mixed and placed. In case small depressions do occur the time to look after them is as soon as they appear. We believe the best method to be about as follows:

The surface should be first swept with a steel broom to loosen any dirt; after this the spot should be thoroughly swept with fibre street brooms; to remove the fine dust which the steel brooms leave behind we use ordinary house brooms which leave the surface in fairly clean condition. The depression is then covered with hot Tarvia X and covered with coarse sand or screenings and opened to traffic. In case the depression is of considerable depth, or what might be called a hole, I would advise one of two methods.

The first method (used in case it is desired to avoid delaying traffic) is to clean the depression as described, and paint it with a tar After this bring the whole to grade with crushed stone, being careful not to have stone as large in size as the depth of the depression. Tamp the stone in place with hand tampers or roll with a roller, if one is available, and fill the voids with a heavy bituminous road binder, allowing about 1 gal. per square yard per inch in depth.

The second method is to cut the poor place out entirely and after trimming the hole and thoroughly sprinkling the sides, fill with the same mixture as was used in the original road. After pouring the concrete, treat the same as in reconstruction. Small defects due to balls of clay, sticks or coal getting into the aggregate may be best repaired the same as described for shallow depressions. The same is true of battered joints or cracks that may appear.

We consider it economy to have a small maintenance crew who go over all the roads in the county once or twice each year. Such a crew consists of a foreman, one team, and four laborers. This crew will under average conditions, in Milwaukee county, cover all the joints, cracks and small pits in from one to two miles of 18-ft. road in one day at a cost of from $15 to $30 per mile for labor and material.

When it is deemed advisable to cover the entire surface, the same method of cleaning may be followed, except that most of the dirt may be removed with a power sweeper and the tar applied with a power sprayer. After the first treatment of ¼ to ⅓ gal. of tar has been applied, a second may be added in the same manner except that an asphalt may be substituted for the tar as it will adhere to the tar already placed, while it will not adhere to the concrete. We have several pieces treated in different manners as to materials used and are looking forward with interest to see their condition this spring.

Treatment of concrete roads as a whole whether necessitated by poor workmanship, defective materials, or freezing is considerd a rather expensive process compared with spending more in the original cost and getting a road of a quality that will not require such a coating for many years. Even if a treatment will last for two seasons, which is very doubtful under conditions of heavy mixed traffic, the cost will come to several hundred dollars per mile per year. Of course such a coating has some advantages such as acting as a cushion to horses, preventing wear on the concrete itself, doing away with glare and being applied without delaying traffic. On the other hand it makes the road more slippery and a little less clean. The writer thinks that the time is not far distant when a coating of concrete one or more inches in thickness will be applied to a poorly built concrete road and made to stay there, thus giving an entirely new wearing surface.

In conclusion, it is believed that maintenance varies inversely as the quality and uniformity of the concrete in the road, not arithmetically but more nearly geometrically, due to the uniform wearing of a uniform concrete.

Award of E. H. Harriman Gold Medal.— The E. H. Harriman Memorial Gold Medal for the American Steam Railway making the best record in accident prevention and industrial hygiene affecting the public and its own personnel during the year ending June 30, 1914, was awarded to the New York Central Railroad. The medal was offered by Mrs. E. H. Harriman to be awarded through the American Museum of Safety. The committee of award consisted of: Mr. Arthur Williams, President American Museum of Safety; Mr. Samuel O. Dunn, editor Railway Age Gazette; Prof. Alexander C. Humphreys, president Stevens Institute; Hon. Chas. P. Neill, former U. S. Commissioner of Labor; and Hon. Edgar E. Clarke, member Interstate Commerce Commission. The medal was received on behalf of the railroad by Mr. Alfred H. Smith, president.

The progressive steps taken in the installation of block signals, improved roadbed, steel equipment and modern safety devices were taken into consideration, as well as the actual record of accidents in awarding the medal to the New York Central. There has not been a passenger killed in a train accident on the road in four years, during which time the number of passengers actually carried on its trains equaled approximately twice the entire population of the United States. Nearly three million freight and passenger trains were operated day and night in all kinds of weather. During the year ended June 30, 1914, as compared with the previous fiscal year there were 102 fewer persons killed and 1,068 fewer persons injured. One of the interesting features of the road's record is in the efficiency of its employes as indicated by surprise tests wherein the employes without previous warning were tested as to their observance of signals set against them, as to flagging, blowing whistles at grade crossings, speed restrictions, etc. Out of 323,892 such tests made in the year in only 389 cases were the employes deficient, the percentage of efficiency being 99.88 per cent.

Engineering and Contracting

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An Unwise Amendment to the Ohio Conservancy Law 187

Editorial comment on the proposed amendment which virtually forbids the use of reservoirs as a means of flood prevention. E. & C., Mar. 3, 1915; ⅓ col.

STREETS: Motor Buses.

Motor Buses and Passenger Transportation in Cities 187

Discusses editorially the use of motor bus lines to relieve traffic congestion in cities. Outlines advantages of this type of transportation E. & C., Mar. 3, 1915; 1 col.

QUANTITY SURVEYORS: St. Louis Ordinance Governing.

The St. Louis Ordinance Governing Quantity Surveyors 187

Cites the provisions of an ordinance passed by the authorities of St. Louis, Mo., governing quantity surveyors. Gives editorial comment on the provisions, and discusses certain features of the quantity surveying system. E. & C., Mar. 3, 1915; 1¼ cols.

ROADS: Contractor as Engineer; Daily Cost Records.

A Contractor as Road Engineer and His Daily Cost Record System 187

Discusses editorially the advantage of daily costs that enable a road superintendent to check extravagance and institute economies as soon as they occur. E. & C., Mar. 3, 1915; ½ col.

ROADS: Contracting; Causes of Failures.

"Going Broke" in Road Contracting 188

Editorial discussion of the reasons for the numerous financial failures in the road contracting business. Asserts that the primary cause is ignorance of costs. E. & C., Mar. 3, 1915; 2 cols.

WATER STERILIZATION: Liquid Chlorine; St. Catharines, Ont.

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Describes conditions calling for sterilization, and illustrates and describes recording and controlling apparatus, buildings and piping. Describes operation of chlorine feeding apparatus. E. & C., Mar. 3, 1915; 5½ cols.

METERAGE: Columbus, O.; Lawn Sprinkling

The Results of Meterage at Columbus, O., with Special Reference to Restriction of Waste in Lawn Sprinkling 190

Discusses general aspects of lawn sprinkling regulations and shows how meterage at Columbus has obviated necessity of imposing such restriction by ordinance. E. & C., Mar., 3, 1915; 2¼ cols.

WATER SUPPLY SYPHON: Use of at Kokomo, Ind.

Syphoning Water from Series of Drilled Wells to a Common Pump Well at Kokomo, Ind. 191

Describes and illustrates design and states construction methods employed. E. & C., Mar. 3, 1915; 1¾ cols.

WATER RATES: Schedules; Suggestions for Making.

Suggestions for the Making of Water Meter Rate Schedules 191

From report of Committee on Meter Rates of New England Water Works Association. Discusses divisions of the sliding scale, the amount of slide in the scale, the service charge and the manner of applying it, alternate procedure where service charge is objectionable, use of gallons or cubic feet as unit of measurement, and the form of the schedule with and without provision for a service charge. E. & C., Mar. 3, 1915; 4⅔ cols.

BUILDINGS: Edison Fire, Report on.

Preliminary Report of Committee on Edison Fire 193

Gives the essentials of a preliminary report on the Edison fire by the committee appointed by the American Concrete Institute. The report is very complete, and gives the origin and progress of the fire, data on the various reinforced concrete buildings and their contents, severity of the fire, effect of the fire on the concrete work, effect of the design on the portions damaged, and estimated cost of restoring concrete buildings. E. & C., Mar. 3, 1915; 9 cols.

MORTAR, CEMENT: Effect of Freezing.

Results of Some Tests to Determine the Effect of Normal and Low Temperatures on the Strength of Cement Mortar 196

Gives the results of a series of tests to determine the effect of normal and low temperatures on the strength of cement mortar. The tests cover a variety of conditions and various temperatures. They were planned by the Aberthaw Construction Co., Boston. E. & C., Mar. 3, 1915; 2½ cols.

BUILDINGS: Ventilating Fans for, Specific Data.

Data on the Operation of Ventilating Fans 197

Classifies ventilating fans for various types of buildings, and gives diagrams and tabular data on the operation of them. These data are arranged in form for ready use and will be found of considerable value. E. & C., Mar. 3, 1915; 5½ cols.

BUILDING CONTRACTS: Arbitration Provisions.

Arbitration Provisions for Building Contracts 199

Letter from E. T. Thurston, San Francisco, Cal., emphasizing the need for arbitration provisions in building contracts. Also gives a recommended form of arbitration provision for use in contracts. E. & C., Mar. 3, 1915; 1½ cols.

CONCRETE: Mixing, Curing and Placing by Steam Ejections.

Mixing, Curing and Placing Concrete with High Pressure Steam 199

Describes machine for mixing and placing concrete by steam ejections. Describes process and shows views of work done by the Lackawanna Railway in repairing walls. E. & C., Mar 3, 1915; 3½ cols.

ILLINOIS WATERWAY: Proposed Channel.

The Illinois Waterway—Proposed Eight-Foot Channel from Lockport to Utica . . 201

Brief outline of three proposed projects for providing a navigable depth from Lockport to Utica. Table of estimated costs. Engineer's recommendation. Map. E. & C., Mar. 3, 1915; 3 cols.

DRILLING: Churn, Costs of.

Costs of Drilling With Well Drilling Machines in Ore Prospecting 202

Describes work with steam drills at two mines and gives unusually detailed itemized costs. E. & C., Mar. 3, 1915; 3¼ cols.

BOULDER-BREAKING: Adobe Shots and Block Holing, Tests.

Comparative Tests of Mud Capping and Block Holing for Breaking Boulders 203

Results of tests by Bureau of Mines comparing adobe-shot and block-holing methods of breaking limestone blocks. E. & C., Mar. 3 1915; 1 col.

ROADS: Concrete, Rolled, Washington.

Methods and Cost of Constructing a Rolled Concrete Road in Washington 203

Describes grading, handling of materials with traction engines and industrial railway, concrete rolling with the Bowlby roller, and gives complete cost of constructing 9.5 miles of road. E & C., Mar. 3, 1915; 9¼ cols.

ROADS: Cost System, Inspection, Cook Co., Illinois.

Inspection and Cost Record System on Road Work in Cook County, Illinois 206

Gives forms used on inspection and daily cost record system used. The notable feature of this system is that the cost of the work at any time may be quickly obtained with a small amount of labor. E. & C., Mar. 3, 1915; 4½ cols

ROADS: Concrete, Milwaukee, Wis.

Estimating the Cost of Concrete Roads in Milwaukee County, Wisconsin, and Methods and Cost of Maintenance 207

Describes method of preparing estimates to submit in competition with contractors' bids, giving units used. Discusses the methods and cost of maintaining concrete roads. E. & C Mar. 3, 1915; 3 cols.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Electric Motors, etc.—Management of cotton mill in South America desire to electrify the entire mill. It is stated that plans, drawings, etc., of a modern oil-engine plant should be submitted. It is explained that it will require about 40 motors from 4 to 20 HP. each. Correspondence may be in English. No. 15,776. [For address see first paragraph.]

Central Heating Plants.—Firm in Russia wishes to establish permanent commercial relations with American manufacturers of equipment for the installation of central heating plants, such as regulating valves, fittings for joining pipes, sectional boilers, heating apparatus of stamped iron, and tools for connecting pipes, etc. No. 15,804. [For address see first paragraph.]

Machinery, Wood Vats.—Business man in West Indies is about to organize a company with a view to establishing a distillery and wishes to get into communication with manufacturers of machinery for distilling purposes; also with manufacturers of wood vats of large capacity. No. 15,782. [For address see first paragraph.]

Water Meters, Small Tools, etc.—Large electrical supply house in South America wishes to get in touch with American manufacturer and exporters of water meters, small lighting sets, shovels, hoes and small implements. No. 15,784. [For address see first paragraph.]

Railway Materials, Ties, etc.—Representative of a foreign Government is in New York City for the purpose of purchasing railway supplies, especially locomotive parts, coaches, and ties. No. 15,790. [For address see first paragraph.]

Electric Railway Signal System.—Railway and power company in Latin America desires to get into communication with American firms which may be in a position to supply electric railway signal apparatus. Catalogues and prices, etc., should be sent at once. Correspondence should be conducted in English. No. 15,793. [For address see first paragraph.]

Pipe Fittings.—Firm in Great Britain is in a position to place large orders for wrought-iron fittings for gas, water, and steam pipes, etc. No. 15,676. [For address see first paragraph.]

Street Cleaning Machinery.—The manager of the street cleaning department of a city in Greece wishes to purchase motor-driven street-cleaning machinery. Plans and specifications may be seen at the Greek Legation in Washington, and arrangements may be made to demonstrate American machinery to a representative of the Greek Legation in this country. To deal with this matter in Greece it will be necessary to do so through local representatives. No. 15,688. [For address see first paragraph.]

Electric Motor.—Electric light company in Mediterranean city wishes to purchase 100 HP. electric motor. No. 15,699. [For address see first paragraph.]

Centrifugal Pumps.—European business man desires to represent American manufacturers of centrifugal pumps, particularly the self-contained type, operating by direct electrical current at 220 volts. Correspondence should be in Spanish. No. 15,714. [For address see first paragraph.]

Concrete Mixers.—A firm in southern Europe wishes to secure catalogues, etc., on concrete mixers. It is stated that a great deal of construction work is contemplated. Catalogues and all correspondence should be in Spanish. No. 15,744. [For address see first paragraph.]

Railway Ties.—Merchant in Neutral European country wishes to import railway ties. No. 15,746. [For address see first paragraph.]

Structural Steel.—A firm in one of the insular possessions of a foreign country wishes to establish commercial relations with American manufacturers and exporters of iron and steel beams and girders. No. 15,770. [For address see first paragraph.]

INDUSTRIAL NOTES

William F. Gurley, of the firm of W. & L. E. Gurley, Troy, N. Y., died Feb. 17 at Atlantic City, N. J.

W. B. Mallette has been appointed railroad representative of the H. W. Johns-Manville Co., at St. Louis, Mo., succeeding John N. Trent, who has been transferred to New Orleans, La., as branch manager.

The Lea-Courtenay Co., manufacturers of high duty turbine pumping machinery, 90 West St., New York City, which has been represented heretofore in Chicago territory by Maher & Bryne Co., has established an office of its own in the Conway Bldg., Chicago. Mr. Maher has resigned from the Maher & Byrne Co., and is now associated with the Lea-Courtenay Co. as its Chicago manager.

NEW CATALOGUES

FORMS.—Paper, circular, C-S Concrete Form Co., 716 Dwight Building, Kansas City, Mo.

Calls attention to C-S adjustable concrete column forms for use with either beam or mushroom system. Illustrated.

DRAWING TABLES.—Paper, 3½x6¼ ins.; 8 pp; R. E. Kidder, 39 Hermon St., Worcester, Mass.

Shows several styles of Academy drawing tables, with brief descriptions, dimensions and price list.

NAIL COLLARS.—Paper, 3½x6¼ ins.; 4 pp. Wagner-Behm Company, 20 E. Jackson Blvd., Chicago.

Describes "Pull-Easy" nail collars for use with wire nails used in temporary scaffolding, false work, etc. Illustrated.

DUMP WAGONS.—Paper, 8x11 ins.; 12 pp. Peter Schuttler Co., 22d and Rockwell Sts., Chicago.

Illustrates, briefly describes and gives general specifications for several models of Schuttler dump wagons, and explains the uses to which each model is particularly adapted.

CENTRIFUGAL PUMPS.—Paper, 9x6 ins.; 48 pp. Lawrence Pump & Engine Co., Lawrence, Mass.

Catalogue "C" showing a number of standard designs of Lawrence "Vortex" centrifugal pumps. Gives specifications for general construction, dimensional data for each pump shown, and tables of pipe capacities, friction head, horse power, etc.

OXY-ACETYLENE APPARATUS.—Paper, 6¾x9¾ ins.; 20 pp. The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago.

Catalogue No. 111, showing Imperial oxy-acetylene welding and cutting apparatus. Describes a number of outfits and their particular uses, shows some illustrations of practical application in wrecking or construction work and gives details as to accessories.

ROAD MACHINERY.—Paper, 6x9 ins.; 36 pp. Kinney Manufacturing Co., 104 Boylston St., Boston, Mass.

Describes and illustrates the Kinney patent heater and distributor, auto distributor, motor truck, road oiling equipment, automatic horse drawn heater and distributor, auto street flusher, rotating plunger pump, gas generating heater, and other equipment for handling bituminous materials.

Licensing of Engineers.—The Committee on Legislation of the Michigan Engineering Society has submitted the following report:

At the present time we do not think it wise to suggest the licensing of all engineers. This seems to be in accordance with the opinion of the American Society of Civil Engineers, and most of the practicing engineers in the different states. We are of the opinion, however, that a law should be passed requiring that no one shall qualify as county surveyor in this state unless he is a graduate of a reputable engineering college or has had at least five years of actual experience as surveyor, or has completed all of the surveying work in some reputable engineering college and has had three years of actual experience as a surveyor. We further recommend that the pay of county surveyors be increased to six dollars per day.

$10,000,000 of Track Elevation Work in Chicago.

About $10,000,000 probably will be expended during the present season by the railroads on track elevation in Chicago. The expenditure last year for work of this kind in this city was over $6,000,000. The plans for 1915, however, provide for a great deal more construction than was undertaken in 1914. As a result it is expected that about 20.87 miles of road bed will be improved. The schedule of track elevation work planned by the railroads for this season includes the following:

Railroad and location.	Miles roadbed.	Miles track.
B. & O. terminal—Main line, Leavitt, from 59th to 69th Sts.	3.80	7.60
Panhandle — Main line, Leavitt, from 59th to 69th Sts.	3.80	51.47
St. Paul—Bloomingdale Road, Ashland to Lawndale	2.63	7.66
St. Paul—Evanston Division, Montrose to Howard	1.50	3.59
Rock Island — Main line, 76th to 90th; South Chicago line, 87th to South State; main line, 87th to South Carpenter	1.81	7.09
Western Indiana—Main line, 71st to State, 86th to Stewart	1.50	8.00
Illinois Central—Main line, 100th to Kensington	2.00	8.00
Illinois Central — Kensington and East, 111th to Kensington	.50	1.00
Wabash—Along 75th W., 74th to Wood	3.08	11.44
Michigan Central—E. 113th St. to Kensington	.25	.25

It is expected that construction on a considerable part of this work will be started early this month.

Tenders Asked for Moncton, N. B., Bridge.

A bridge involving some difficult constructional features is now being advertised for tenders by the Public Works Department of the Province of New Brunswick, Canada. The structure is to be erected over the Petitcodiac River, between the city of Moncton and the Parish of Coverdale. The site of the work is over a turbulent tidal water with some 30 ft. extreme rise and fall. The bridge will consist of one through fixed rivetted steel truss span of 355 ft. from center to center of end bearings, and four through fixed rivetted steel truss spans of 261½ ft. The substructure embraces the construction of two masonry abutments and four masonry piers, the abutment ends retaining continuous stone and embankment approaches. The roadway surface will be some 54 ft. above the river bed. The superstructure will require 2,420,000 lbs. of steel. Tenders for the bridge will be received until noon, March 31, by John Morrisey, Minister of Public Work, Fredericton, N. B.

Good Roads Convention to Meet in Toronto.—The first general meeting in the interest of the good-roads movement in Canada was held in Montreal in May last. The convention proved so successful that the Canadian and International Good Roads Association was organized to prosecute the work regularly. The second convention of this organization will be held in Toronto March 22-26, 1915.

It is announced that this convention will give much attention to the plans for the improvement of the highways of Ontario. In addition to the attendance of delegates from all parts of the Dominion, it is expected that a number of representatives of the good-roads organizations in the United States will also be present at the Toronto meeting.

CURRENT NEWS

The Doings of the Week.

The past week has shown renewed expansion in trade and a satisfactory increase in industrial operations. Developments affecting construction operations have been favorable. The excellent weather conditions and the prospects of an early spring have brought out much work. As a result many important undertakings in the heavy construction line and building have been started in the last few days. War orders continue to furnish activitiy in many lines. Railway earnings are improving and the carriers and other large buyers are showing more disposition to place orders. Rail buying during the past week was light, orders for only about 28,600 tons being placed, with contracts for about 60,000 tons additional pending. One of the largest railroad orders of the week was for 4,000 cars for the Chicago, Burlington and Quincy R. R. In the construction field the activity of the past three weeks has been well maintained. Municipalities are beginning to advertise their improvements, and county and state highway commissions are getting ready for their season's work. Bids were opened last week on several large jobs and a number of new undertakings of importance reached the call for bids stage. In the iron and steel trades there has been no falling off from the activities of the last few weeks. It is expected that operations of the steel mills will be further increased by large orders now being figured on. There is about 100,000 tons of structural orders now in sight and most of this will probably be placed this month. Grade crossing elimination work at Indianapolis, Ind., will require about 17,000 tons; the Clark Ave. viaduct at Cleveland, O., will take about 9,400 tons, and 20,500 tons will be needed for elevated railroad work in Brooklyn, N. Y. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending Feb. 24 were as follows:

Finished Iron and Steel, Per lb. to large buyers.	Feb. 24. Cts.	Feb. 17. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.20	1.20
Iron bars, Pittsburgh.........	1.10	1.10
Iron bars, Chicago............	1.10	1.07½
Steel bars, Pittsburgh........	1.10	1.10
Steel bars, New York.........	1.269	1.26
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York.......	1.269	1.26
Beams, etc., Pittsburgh.......	1.10	1.10
Beams, etc., New York......	1.269	1.26
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh......	1.25	1.20
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.80
Galv. sheets, No. 28, P'gh.....	3.40	3.25
Wire nails, Pittsburgh........	1.60	1.60
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh.. ..	1.40	1.40
Barb wire, galv., P'gh........	2.00	2.00

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.10 cts.

Railroads.—The railroads are showing no particular haste in placing construction undertakings in the hands of contractors. No developments of particular importance in this line appear to have taken place during the past week. The Southern R. R. is understood to have some double track work on its Charlotte division that will be let soon. There also are several other improvements on other roads that it is rumored contractors are now figuring on.

Roads and Streets.—Several good-sized county highway jobs came up for advertising during the past week: Milwaukee County, Wisconsin, opens proposals March 5 on 63,900 sq. yds. of concrete paving and 33,000 sq. yds. of sheet asphalt; the county commissioners at Findlay, O., are asking bids on 24 miles of waterbound macadam, the first letting of work to cost $300,000; the county auditor at Bluffton, Ind., is asking bids on gravel and stone roads to cost $63,000. The State Roads Commission of Maryland opens proposals March 16 on 3 miles of concrete roadway and for oiling 475 miles of highway requiring about 1,278,000 gals. of oil. The State Highway Department of Louisiana is asking proposals for 26 miles of road in St. Tammany Parish. Philadelphia, Pa., opens bids March 16 for an improvement of the Parkway from 19th St. to 22nd St., an undertaking that calls for an expenditure of several hundred thousand dollars. Other municipal paving work includes 23,000 sq. yds. for Vincennes, Ind.; 12,000 sq. yds. for Kinston, N. C.; 27,100 sq. yds. asphaltic concrete or concrete for Clarinda, Ia.; a large amount of asphaltic concrete for Cedar Rapids, Ia., and the repaving of 23 streets for Bayonne, N. J. Illinois awarded contracts for four sections of concrete, one of brick and one of gravel; Milwaukee County, Wisconsin, let contracts for over 69,000 sq. yds. of concrete paving; Mason City, Ia., awarded 70,000 sq. yds. of asphalt pavement.

Bridges.—The principal development of the past week in the bridge field was in the opening of bids for the construction of the $1,750,000 interstate bridge at Portland, Ore. The Pacific Bridge Co., Portland, is reported to be low bidder on the superstructure, and the Graff Construction Co., Seattle, low bidder on the concrete substructure. The Cumberland Valley R. R. is reported to be taking bids for its $750,000 bridge over the Susquehanna River at Harrisburg, Pa. The Minister of Public Works of New Brunswick is asking tenders until March 31 for a bridge over the Petitcodiac River at Moncton, that will require 2,321,000 lbs. of structural steel. Bids are being asked by the county clerk at Billings, Mont., for two fair sized bridges to be erected over the Yellowstone River. Arthur McMullen Co., Inc., Singer Bldg., New York City, was awarded contract at $242,250 for the Broad St. bridge at Philadelphia, Pa.

Drainage and Irrigation.—No particularly large undertakings in the drainage or irrigation fields appear to have reached the call for bids stage during the past week. The Commissioners of Drainage District No. 5 of Jackson County, Texas., are asking proposals for canals, drains, levees, etc., that will require the handling of about 627,390 cu. yds. of material. The Wasatch Grading Co., Salt Lake City, Utah, at $47,084, was low bidder for about 8½ miles of lateral for the high line canal for the U. S. Reclamation Service.

Water Works.—A number of calls for bids for furnishing pumping machinery, valves, etc., are being advertised. Chicago, Ill., is calling for proposals for supply of five pumping engines for its Mayfair station; three are to have a capacity of 25,000,000 gals, and two to have a capacity of 17,500,000 gals. Woodruff, S. C., is asking bids for water works. Milwaukee, Wis., will call for bids shortly on 5,680 ft. of 9-ft. shore tunnel.

Sewerage.—A considerable amount of sewer work is being advertised by small municipalities. Woodruff, S. C., is calling for bids on 23,425 ft. 8-in. sewer; Osborne, Kan., for 22,675 ft. sewer; Mason City, Ia., for 23,000 ft. 8 to 15 in. pipe sewer; Kinston, N. C., for 8 miles 8 to 18 in. pipe sewer; Leon, Ia., for 64,000 ft. 6 in. to 12 in. pipe sewer. Milwaukee, Wis., awarded the first contract in connection with its new $10,000,000 sewer system. Jones & Erbach, Pittsburgh, Pa., secured the construction of the east side sewer at $212,000. Peoples Bros., Inc., Philadelphia, Pa., was low bidder, at $133,555, for the Walnut St. sewer.

Alien Labor Law.

A decision of the utmost importance to contractors was rendered last week by the Court of Appeals of the State of New York. The court held that the state law prohibiting the employment of aliens on the construction of public works was constitutional. The suit was brought in connection with the employment of this class of labor in building the dual system of rapid transit in New York City. The New York statute provides that on contracts where alien labor is employed such contracts shall be forfeited. A taxpayers' suit was brought to restrain the Public Service Commission of the First District from declaring forfeited contracts for the construction of the subways. In order to fully determine the question, criminal proceedings also were brought against a representative of the contractors. The Court of Special Sessions found this man guilty and fined him $50. This decision was reversed by the Appellate Division and the cases were then carried to the higher court. It was claimed that the enforcement of the act would deprive persons of property without due process of law, and also would violate the Federal Constitution and provision of treaties with foreign nations. The Constitution, it was pointed out, granted equal protection of the laws to any person within its jurisdiction. The prevailing opinion of the Court of Appeals stated that

> The construction of public works involves the expenditure of public moneys. To better the condition of its own citizens, and it may be to prevent pauperism among them, the Legislature has declared that the moneys of the state shall go to the people of the state. The equal protection of the laws is due to aliens as to citizens; but equal protection does not mean that those who have no interest in common property of the state must share in that property on the same terms as those who have an interest.

The contractors engaged in the construction of the dual system of rapid transit in New York City have been employing large numbers of foreigners. The decision brings about a crisis in this, the greatest public work now underway in this country. The city now has outstanding construction contracts aggregating $142,000,000 for subways and elevated lines. Some of these contracts are nearly completed, others are only just begun, and others are in various intermediate stages of construction. Some 30 separate contracting firms are engaged in this work. With the drastic penalty of forfeiture of contract staring them in the face if they continue construction with alien labor, many of these contractors probably will be obliged to suspend their work. It will be a difficult matter to find enough citizens willing and capable of carrying out the unskilled labor work of construction in the subways. There is no great number of Americans that depend on pick and shovel work as a means of livelihood. The employment of alien labor on public works construction has been due mainly to the fact that there was no other class of labor available.

Municipal Construction.

One encouraging development of the past few weeks is the considerable number of municipalities that have made an early start in calling for bids on their construction undertakings. Cities in the middle west have been particularly active in this respect. In the east very little municipal work has been advertised as yet. Many eastern cities, however, are now taking steps to secure the necessary money for their improvements, and it is probable that a considerable volume of work in that section of the country will be offered to bidders in the near future. Financial interests in New York City are now making arrangements to make large advances to syndicates and other bidders for state and municipal bonds which will be publicly offered in the near future. These loans will aggregate a large amount and will provide for a great deal of construction work. In addition to the large loans of this character many temporary loans for small amounts will be arranged for various municipalities. There is plenty of money awaiting investment at the present time and low rates of interest can be obtained. One bank in Chicago, for instance, has $8,000,000 lying idle on which it would be glad to get 4 per cent. With financial conditions as they are at present, indications point to the undertaking of a large amount of municipal construction.

HIGHWAY CONSTRUCTION IN MINNESOTA.

Details of Work Proposed by 39 Counties.

Gravel and Earth Road Construction and Bridges.

There are 91,890 miles of public roads in Minnesota. Of this total 9,904 miles have been improved more or less, and 11,401 miles have been designated as State Roads. The State Road System is composed of a radial system of main roads in each county and includes all main lines of inter-county travel. The state furnishes engineering supervision on all road work and at present has a corps of 76 district engineers stationed at the county seats of the several counties who devote their entire time to the work.

During 1914 the total cost of all road and culvert construction carried out under the supervision of the engineers of the State Highway Commission was $2,802,996. The work accomplished included the following:

	Cost.
Clearing and grubbing, 1,695 acres	$ 197,312
Ditching, 410 miles	194,696
Grading, 2,151 miles	1,476,827
Graveling, 537 miles	366,893
Macadam 29.5 miles	83,989
Other surfacing, 79 miles	123,155
Concrete culverts, 26-in. and less, 1,528	79,602
Concrete culverts, over 36-in., 316	109,434
Corrugated metal culverts, 24-in. and less, 1,678	105,408
Corrugated metal culverts, over 24-in., 346	21,238
Miscellaneous work	41,945

The principal type of improved road construction in the state consists of gravel surfacing. A large mileage of this class of highway has been built and during the next few years several thousand miles more probably will be constructed. A large amount of highway work is projected for the present season. Several notably large undertakings in Minnesota will probably be placed under contract in a few months. Winona County already is calling for bids on a 104 mile road letting that calls for an estimated expenditure of $540,000. A summary of the road work contemplated for 1915 in 39 Minnesota counties is given in Table I. Further details regarding this construction follow.

TABLE I.—ROAD WORK FOR 1915 IN 39 COUNTIES IN MINNESOTA.

	—Type of road—	
County.	Earth, miles.	Gravel, miles.
Anoka	10	20
Beltrami	24	58
Blue Earth	25[1]	9[2]
Brown	48	6¾
Chicago	11¾	7
Cook	10	.
Cottonwood	20[3]	5
Faribault	24[4]	..
Goodhue	?	?
Hubbard	15[5]	..
Isanti	.	10[6]
Itasca	50	10
Jackson	35	8
Kittson	17	..
Koochiching	65	..
Lac qui Parle	16	6
Le Sueur	25	10
McLeod	5	20
Murray	20	.
Nicollet	..	57
Norman	23	2
Otter Tail	40	6
Pine	12	1½[7]
Pipestone	18	3
Pope	13	
Redwood	21	21
Rice	26	12
Roseau	30	2
Scott	10	3
Sibley	35	40
Steele	6	16
Stevens	30	.
Todd	20	2
Wabasha	14[8]	6
Wadena	10	1
Waseca	20	5
Watonwan	48	
Winona	10	50[9]
Yellow Medicine	15	6

[1] Grading and culverts. [2] Gravel surface. [3] May turnpike about 50 miles additional. [4] Grading, turnpiking and culverts. [5] 31 miles under contract; 15 to 20 miles more to be built. [6] Also 1 mile of macadam. [7] County also will build under bond issue 30 miles of state rural highway to cost about $65,000. [8] Includes 6 miles sand-clay surface. [9] Also 50 miles macadam, 4 miles brick and 2 miles concrete.

Anoka County has $35,000 available for highway purposes and will build approximately 10 miles of earth road and 20 miles of gravel road. The work will be done by contract, the first of these to be let this month. H. H. Thurston, Anoka, Minn., is District Engineer.

Beltrami County will construct 24 miles of earth road and 58 miles of gravel road. The county has $38,000 available and will bond to secure the balance for the proposed construction. The work will be done by contract; the lettings will be held in April. Roy K. Bliler, Bemidji, Minn., is District Engineer.

Blue Earth County has $60,000 available for construction purposes and will grade and build culverts for about 25 miles of earth road. It also will surface with gravel 9 miles of highway. A portion of the improvements will be carried out by contract, the remainder being done by day labor. B. M. Gallagher, Mankato, Minn., is District Engineer.

Brown County will construct 48 miles of earth road and 6¾ miles of gravel road during the present season. About ½ of this work will be done by contract. A contract for 25 miles of road already has been let. The county has $30,000 available for construction purposes. C. N. Robertson, New Ulm, Minn., is District Engineer.

Chicago County proposes to construct 11¾ miles of earth road and 7 miles of gravel road this year. Date for awarding contract has not yet been fixed; probably will be early in April. The county has $24,000 available. It also will build a 28 ft. girder bridge on concrete abutments under the plans of the State Highway Commission. This will cost $1,635. C. Spivak, Jr., Center City, Minn., is District Engineer.

Cook County has $18,000 available and will construct 10 miles of earth road. No contracts will be let. Geo. B. Hughes, Grand Marais, Minn., is District Engineer.

Cottonwood County proposes to construct 20 miles of earth road and 5 miles of gravel road. It also may turnpike 50 miles of highway. The county has $24,000 available. No contracts will be let. D. R. Savage, Windom, Minn., is District Engineer.

Faribault County will grade, turnpike and build culverts for 23 miles of road. The work will be done by contracts. Some of these will be let the latter part of this month. The county has $40,000 available. Ray J. Short, Blue Earth, Minn., is District Engineer.

Fillmore County has $50,000 available but will undertake this season only the general maintenance and repair of existing earth roads. This work will be done by day labor. J. J. Davy, Spring Valley, Minn., is District Engineer.

Goodhue County has not yet laid out any road work for this season. The County Board will meet in March and at that time will decide on the improvements. Wm. Geisheker, Red Wing, Minn., is Distriit Engineer.

Hubbard County has 31 miles of earth road under contract and will build 15 to 20 miles more during the present season. The work will be done by contract, and the letting probably will be held in April. The county will have at least $14,000 available for construction purposes. Chas. E. Spencer, Park Rapids, Minn., is District Engineer.

Isanti County has about $18,000 available for highway purposes and will construct 10 miles of gravel road and 1 mile of macadam. It has not been decided whether the work will be done by contract. If contracts are let, the letting will be held some time in April. P. M. Torrell, Cambridge, Minn., is District Engineer.

Itasca County has $100,000 available for construction purposes, and will build 50 miles of earth road and 10 miles of gravel road. Contracts were let in 1914. O. J. Lidberg, Grand Rapids, Minn., is District Engineer.

Jackson County will construct about 35 miles of earth road and about 8 miles of gravel road. The work will be done by day labor, using county equipment and renting some. The sum of $20,000 is available. W. E. Matters, Jackson, Minn., is District Engineer.

Kittson County proposes to construct 17 miles of earth road during the present year. The work will be carried out by contract, for which the letting will be held in April. The county has $25,000 available for construction purposes, which includes the building of eight bridges. J. E. Dishington, Hallock, Minn., is District Engineer.

Koochiching County will expend about $20,000 on new work, most of which will be done by day labor. About 65 miles of earth road will be built, contracts for which were let last year. About $100,000 is available. L. A. Ogaard, International Falls, Minn., is District Engineer.

Lac qui Parle County will build during the present season, 16 miles of earth road and 6 miles of gravel road. The improvements will be carried out by day labor. About $30,000 is available. Fred Roe, Madison, Minn., is District Engineer.

Le Sueur County has about $25,000 available for road construction purposes and will build about 25 miles of earth road and 10 miles of gravel road. The work will be done by day labor. J. W. Hruska, Le Sueur Center, Minn., is District Engineer.

McLeod County proposes to construct during the present season 5 miles of earth road and 20 miles of gravel road. The work will be done by contracts, the lettings to be held May 1. About $25,000 is available for construction purposes. J. C. Christlieb, Glencoe, Minn., is District Engineer.

Murray County has about $35,000 available for highway purposes and proposes to build 20 miles of earth road. No contracts will be let. P. L. Minder, Slayton, Minn., is District Engineer.

Nicollet County has $25,000 available for 17 miles of state road jobs. It also will construct two state rural highways, 40 miles in all, at an estimated cost of $80,000. The county will issue bonds for its share of the latter work. The improvements will be gravel roads. Contract for State Rural Highway No. 54 has been let at $53,156. The other work will be carried out by contract, which will be let when the plans are completed. H. W. Daniels, St. Peter, Minn., is District Engineer.

Norman County proposes to build 23 miles of earth road and 2 miles of gravel road during the present season. The work will be done by day labor. The county also will construct by day labor under plans of State Highway Commission and supervision of the District Engineer, six concrete and steel bridges of the following spans: 22 ft., 26 ft., 36 ft., 54 ft., 60 ft. and 60 ft. The sum of $34,000 is available for construction purposes. J. A. Erickson, Ada., Minn., is District Engineer.

Otter Tail County has a county appropriation of $30,000 for road construction. The appropriation from the state fund, which is not made before March 2 will not be less than $25,000 and probably will be $30,000. The county probably will construct 40 miles of earth road and 6 miles of gravel road. All of the work will be carried out by day labor. Martin Aalberg, Henning, Minn., is District Engineer.

Pine County has $30,000 available for highway construction, this sum including state aid. It proposes to construct 12 miles of earth road and 1½ miles of gravel road. In addition the county will build under a bond issue 30 miles of state rural highway at a probable cost of $65,000. Most of the work will be by contracts, which will be let about May 1. W. J. Buckley, Pine City, Minn., is District Engineer.

Pipestone County will build 18 miles of earth road and 3 miles of gravel road during the present year. About $18,000 is available for construction purposes. No contracts will be let. Elmer Keeler, Lake Benton, Minn., is District Engineer.

Pope County will let contracts March 16 for road building. The county has $20,000 available for construction purposes and will build 13 miles of earth road. Lynn Martin, Glenwood, Minn., is District Engineer.

Redwood County will construct 21 miles of earth road and a like amount of gravel road. The work will be done by contracts, which will be let sometime this month. About $32,000 is available for construction purposes. Orin L. Kipp, Redwood Falls, Minn., is District Engineer.

Rice County has about $40,000 available for road purposes and will construct approximately 26 miles of earth road and 12 miles of gravel road. No contract will be let. R. W. Hosfield, Faribault, Minn., is District Engineer.

Roseau County proposes to construct approximately 30 miles of earth road and 2 miles of gravel road during the present year. The county has about $20,000 available for construction purposes. No contract will be let. V. B. Chapin, Roseau, Minn., is District Engineer.

Scott County will construct 10 miles of earth road and 3 miles of gravel road. No contract will be let for this work. It also will build by contract 7 bridges. The sum of $24,000 is available for construction purposes. Donald Childs, Shakopee, Minn., is District Engineer.

Sibley County has about $23,000 available for construction purposes. It proposes to construct about 35 miles of earth road and about 40 miles of gravel road. About 50 per cent of the improvements will be carried out by day labor, the remainder being done by contracts, which will be let in the spring. S. F. Mullen, Green Isle, Minn., is District Engineer.

Steele County has $25,000 available for highway purposes and will construct 6 miles of earth road and 16 miles of gravel road. The work will be done by day labor. J. A. Prior, Owatonna, Minn., is District Engineer.

Stevens County will build 30 miles of earth road. The work will be done by contract; the date of letting has not been determined. The county has $18,000 available. W. A. Hunt, Morris, Minn., is District Engineer.

Todd County has $20,000 available for construction purposes and will build 20 miles of earth road and 2 miles of gravel. It also will erect two 120 ft. span bridges and seven 20 ft. to 30 ft. spans. Contract for 120 ft. span and two 20 ft. bridges was to be let March 1. The road work will be done by force account. S. R. Green, Wadena, Minn., is District Engineer.

Wabasha County will have $57,000 available for road and bridge construction purposes if state apportions amount requested. It proposes to build 8 miles of earth road, 6 miles of road with sand-clay surface, and 6 miles of gravel road. A number of concrete bridges also are to be built. The work will be done by day labor. A. L. Flygare, Wabasha, Minn., is District Engineer.

Wadena County will construct 10 miles of earth road, 1 mile of gravel road, a 120 ft. span bridge and an 80 ft. span bridge. It has $17,500 available. S. R. Green, Wadena, Minn., is District Engineer.

Waseca County has approximately $24,000 available for construction purposes. It will build about 20 miles of earth road and 5 miles of gravel road. The work will be done by day labor. R. F. Nichols, Waseca, Minn., is District Engineer.

Watonwan County proposes to construct 48 miles of earth road by contract and day labor. It has $21,000 available for construction purposes.

Winona County's construction program for the present season includes the following:

	Miles.
Earth road	10
Gravel	50
Macadam	50
Brick	4
Concrete	2

The county has $550,000 available from a bond issue for construction purposes. The work will be done by contract. A letting calling for 104 miles of road estimated to cost $540,000 is now being advertised. Bids on this will be received until March 22. A description of the work is given elsewhere in this section. H. B. Childs, Winona, Minn., is District Engineer.

Yellow Medicine County will construct 15 miles of earth road and 6 miles of gravel road. No contracts will be let. The amount available for construction is $21,000. E. W. Youngdale, Granite Falls, Minn., is District Engineer.

SANITARY SEWERS AND TREATMENT PLANT FOR JOHNSTOWN, PA.

Improvements to Cost $1,100,000 Proposed.

Fine Screen System of Sewage Treatment Contemplated.

Extensive sewerage developments, to include a sanitary sewer system to cost about $994,000 and a $105,000 treatment plant, are proposed for Johnstown, Pa. A preliminary report and plans have been submitted to the State Board of Health. It is expected that the report from the State Department will be received shortly after March 1, after which detailed plans will be prepared. An election is to be held on April 20 at which time the citizens will vote on the project.

The following details of the proposed improvement are taken from the preliminary report of C. P. Collins, Sanitary Engineer for the city. The city of Johnstown is located on the main line of the Pennsylvania R. R., 78 miles east of Pittsburgh. It lies in the valley of the Little Conemaugh and Conemaugh Rivers, in the shape of a V, surrounded by high hills. Throughout the greater portion of the city the street grades are very light, but those streets extending up on the hillsides have heavy grades, reaching a maximum of about 22 per cent. There are 82 miles of streets, of which 34.3 miles are paved. There are also 52.9 miles of alleys, 5.5 miles of which are paved. The present area of the city is 3,197.3 acres and the present population is estimated to be 66,000 with an assessed valuation of $48,600,000.

The plan of improvement provides for an entirely new system of sanitary sewers, and such additional relief sewers as may be required from time to time for the removal of storm water. The present sewers will be used to take care of the ordinary storm flow from the streets. The territory which the system has been designed to drain has been divided into 11 sewer districts.

All sanitary sewers up to and including 27 in. in diameter are to be built of salt glazed vitrified pipe; all sizes over 15 in. are to be double strength pipe. Sewers over 27 in. in diameter are to be built of brick, reinforced concrete pipe, segmented block or concrete, depending on existing conditions. There will be five river crossings, three of which are inverted siphons. At all crossings two pipes have been arranged for: one to take care of the present flow, and a larger additional pipe for future needs.

The main trunk sewer will cross the Little Conemaugh River just below the foot bridge. At this point it is a 48-in. circular section. It follows Iron St. to Connelly Ave., where it increases to a 54-in. circular section. At the end of Connelly Ave. it parallels the yard tracks of the Cambria Steel Co. to a point 700 ft. above the Coopersdale bridge where it joins the outfall sewer leading to the disposal plant. The outfall sewer is egg-shaped, 54 in. by 82 in. in section. The grade of the outfall is 0.06 per cent, with a maximum capacity of 67½ cu. ft. per second. The grade of this sewer has been made as light as possible in order to enter the disposal plant at a higher elevation and thus avoid pumping. The total cost of the sanitary sewer system complete to the year 1945 is estimated as being $993,717. In making this estimate labor was taken at $1.80 per day, and 20 per cent was added to all labor costs and 5 per cent to all material costs. In addition 10 per cent was added to cover engineering and contingencies. The cost of the vitrified pipe was arrived at from average prices of the eastern market during the past 10 years.

The plan of sewage treatment has been designed to meet the needs of the city up to the year 1930. At that time it is estimated the population will reach 104,000. The site of the plant will be about 6,000 ft. below the present city line, where the city already has acquired nearly 2 acres of land. This site will allow sufficient area to give the sewage a partial treatment and discharge it into the Conemaugh River without pumping. It is proposed to employ the fine screen system of treatment using Reinsch-Wurl screens. The plant proposed by the Sanitation Corporation of New York, which controls the American patent rights to this screen, contemplates the removal of objectionable solids by fine screening, chlorine disinfection for effluent during the periods of low water in the river, and disposal of the screenings by burning.

The equipment generally speaking comprises three main divisions: Reinsch-Wurl fine screens; sterilizing equipment and contact tank; high temperature destructor. There will be two Reinsch-Wurl screens each 14 ft. in diameter set on an inclination of 25°. In determining the size of screens provision was made for a maximum flow of 225 gals. per capita. The screen disk will rotate at the rate of about ½ to 20 revolutions per minute, and it is assumed that the screen on the average will separate from 50 to 60 per cent of removable solids from the sewage and deliver them with the moisture content reduced to not more than 80 per cent.

The screening plates will be manganese bronze ⅛-in. thick, perforated with 1/32 by 2 in. V-shaped slots. The screens will be of the overhung type and will be driven by a variable speed motor; each screen will require 1 to 2 hp. Auxiliary emergency power will be provided by a small oil or gas engine.

The sterilizing equipment will be of the chlorinator type, for disinfection of the effluent by chlorine gas. The destructor will be of special, extreme high temperature type, capable of receiving screenings at about 80 per cent moisture from the screens and completely destroying them in a period of 8 to 10 hours continuous operation. Crude oil will be used as fuel, and an operating temperature of 2,500° F. developed. The sewage will be delivered to the plant in the 54 by 82-in. outfall sewer. It will flow through two sluice gates to the screens, where the solids retained by the screen plates will be raised from the sewages and collected in covered cans and stored for burning. The effluent will flow through the screen to the discharge conduit where the sterilizing agent is automatically added. From the detention tank the sterilized effluent will pass into the river. The estimated cost of the proposed plant is:

Mechanical equipment	$ 57,000
Substructure and superstructure	48,000
Total cost	$105,000

A $150,000 PARK DEVELOPMENT.

Proposed Improvement of Island at Beaumont, Texas.

Work Calls for 700,000 Cu. Yds. Filling, Boulevarding, Etc.

An interesting park development is proposed by the city of Beaumont, Tex. The park site is located on an island surrounded by the Neches River, Brakes Bayou and the canal of the Kirby Lumber Co. This island at present is a swamp and subject to overflow. It has an area of 67 acres. It is proposed to raise the grade of the land by pump dredging from the Neches Riber bottom. About 700,000 cu. yds. of material will be required for the fill. The material is chiefly sand and will be retained within a levee which will girdle the island. This levee will be constructed by dipper dredge to a height of 14 ft. above normal tide water.

The plans call for the construction of a 30 ft. boulevard on top of the levee with walks on each side. This boulevard will be 1½ miles long, and there will be a fringe of natural forest from 40 ft. to 300 ft. in width left between the levee and the river bank. There will be constructed in the area enclosed by the boulevard a winding creek 30 to 40 ft. in width and about 2,000 ft. long and a swimming lake about 80 ft. by 250 ft. with sand bottom. The lake level will be about 7 ft. above the normal creek level. The water from the creek will be supplied by filtering through a sand stratum from the river; that for the swimming lake will be obtained from artesian wells or by pumping from the creek.

The chief buildings will be a main circular pavilion and a comfort station. The pavilion will be 130 ft. in diameter with concrete floor, hollow concrete columns, 4 ft. in diameter, and with dome and lantern rising to a total height of 88 ft. This stadium is situated so as to command four beautiful vistas of the river, each nearly a half-mile in length which is made possible by the graceful natural bends of the stream which is 300 to 400 ft. in width. The comfort station will be 50 by 100 ft. 1-story, of concrete construction, bungalow style, provided with rest rooms, toilets, etc. In addition to the two main buildings there will be a refectory, tennis, and bath house and shelters About $5,000 is to be spent in tree planting and grass sowing.

There will be about 20,000 lin. ft. of gravel walks, 10,000 sq. ft. of concrete walks and about 11 acres of top-soiling for athletic grounds. The children's playground will be equipped with modern appliances, wading pool, swings, slides, teeters, etc. There will be baseball and football grounds, tennis courts, and running track.

There will be numerous fishing wharves around the river bank and a mile boat course laid out on the river. The western end of the park, about 20 acres, will be used by the regional fair (The South East Texas Fair Association) for its home. The park will be equipped throughout with water and sewer systems and electric lights. There will be a wooden pontoon bridge, 30 ft. wide and 160 ft. long, over Brakes Bayou.

The estimated cost of the entire improvement is $150,000. The plans were prepared by Jas. F. Weed, Consulting Engineer, Beaumont, Tex., and were adopted by the Board of Park Commissioners and the City Council on Jan. 19. An election will be held March 3 to vote on the issuance of $150,000 of bonds for improving the park in accordance with the plans.

A $7,000,000 Industrial Development in Oregon.

The ratification two weeks ago by the Oregon legislature of the lease of Lake Summer and Lake Albert makes possible the beginning of active construction in the near future on one of the largest private developments ever undertaken in the state. This project provides for the utilization of the rich salt deposits in the lakes by a syndicate headed by Jason C. Moore, New York City. The lakes are situated in the north central part of Lake County, Oregon, about 30 miles apart, and approximately 270 miles north of the intersection of the Deschutes and Columbia River. The plans call for the construction of pipe lines from the lakes to the confluence of the rivers, where it is proposed to locate a manufacturing plant, utilizing the available water power.

Present plans contemplate the construction of a wood stave pipe line 14 ins. in diameter to cost about $2,000,000. At the lakes it is intended to install pumping plants to cost about $500,000. The main feature of development will be a manufacturing plant which may call for an ultimate expenditure of $5,000,000. This plant will produce nitrates, potassium, sodium chloride, carbonate, bi-carbonate, caustic sodas and baking and bleaching powders. It is stated that plans for the development have been prepared by engineers of New York City. The local engineering work has been in charge of J. G. Kelley, Portland, Ore.

During the calendar year 1913 Costa Rica imported 37,931 bbls. of Portland cement (bbl. =397 lbs.). The countries whence imported and amounts purchased therefrom were as follows: Germany, 17,534 bbls.; United States, 14,696 bbls.; Belgium, 3,401 bbls.; Great Britain, 1,755 bbls.; other countries, 545 bbls.; total, 37,931 bbls.

A $540,000 HIGHWAY LETTING IN MINNESOTA.

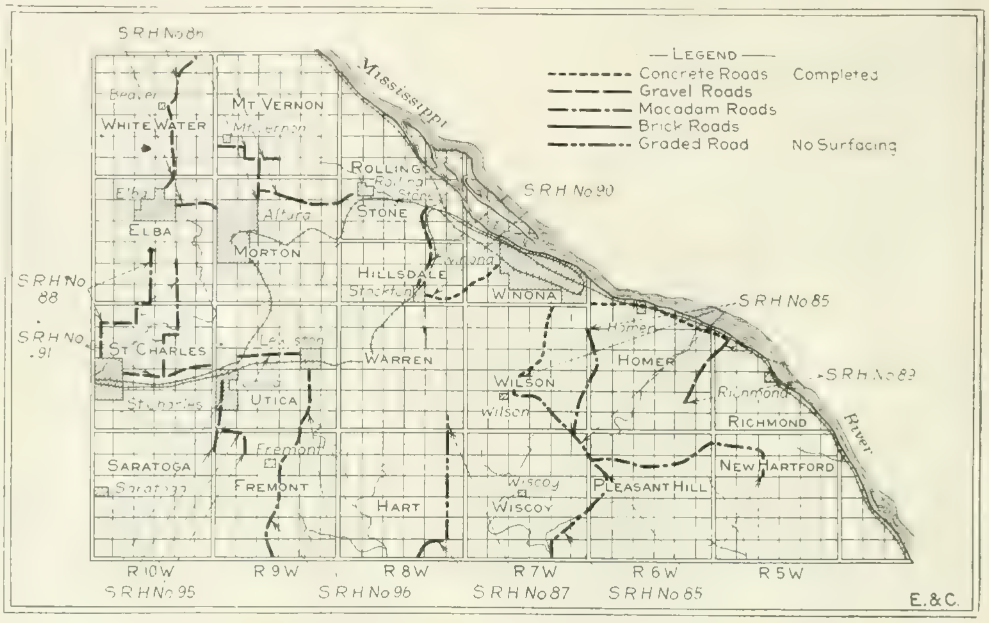
104 Miles of Road to Be Constructed in Winona County.

Excavation—Turnpiking — Macadam — Brick—Gravel—Culverts.

Bids are now being asked on one of the largest highway lettings ever held by a county in Minnesota. The undertaking calls for the construction of 104 miles of road, the estimated cost being $540,000. The work is to be done for Winona County under the Elwell Law, which provides for an issue of 10-year bondsd by the county. One-half the cost of the improvement is paid by the state, one-fourth by the county, and one-fourth by the benefited property owners. The roads to be improved are State Rural Highways Nos. 85, 86, 87, 88, 89, 90, 91, 95 and 96. Their locations are shown on the accompanying map. The approximate quantities for each road are given in Table I.

Separate bids for each of the roads will be received. No proposals will be entertained which by more than 30 per cent exceed the estimated cost. The work must be completed in two years. The contracts will be awarded subject to a favorable decision by the Supreme Court on some points of the law brought up by the bond companies and other interested parties.

Bids for the above work will be received until 2 p. m., March 23, by C. W. Anding, County Auditor, Winona, Minn. The improvements will be carried out under the supervision of H. B. Childs, District Engineer, Winona.



Location of Highways to Be Improved in Winona County.

TABLE I. APPROXIMATE QUANTITIES IN WINONA COUNTY ROAD LETTINGS TO BE HELD MARCH 23.

	No. 85.	No. 86.	No. 87.	No. 88.	No. 89.	No. 90.	No. 91.	No. 95.	No. 96.
Clearing, acres	6	.6	3	.3	1.8	1.2	...	[illegible]	1.2
Grubbing, acres	3	4	.3	....	.6				.
Earth excav., cu. yds.	22,520	27,270	17,600	7,440	7,500	[illegible]	16,590	4,800	14,060
Loose rock exc., cu. yds.	6,160	5,060	4,700	210	1,900	700	920	800	1,300
Solid rock exc., cu. yds.	900	2,150	700	. .	1,500		500	700	400
Turnpiking, lin. ft.	82,650	60,110	16,000	17,300	5,800	16,680	36,210	24,300	40,150
Macadam, sq. yds.	109,290		.	.....	.		.	.	13,500
Gravel, cu. yds.	..	15,395		5,620	3,520	3,640	10,920	4,700	6,000
Brick, sq. yds.	4,700	7,600	7,000	.....	.....	500		. .	. . .
Concrete, cu. yds.	360	320	55	30	45	360	200	70	70
Shoulders, cu. yd.	300	320	300	.. ...		100			.
Riprap, cu. yds.	150	125	120	.. ..	50	.	10		
Masonry, cu. yds.	510	350	1,068	20	30	0	60	.	.
Rock paving, sq. yds.	930	1,150	300²	. . . ..				.	
Scarifying mac., sq. yds.	24,000	4,500	. .	. . . . .	.		4,000⁵	.	....
Clay surfacing, cu. yds.	.....	2,000	...	.....			....	6,000	3,000
Drain tile, 6-in., lin. ft.	1,500	400	.	200	. .	800	500	.	
Bridges	1	2	2	......	...	.	.	.	1
Culverts, 12-in., lin. ft.	1,600	900	700	360	300	160	600	220	650
Culverts, 18-in., lin. ft.	1,700	1,250	.	450	300	250	1,000	400	1,000
Culverts, 24-in., lin. ft.	1,000	1,600	300	100	25	150	300	50	50
Culverts, 36-in., lin. ft.	300	200	500³	50	. .	100	.		
Culverts, 48-in., lin. ft.	. .	100	100	. ....	50	. .	.....	70	50
Culverts	¹	.....	3⁴	....	...	...	..	..	
Estimated cost	$162,510	$100,504	$38,678	$32,577	$17,845	$17,164	$50,7[illegible]	$23,543	$46,777

¹25 lin. ft. 10x6 ft. and 50 lin. ft. 6x6 ft. ²Lin. ft. ³30-in. ⁴One 10x5 ft.; two 7x8 ft. ⁵S[illegible]

Road Construction for Wells County, Indiana, for 1915.

Wells County, Indiana, is now calling for bids on road work estimated to cost about $63,000. This work covers all of the new construction contemplated for the present year. The locations of the road, types, lengths and estimated costs are as follows:

Location.	Type.	Length, ft.	Est. cost.
Jefferson	Stone	15,806	$10,453
Lancaster	Stone	3,960	2,967
Jefferson	Stone	5,195	3,241
Lancaster	Stone	9,430	7,278
Lancaster	Stone	7,994	5,228
Liberty	Stone	15,400	10,229
Bluffton	Macadam	1,317	3,595
Bluffton	Asp. macadam.	1,975	7,738
Bluffton	Macadam	3,700	6,884
Bluffton	Macadam	1,368	3,295
Bluffton	Macadam	692	1,648
Harrison	Gravel	2,648	1,931

Bids for the above improvements will be received until 10 a. m., March 19, by C. T. Kain, County Auditor, Bluffton, Ind. T. C. Guldin, Bluffton, is County Surveyor.

NEWS LETTERS

St. Louis Items.

Wm. List sent us a couple of postal cards from Florida last week, showing how easy they live and what good times they have in the sunny south. List expects to be back in Kansas City and on the job the latter part of this week.

Capt. A. V. Fetter has gone to Hot Springs, Ark., to get in condition for spring work. He expects to be back in time to begin work on his Government revetment job by March 15.

Mike Costello of Costello Bros. spent a couple of days with us. They have two steam shovels and 70 teams at work near Danville, Va. Bartley Cook is in charge of one of the shovels, while Rich and Con Costello are taking care of the other shovel and team outfits. C. J. Fox is boss of the office and bookkeeping. Mike's face got very red, clean to the back of his neck, when we asked him about the "girl" that is keeping close to Danville and when it "was going to happen." After some coaxing he said pretty soon, and promised to send us an invitation to the wedding. Let it be soon, Mike.

The $1,500,000 plant of the Alton Steel Co., which has been closed several months following receivership proceedings, probably will reopen about May 1, it was announced, following a conference of lawyers and bankers at Alton the other day. H. C. Fownes, Jr., of Pittsburgh, accompanied by his attorney, conferred with J. V. E. Marsh, attorney for the bondholders, and Fownes and his associates are said to have agreed to furnish $150,000 cash with which to remodel the plant and resume business. The plant was one of the largest in Alton and its closing threw several hundred men out of employment.

Tom Glynn died on February 1 at Terre Haute, Ind. His widow will finish the contract he had there at the time of his death.

Invitations were received by executives of St. Louis railroads to attend the ceremonies at the laying of the corner stone of the new union depot at Dallas, Tex., on March 9. The structure is being built by the Union Terminal Co. of Dallas, and with the terminals will cost $7,000. The proprietary roads of the terminal company are the Cotton Belt, Missouri, Kansas & Texas, Frisco, Houston & Texas Central, Rock Island, Atchison, Trinity & Brazos Valley, and the Texas & Pacific.

Federal Judge Hook in Kansas City has authorized an issue of $1,750,000 receiver's certificates of the Missouri, Oklahoma & Gulf. The proceeds of $750,000 certificates, which will be sold at once, will go for road construction and repairs.

John McInerney of McInerney & Kelly was in from their Elsberry Levee job. The frost is all out of the ground and they resumed work for the season.

Two bids made for the deposit of fire clay on the site of Kemper Park, Arsenal St. and King's Highway, were opened by the Board of Estimate and Apportionment. Both were rejected, as neither offered a price approximating the board's estimate of the value of the deposit. The municipal assembly recently passed an ordinance authorizing the board to advertise for bids for the purchase and removal of the deposit to the street grade. The highest of the two bids received was 4⅜ cts. per cubic yard. There are 74,000 cu. yds. of clay to be removed. The bids also were not made for the removal of the clay to the street level, as the bidders contended that the deposit of fire clay did not extend to that level. Comptroller Player, who is a member of the board, said that the fire clay deposits on the land adjoining the site of the park extended below the street grade. He said he will ask the Board of Public Service to make borings to test the depth of the deposit on the park site. The park site was donated to the city several years ago and has never been improved. It is 123 ft. in width and 1,847 ft. in length. Its surface varies from 16 to 5 ft. above the street level.

Ralph Oliver left Chicago last week with his wife for Florida. We are very sorry to hear that she had a paralytic shock there one day last week. Doctors advised taking her to a warmer climate, but from latest reports she is not improving.

The Park Board of Kansas City, Mo., approved plans for a bridge to be constructed across Brush creek to connect with the extension of Benton Blvd. into Swope Parkway. The approach from the north, which is to be 355 ft. in length, is to be of frame construction, while the approach of 64 ft. from the south will be of concrete. The total cost is to be $40,000, and it will be paid by a benefit district bounded by Linwood Blvd., Brush creek, Prospect Ave. and Cleveland Ave.

Keating Bros. secured a small job from the Chicago & Illinois Midland Ry. putting in a spur at Kincaid, Ill. They were also awarded some street work there the other day.

Announcement was made that the Missouri, Kansas & Texas System will send 105 of its St. Louis employes to Parsons, Kan., next month. This will be done in compliance with a court decision last fall to the effect that the Katy must maintain a larger force at its general offices at Parsons. While part of the general offices will be retained in St. Louis, it is understood that the entire claim department of 45 men and half of the auditing department, or 60 men, will be transferred to Parsons. The railroad was incorporated in Kansas and one of the provisions of the charter was that it should maintain general offices in Kansas. General offices accordingly were opened at Parsons and still larger offices have been maintained in St. Louis. Then the state of Kansas brought suit against the Katy and won.

Dan Sullivan will finish his work at McClure, Ill., in about five weeks, weather permitting.

Charles H. Degenhardt of Alton, Ill., was the lowest bidder on the building of the state aid road out of Alton, bids for which were opened at Springfield. Mr. Degenhardt's bid was $29,982. Robert Curdie, another Alton contractor, bid $32,666. Other bidders were Hanes & Nelson, $30,195; the Granite City Lime & Cement Co., $32,100; Walter Coonan of East St. Louis, $33,100; P. M. Johnson & Co. of East St. Louis, $30,980; the Dumlap Dinold Construction Co. of Edwardsville, $32,981; Meyer & Thomas of East St. Louis, $33,300. The engineer's estimate of the work, exclusive of machinery and materials to be furnished by the state, was $33,366.70.

The Missouri, Kansas & Texas is considering a proposition to build an extension from Newcastle to Cisco, Tex., a distance of about 50 miles.

Geo. C. Smith & Sons were awarded 40,000 yds. of more work near Valmeyer, Ill., a continuation of the ditching they had been building over a year and which they finished recently.

E. P. Bracken, general manager of the Burlington R. R., W. C. Welch, superintendent, and other officials of the road were in Alton negotiating for better trackage arrangements between Alton and East St. Louis. The Burlington sends a large volume of freight over the Alton bridge, and having no track of its own between Alton and East St. Louis, now use the Big Four. The negotiations for better trackage are with the Bluff Line and the Illinois Terminal and include yardage arrangements at Alton with the Illinois Terminal. Another conference was arranged for next week.

Roger Faubin of the J. W. McMurray Contracting Co. was in from Cape Girardeau, Mo. They will resume work at that point on the Frisco R. R. as soon as the river and weather permits.

Chester Bondurant informs us that he has 100,000 yds. of levee work opposite Hannibal, Mo., that he will sub-let at a good price. Does not want to move any of his outfits from the southern jobs if he can help it. The Bondurant Construction Co. has secured 2,000,000 yds. of additional levee work at the letting at Clarksdale, Miss. This work runs from mile 35 down to below Friars Point, Miss. With the exception of 2 miles, this work has all been sub-let. The Bondurant Construction Co. headquarters are at Hickman, Ky.

The Board of Public Service last week directed that Florissant Ave., between Carrie and Bernays Aves., be paved with asphalt, overruling a protest by several residents on the street. The cost is estimated by the board at $101,460. The paving will extend the entire distance in front of Bellefontaine and Calvary cemeteries. It is planned to place the street car tracks on the north side of the highway, leaving a roadway of 52 ft. unobstructed by car tracks. This will eliminate trolley poles on one side of the street. The board decided not to pave Robin Ave., Vermont Ave., Goethe Ave. and Union Ave., between Florissant and Lillian Aves., at present. These sections of streets proposed to be paved are in districts inhabited by small home owners, and a majority of the residents protested against the improvement until their homes are paid for. Soulard St. will be paved with asphalt, according to the order of the board.

Edw. Longevine, superintendent on one of the Merritt-Gilbert Contract Co. ditch jobs, near Cape Girardeau, Mo., became the proud papa of a baby girl last week. Mrs. Longevine and the girl are getting along nicely.

The Bondurant Construction Co. of Hickman, Ky., sub-let 500,000 yds. of levee work near Longwood, Miss., to Roger Holmes, who will do this work with a cableway machine.

Steel construction work for the new bridge over the Mississippi River at Memphis, Tenn., will begin in a couple of weeks. The Virginia Bridge & Iron Co. will begin work on the Arkansas approach as soon as the overflowed ground has dried out.

Kremer & Voirol were awarded the contract to erect a new exchange building for the Southwestern Telegraph & Telephone Co. in the western part of the city. The building will be a three-story structure, and the estimated cost, exclusive of equipment, is $18,000.

Geo. W. Thompson, a prominent contractor and builder of Bowling Green, Mo., died on Feb. 19 at the age of 49 years. The funeral services were held in Bowling Green on Sunday, Feb. 21, from the Baptist Church.

Charles Fleming is in serious condition in the hospital in Forest City, Ark., as a result of a pistol duel that happened on Feb. 22 between himself and Thos. Keen, a planter near Round Pond, Ark. Fleming was on the point of selling a bunch of cattle under mortgage as administrator of an estate in which Keen was financially interested, it is stated, when Keen got an injunction preventing the sale, and when he and his attorney appeared on Fleming's premises, an argument ensued and before friends could interfere both men had emptied their weapons. Keen was rushed to Memphis, where he died, and Fleming was sent to the hospital in Forest City, where, it is stated, he would recover.

T. J. Dolan, the hustling secretary of the International Brotherhood of Steam Shovel & Dredgemen, was here last week as a delegate to the deep waterway convention. Dolan left for Pittsburg, Kan., where there are several hundred brotherhood men employed. He reports that he has several good steam shovel runners idle in Chicago that he would like to place on work immediately.

Chas. Nagel spent a couple of days in town. Nagel will begin getting out rock for the Government revetment north of here next week.

J. W. McMurray was in and out of town last Monday. Left here for Kansas City, promising to be back one day next week. He is ready to begin on his new revetment job north of the city as soon as the water in the Mississippi falls sufficiently to allow him to do so.

Two weeks of warm weather here has taken all of the frost out of the ground and public works opening up with a rush. While labor is plentiful here just now, it will only be a matter of a few weeks before it will be a scarce article. We would advise all contractors and railroad companies who intend to do any work this year to get an early start if they expect to get any labor out of St. Louis.

Contractors having idle outfits and wanting work for same write Koenig's Labor Agency, 612 Walnut St., St. Louis, Mo., or 503 W. 5th St., Kansas City, Mo. Koenig will post you on new work and see that your outfits are put to work in a hurry.

The St. Louis County Court will issue a permit to the city to construct a water pipe line from the city limits along Bellefontaine road to the new Industrial School at Ft. Bellefontaine. In consideration of the granting of the permit to the Board of Public Service will sign an agreement that water will be furnished for household purposes to persons living adjacent to the pipe line until such time as the St. Louis County Water Co. installs a water service in that territory. An appropriation of $40,000 is available for this job.

The Gilsonite Construction Co. of St. Louis was awarded the contract for the construction of a new mill building at Chester, Ill., by the H. C. Cole Milling Co. The building will be a six-story structure of concrete and glass and will include engine room, warehouse and offices. It is to be finished by July 1. The contract for machinery and equipment will be let in a few days.

Chas. A. Truitt of the Federal Boarding & Commissary Co., has opened an office at 328 River St., Chicago, but spends a good deal of his time around the Illinois Athletic Club.

The question of establishing a new passenger station for the steam railroads at Main and N. Market Sts. and of extending the tracks of the United Railways lines to it, was presented to the State Service Commission, which met at the Hotel Jefferson last week. The measure is being urged by the St. Louis Real Estate Exchange and the civic improvement associations of the northern part of the city.

The controversy between City Auditor Sheehan and the Board of Public Service with regard to the appointment of William F. Collar of New York City as superintendent of construction for the eastern approach to the free bridge was settled on Feb. 24 when the Board of Estimate and Apportionment approved the appointment. Sheehan refused to audit the salary voucher of Collar for four days of the first half of this month at the rate of $350 a month, on the ground that under the charter his appointment as an expert should be approved by the Board of Estimate and Apportionment. President Kinsey of the Board of Public Service contended that this approval was not necessary, inasmuch as Collar was appointed under a recent ordinance authorizing the expenditure of $100,000 for labor and material on the approach. At a conference on Feb. 24 between Kinsey and the members of the Board of Estimate and Apportionment, Mayor Kiel and Comptroller Player, it developed that the issue was based on a technicality, as there was no opposition to Collar's appointment. To avoid delay, Kinsey asked the approval of the board, and it was given.

The John L. Roper Lumber Co., Norfolk, Va., want to let a contract for cutting and clearing off 100,000 acres of land in Virginia in blocks of 10,000 acres. A. B. Koenig.

PERSONALS

Mr. C. F. Wallow has been appointed city engineer of York, Pa. Mr. Wallow has been connected with the York city engineering department for about twelve years, first as draftsman, then as assistant city engineer, having charge of a field party. He also has had experience in railroad work, and in contracting and construction of municipal work.

Mr. R. Fraser Armstrong has been appointed engineer and superintendent of water and sewerage at St. John, New Brunswick. Mr. Armstrong is a graduate of the University of New Brunswick, and took a post-graduate course at McGill University in water supply, hydraulics and sanitary engineering. For the past four years he has been engaged in general municipal consulting work in Western Canada.

Professor Arthur H. Blanchard of the Highway Engineering Department at Columbia University, on Feb. 9, delivered an illustrated address on the subject "Economic Phases of Highway Engineering" before the Middletown Scientific Association at its meeting at Wesleyan University. On Feb. 11 he delivered an address on the subject, "The Highway Engineer in Public Life" at the annual meeting of the Engineers' Society of Northeastern Pennsylvania.

Mr. Walter G. Kirkpatrick, member of the American Society of Civil Engineers, and until recently, city engineer of Birmingham, Ala., and special engineer in the executive department of the Alabama Power Co., has opened an office at 703-704 Farley building, Birmingham, Ala., and has again taken up the practice he formerly conducted, including consultation, reports, valuation, designs and supervision for water supply and filtration, sewerage and sewage disposal, garbage disposal, paving and hydro-electric power development.

Mr. Howard S. Morse has been elected director of the Cincinnati Bureau of Municipal Research. Mr. Morse is a graduate of the Massachusetts Institute of Technology, and was for a time assistant instructor in civil engineering at that school. From 1904 to 1907 inclusive he was an engineer with the U. S. Reclamation Service. From 1908 to 1911 he was resident engineer for the Commissioners of Sewerage at Louisville, Ky. For two years following Mr. Morse was engineer in charge of the Division of Sewerage, Department of Public Service, Cincinnati. Recently, until selected for his present position, he has been engineer for the Ohio Institute for Public Efficiency, Columbus, Ohio.

Mr. Charles P. Williams of Great Falls, Mont., has been assigned to the position of acting supervising engineer, northern division, U. S. Reclamation Service, having supervision of the work in Montana, North Dakota and northern Wyoming. Mr. Williams is a member of the American Society of Civil Engineers, and a graduate of the University of Missouri. For ten years he was employed in work under the Corps of Engineers, U. S. Army, including river and harbor improvements and the constructing of sea coast defenses. For ten years past he has been with the Reclamation Service, engaged in design and construction work. He has been successively project engineer on the Huntly and Milk River projects in Montana, and the Shoshone project in Wyoming. For the past three years he has been engaged chiefly in executive work in connection with work in the Northern Division and on specifications and designs for irrigation works for the Sun River and Milk River projects and for the St. Mary Storage Unit.

Mr. J. W. Fletcher has been appointed engineer in charge of valuation, construction, betterments, inspection, tests and standards for the Carolina & Northwestern Railway, with headquarters at Chester, S. C. Mr. Fletcher has been connected with that railway since March, 1899, in December of which year he was appointed roadmaster. In July, 1913, he was appointed roadmaster in charge of all maintenance and engineering. Prior to his connection with the Carolina & Northwestern, Mr. Fletcher had been employed in various fields of engineering work. His first experience was with Carter & Parks, civil engineers of Knoxville, Tenn., in 1888, soon after leaving the University of Tennessee. He was in private practice for several years, and later was engaged on construction of various Tennessee railways. For a time he was in charge of water works construction at Knoxville, and from 1895 to 1899 was employed by G. W. Sturtevant, consulting engineer of Chicago, on water works, surveys and railway locations. For a time he also engaged in gold and talc mining in North Carolina.

Mr. W. J. Fairbairn has been elected by the City Commission of Big Rapids, Mich., as general manager for that city, succeeding Mr. Claude E. Chappell, who resigned to accept a similar position at Jackson, Mich. Mr. Fairbairn will have the management of the city water works, sewers, highways, bridges, fire department, police department and such other work as the commission shall order. Mr. Fairbairn is a young man with considerable municipal engineering experience. He started in his career with the Standard Engineering Co. of Detroit, and later was employed by Charles E. Wisner, mechanical engineer of Detroit. For a time he was on the U. S. Lake Survey at Sault Ste Marie. He then attended the University of Michigan, and in 1906 entered the service of the Detroit Water Board, rising to the position of superintendent of construction and having charge of a number of important undertakings in street work, water main extensions and concrete construction. In 1912 he went to Springfield, Ohio, where he practiced civil engineering and was employed on design and construction of steel and reinforced concrete work, surveys, and on machine designs, etc.

Mr. R. O. Wynne-Roberts announces that his engagement with the Regina, Sask., city council, as their consulting engineer will terminate on May 31. The name of Mr. Wynne-Roberts is well known to readers of Engineering and Contracting, as he has frequently contributed to its columns. He has had a long and arduous training in his profession, having practiced since he was 18, largely in municipal engineering work in Wales, England, South Africa and Canada. He began as assistant town engineer of Llandudno, Wales, holding that position for over seven years. For five years he was borough, water and gas engineer of Carnarvon, and later was selected from a list of 120 candidates as borough and water engineer of Oswestry. In 1898 he was chosen out of a list of 70 candidates as city and water engineer for Capetown, South Africa. He held that position for eight years, and accomplished a vast amount of municipal work in that time. For four years following his return to England, in 1907, he practiced as consulting engineer and was employed by several municipalities and by the British Government in important municipal matters. In 1911 he visited Canada, and the United States, and shortly after was retained by the city of Regina as consulting engineer. He has also been engaged by the Provincial government of Saskatchewan and by other municipalities. The Regina water scheme will ultimately cost about $2,000,000. Mr. Wynne-Roberts is a member of the Institution of Civil Engineers, Canadian Society of Civil Engineers, Institution of British Water Engineers, Institution of Municipal and County Engineers, American Water Works Association, Illinois Water Supply Association and is a Fellow and Examiner of the Royal Sanitary Institute. He is the author of a number of books on sewage disposal and hydraulic calculation and of innumerable articles for the technical press.

CONTRACTORS.

Mr. Edgar H. Adams has opened an office as general contractor at 278 Madison avenue, New York City. Mr. Adams is prepared to take out-of-town work, making country residences his specialty. He has in hand at present a large private residence at Waterbury, Conn., and a number of New York City structures. Mr. Adams has been in the contracting business for about eight years. He graduated from the University of Vermont in chemical engineering. For ten years he worked as chemical engineer, then entered practical construction work, learning both the mason and carpenter trades. For eight years he has been superintendent of construction and estimator, taking full charge of the work. During the past two years Mr. Adams has specialized in country house work, having constructed more than $123,000 of this class of building in New York City and vicinity, and has also done some factory construction work in Brooklyn.

Mr. R. M. Hudson, 422 Healy Building, Atlanta, Ga., who was recently awarded a $200,000 sewer, water and paving contract at Manatee, Fla., has been in business for twenty years, and has constructed many of the streets, sewers, and water pipe lines in the southern cities. Some of his more important works of recent years are as follows: sheet asphalt paving at Charlotte, N. C., $175,000; sheet asphalt, Concord, N. C., $30,000; sheet asphalt and asphaltic concrete at Columbia, S. C., $150,000; sheet asphalt, Charleston, S. C., $55,000; bituminous macadam, Atlanta, Ga., $100,000; brick paving, Hillsborough County, Florida, $60,000. The present contract includes 21,000 ft. of water pipe, power house, storm and sanitary sewers and 44,476 yards of brick paving.

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and to Methods and Cost of Construction

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Honors for the Engineers of the Panama Canal.

A merited recognition of the services rendered by the engineers of the Panama Canal was given by Congress in the closing hours of its session just finished. Col. Geo. W. Goethals was advanced in rank to major general and his army assistants, Col. H. F. Hodges and Lieut. Col. W. L. Sibert, were made brigadier generals of the line. Brigadier General Wm. C. Gorgas was promoted to major general, medical department. The navy representative on the Commission, Commander H. H. Rousseau, was made rear admiral. With the act providing for these promotions went the formal thanks of Congress to the officers named.

These are not spectacular honors and spectacular honors would not have been welcomed by the men signalized. There was little of the spectacle in the manner of the bestowal. Honor of an unusual degree was, however, shown by the action of the Senate in confirming the nominations immediately upon their presentation. The formal thanks of Congress carried with the promotions are no less unusual. No mark of distinction which great nations bestow for notable service has been so rarely awarded as the thanks of the Congress of the United States of America.

The Effect of Improved Methods of Manufacturing Paving Materials Upon the Construction of Various Pavements.

New paving materials are in reality most generally materials formerly in use but abandoned on account of developments in the manufacturing of other materials previously inferior in quality. It would seem that all materials in use at the present time have had their day of popularity and superiority and many appear to have had several periods of popular favor among engineers. This popularity, however, is influenced by other factors, such as the type of traffic and suitability to local conditions.

The influence of methods of manufacture upon the quality of the pavement is well illustrated in the use of stone blocks. Stone blocks have been in use since the time of the Romans but the characteristics of stone block pavements have changed repeatedly. The modern machine cut stone blocks laid upon a mortar bed result in a distinctly different pavement from that produced by the use of the old type of rough blocks.

Improvements in the methods of preparing asphalt have resulted in the development of pavements suited to any temperature and capable of withstanding the wear of various types of traffic. The uses of asphalt have been increased in number until it finds a place in construction of practically all types of pavement. This has come about largely through improved methods of manufacturing. Similarly paving cements manufactured from coal tar have found an enlarged field of usefulness through the work of the chemist and manufacturer.

Wood block pavements have passed through various stages of development and in each stage the characteristics of the pavement have changed. Throughout their process of development the manufacturer and not the builder has influenced the changes.

Similarly in the development of Portland cement and its application to paving uses and the discovery of various mineral binders of utility in pavement construction the efforts of the manufacturer are again felt. Vitrified brick furnish perhaps the best illustration of this point. Fifty years ago the best brick manufactured were considered too soft to withstand the wear due to iron tired vehicles. Recent tests have demonstrated conclusively the strength and toughness of modern paving brick.

The important part played by manufacturers and chemists and engineers employed by them in the development of various materials of construction is worthy of praise. That further developments will be made there can be no doubt. It would seem that the endowment of scholarships to be used for experiments with and study of paving materials in various universities would further rapid improvement. We commend this procedure to the attention of manufacturers.

Financial Safety Engineering.

A notable article on water power development is published in another section of this issue. There are two sorts of engineering problems to be solved in every water power development: (1) engineering *business* problems, and, (2) engineering *technical* problems. The defining terms used are not remarkably apt, but their meaning will, we think, be plain. Also water power engineering is not the only kind that involves both the sorts of problems named; it is, though, a kind that presents them perhaps most distinctly. It therefore affords particularly excellent exemplification of the subject selected here for comment and which we, borrowing an idea, have called financial safety engineering.

Water power engineering records more failures than any other kind, perhaps, though as the words are written there comes to thought irrigation engineering. These failures have rarely been engineering failures in the sense that good engineering was lacking in design and construction—in solution of purely technical problems. Nearly always the failure of a water power development can be traced to inadequate consideration—often no consideration—by the engineer, of the fact laid down by the writer in another column as the one of supreme importance: the necessity for the complete control in water power work of the engineering *business* problems over the engineering *technical* problems. If we turn to irrigation works, hinted at above as a rival to water powers in number of recorded failures, we find the same fact true.

Conceding to the engineer all that we can, the conclusion still remains true that his thought has been directed more often to the technical excellence and completeness of his work than to its financial safety. The harvest of this sowing has been the condition that the writer of the article in this issue indicates so clearly. A little further analysis will demonstrate better the logic of this condition. Keeping to the illustration selected the banker who finances a water power knows that success depends upon the balancing of financial forces just as unyielding and persistent as any with which the engineer deals in his work of design and construction. Gross revenue from users must balance investment and operating charges. This is the least requirement that will prevent failure. Considering that both of these forces can only be estimated, the difficulty that confronts the banker is evident. At the very best he assumes risk. This risk he feels is intensified by the fact that commonly the engineer's estimate of investment and operating costs cannot be depended upon, and more than commonly the engineer has made no intelligent estimate of probable revenue.

These are not statements that please the engineer. They were never true of many engineers. They are much less true now of all engineers than they were even a few years ago. But they are still true of enough engineers to call forth frequent criticism. These columns have contained within a few weeks entirely just criticisms and well attested examples of sinfully faulty engineers' cost estimating. One will not concede for a moment that these facts exist because engineers cannot estimate correctly. They exist, as we have very recently remarked editorially, because engineers do not all grasp the truth that estimating the cost of an engineering work means more than approximating the physical construction expenditure necessary. If this were the full duty of the engineer estimator at any time, it certainly is not now his full duty; the estimating of construction costs is a part only of the art of engineering estimating.

To secure money for developing the water power described in this issue the engineer was bound financially to guarantee the cost of the plant. The circumstance is, we believe, unique. Comment on the justice and equity of the action will not concern us here. The fact emphasized is that this action begot as noticeable a piece of financial safety engineering as we now readily recall. The story is too well told in the article which we republish to bear repeating. There is in this story a most useful lesson in engineering. It is a lesson in the "new engineering," whose epoch is beginning.

The engineer has established his reputation as a technician. Capital does not doubt engineering ability to design and construct a water power plant or an irrigation works of the highest mechanical efficiency and structural durability, but it does doubt, except in proved individuals, engineering ability to determine the financial safety of such works. The new engineering, without excluding anything of the technical attainment now possessed, includes ability to appraise the financial safety of engineering works. The engineer who can meet these demands on his talents will possess a worth that brings fortune and reputation.

Planning Road Crossings of Drainage Ditches to Permit Ditch Enlargement.

Drainage work and road construction are beginning to interfere with each other in many of the western states. In some cases roads have been constructed first and offer obstacles to the planning and building of economical drainage works; in other cases the country was ditched first and the drainage works planned without roads in mind have become obstacles to the road builder who later came into the field. These conditions are certain to be intensified as time goes on. New drainage works are being built in greater numbers and old drainage works are being enlarged in still greater numbers while improved road construction is being promoted and planned for prosecution in volumes far beyond any conception a few years ago of the probabilities. A real problem in construction of drainage work and road construction confronts many sections of the middle west, and this problem is concerning the state and country drainage and road officials.

The problem of co-ordinating road construction and drainage works has two phases. One phase presents itself where swamp or overflowed lands are being reclaimed and where drains and roads [illegible] works. The other phase is presented where drains or roads have previously been laid down and either the road builder or the drainage engineer coming later must fit his plans to the existing works of the other.

In wholly new land reclamation the problem of co-ordinating drains and roads is comparatively simple. Recent practice in Minnesota offers a good illustration. In this state main roads are, as an integral part of the reclamation plan, laid down along the main ditch lines, the spoil from the ditches being used for grading the roads. Where main ditch lines do not submit to such regularity of plan as in Minnesota, modifications will be necessary, but the broad idea of planning main ditches and main roads as integral parts of one construction is universally applicable. Such co-ordination of drain and road planning eliminates very largely all troubles of adjustment of drain and road crossing structures. If the reclamation plan is comprehensive and well thought out it will be quite certain that future changes in ditch sizes will not be required, or if they are required it will be quite certainly known where they will be required. The road crossing bridge or culvert can then be built with certainty that it will remain, or so built that future expected ditch enlargements can proceed without changing the crossing structure.

When the problem is to fit new drain work to existing roads or new road work to existing drains the problem of co-ordination is confined largely to determining the manner of handling crossing structures. Modern improved road structures across waterways are all-masonry or masonry and steel construction. They are too expensive to permit their demolition and reconstruction to be regarded with unconcern. A desired and otherwise financially practicable ditch enlargement may easily become impracticable with the removal and rebuilding of a few such crossings in sight. On the other hand, to the road engineer, there is nothing good in the thought that he should plan every ditch crossing structure so as not to obstruct a future ditch enlargement which may sometime be desired but which quite as likely never will be desired. Yet conditions require something to be done.

The things to be done are interestingly suggested in a paper by S. L. Kennedy of the Minnesota Engineering Society. They are: first, mutual recognition by the road and drainage officials of the interelation of certain of their construction problems, and second the adoption for drain crossings by roads of types of structures which permit ditch deepening without reconstruction. For example, bridge crossings should be founded on piles or steel cylinders which can be excavated around and built downward for a deepened ditch. When smaller openings are required corrugated culverts, which can be dug out and lowered by dredge, are suggested. In most state road departments very well thought out standard bridge and culvert designs exist. It would be interesting if these departments would study plans of road crossing structures for drainage ditches with the view of devising ones which would permit ditch deepening without heavy expense for remodeling the crossing structure.

Recent Progress in Electric Steel Production.

The rapid progress made in the United States in the installation of electric furnaces for producing steel indicates that the production of electric steel has now passed the experimental stage and has entered the commercial field as an important factor. Although the operation of electric furnaces was originally confined almost exclusively to the production of steel castings, its use appears to be established in the refining of Bessemer and open-hearth steels and in the production of high-grade alloy and other special steels. To indicate the rapid progress made in this country, and to compare it with the progress made in foreign countries, the following data compiled by The Iron Age are given:

In 1909 there were only 2 electric furnaces in operation in this country, in 1910 there were 10, in 1913 the number had risen to 19, while there are now 41 such furnaces. Outside of the United States there were 63 electric furnaces in 1909, 104 in 1910, 121 in 1913, while at present there are 172. It is thus seen that the electric steel industry promises soon to reach large proportions in this country.

In European countries the largest use has been in the production of tool and other special steels, but in this country 22 out of 41 installations are for the production of steel castings, while its use in refining Bessemer and open-hearth steels is being largely extended. The present war will undoubtedly give great impetus to the production of electric steel in the United States as importations of special steels heretofore have been high. It is of interest to note that practically all of the advance in electric steel making has come from within the steel industry and is the result of competitive efforts of manufacturers to improve quality. Electric steel undoubtedly will play an important part in the construction of future long-span bridges.

Underestimating the Cost of Motor Trucking.

There have been published numerous estimates of the cost of hauling with auto trucks. Also there have been many statements as to the "actual cost" of such hauling. But the term "actual cost" has usually been a misnomer, for at least part of the actual cost—and often a very large part—has been merely an estimate. Now, an *estimate* may be based on *cost data*, or not, but an estimate is hardly cost data.

Mr. Everett N. Bryan, in a letter to *Engineering Record*, protests against the publication in that journal of some misleading "costs" of hauling with auto trucks—"costs" of about 6 cts. per ton-mile—and he closes his letter with this statement:

> Cost data, like dynamite, are very useful tools in proper hands, but their accumulation and use by the inexperienced are fraught with danger.

His criticisms of the 6-ct. ton-mile costs, however, are not leveled at the items of actual cost—the cost data—but at the estimated costs of repairs, depreciation and interest. Therefore his closing criticism of published cost data is hardly justified. But he is on sounder ground when criticizing certain estimated costs of interest, repairs and depreciation per ton-mile.

It is evident that Mr. Bryan has had enough knowledge of trucking costs to enable him to offer good suggestions as to estimating. Starting with the actual performance in the given case, he builds up an estimated total cost of nearly 11 cts. per ton-mile, details thus:

DAILY EXPENSES OF 5 TRUCKS FOR 1,600 TON-MILES.

			Cost in cents per ton-mile.
Hauling—			
Labor:			
Ten drivers	$30.00		
Extra drivers	3.50		
Four laborers unloading	8.00		
Total		$41.50	2.594
Fuel and lubricants—Five trucks making twenty 8-mile trips at 4¾ cts. per mile		38.00	2.375
Repairs and extras at approximately 3.09 cts. per mile		24.72	1.545
Tire renewals at approximately 3.50 cts. per mile		28.00	1.750
Interest, insurance and depreciation at approximately 5.125 cts. per mile		41.00	2.562
Total for hauling		$173.22	10.826

The drivers were paid $3 for 12-hour shifts. Each truck hauled 4 tons of broken stone, traveled 160 miles, and thus averaged 320 ton-miles per 24-hour day, the average length of haul being 4 miles. No trailers were used.

Mr. Bryan, based on his own experience, estimated that the item of repairs (including miscellaneous small items of expense) and renewals (except tire renewals) would not average less than 65 per cent of the cost of fuel and lubricants, or about 3.09 cts. per mile.

With a 5-ton truck his experience has been that tire renewals cost 4.58 cts. per mile, from which he infers that it would be 3.5 cts. per mile for a 4-ton truck. He estimates yearly interest, depreciation and insurance on a $4,000 truck (4-ton) as follows:

Interest, 6 per cent of $4,000	$ 240
Insurance	55
Depreciation (exclusive of repairs, renewals and tire expense)	730
Total, 20,000 miles at 5.125 cts.	$1,025

Speaking of depreciation, Mr. Bryan says:

> In the writer's opinion, barring special conditions and special cases, perhaps 100,000 miles is an ample life to assume under average conditions. And the mileage per year for an ordinary road contractor's truck, again leaving out of consideration trucks purchased for a special freight haul, or any other what might be termed haul on schedule, should be placed at not to exceed 20,000 miles. . . . This would give a life of five years to the truck, and it is safe to say that after five years of service, particularly at this stage of motor-truck development, and in view of the advance being made in tractor haul, the contractor should plan to have run out the life of his machine.

It should be noted that in the above given estimate, there is nothing for taxes and for garage expense. Even where a motor-truck is used in the country during the road building season, it should be remembered that it requires housing in the winter. However, the cost of housing is relatively slight, and taxes do not ordinarily exceed 1 to 1.5 per cent.

The two factors most likely to be disputed are the prospective economic life of a motor truck, and the annual mileage that it can be counted upon to perform under normal conditions. As to the life, it seems to us that much more than 100,000 miles may be safely expected.

Road rollers usually average about 100 days of actual work each year, even in the colder northern states. It seems reasonable to estimate fully 100 working days per annum for a motor-truck used exclusively on road work. Question may well be raised as to whether night shift work will be economic in the long run, particularly when the time comes that motor trucks are more common. Motor trucks that are used for roadwork are also used for other work when the road season is ended, so that the annual mileage is not confined to the road season.

There is a large field of usefulness ahead of the motor truck for contracting purposes. But the introduction of motor trucks will be retarded by claims of economy that can not be fully realized. An inevitable reaction occurs as the result of hopes that prove to be too sanguine. Conservative estimates are to be encouraged, particularly when based on experience extending over considerable time. The danger of underestimating costs does not arise from published cost data, but either from a lack of such information or from failure to secure and analyze the cost data that have been published.

Pinnacle Rocks in Alaskan Ship Channel.—Field Engineer John A. Daniels of the U. S. Coast and Geodetic Survey, has located 21 dangerous rocks in 42 miles of ship channel in Alaska during the past season, according to a report sent out by Secretary of Commerce Redfield. These rocks were located by means of a wire drag more than a mile long, the wire being supported by cables to surface buoys and towed along by power boats.

One of these rocks is of pyramid shape and rises over 600 ft. from the bottom of the channel to within 17 ft. of the surface. It is surrounded by deep water on all sides and is now located on the chart where a 109-fathom sounding was formerly recorded. Field engineer Daniels speaks of this 600-ft. pyramid as a sort of a submerged Washington Monument. He says that if the lead struck it in the old survey it probably slipped off into the deep water of 109 fathoms alongside. But he thinks it is more probable that it came in between two soundings and was missed altogether.

BRIDGES

Design and Construction of the Main St. Reinforced Concrete Viaduct at Fort Worth, Tex.

The cost of falsework required for arch construction, and the difficulty of building and maintaining it in streams subject to floods, have often resulted in the construction of other types of bridges. To obviate the use of falsework in the construction of reinforced concrete arches structural steel reinforcement of the arch type has been used, the reinforcement being designed to carry all loads during construction. For high structures over streams subject to sudden and great variation of water level this method of construction is often cheaper and safer than to use falsework supported from the bed of the stream. The following article describes the design, construction and cost features of the Main St. Viaduct at Fort Worth, Tex., the data being taken from a paper by S. W. Bowen, in Proceedings, American Society of Civil Engineers, Vol. XL., p. 1761. The illustrations and some of the data were obtained from Mr. Bowen. The author in his paper also describes three other bridges, one of which, the Samuels Ave. Viaduct, was fully covered in a contributed article appearing in ENGINEERING AND CONTRACTING of April 29, 1914.

The city of Fort Worth, Tex., is traversed by the Trinity River and its branches, this river being very crooked and requiring the construction of a number of bridges. The Main St. Viaduct, which is to be described, is the largest and most important of the four bridges recently constructed. This viaduct has a 54-ft. clear roadway and two 8-ft. sidewalks, provisions being made in the design for two electric interurban car lines in the center of the roadway. The length of this viaduct, from the end of the north approach to the center of the south abutment is 1745 ft. 3 ins., this length being made up of one 225-ft. arch span over the stream; two 175-ft. and one 150-ft. arch spans; one 68-ft. 9-in., two 62-ft. 6-in., seven 50-ft., and two 25-ft. girder spans; and an earth fill approach between concrete retaining walls of the semi-gravity type. The south approach is curved and consists principally of low retaining wall construction. Figure 1 shows a general elevation of the viaduct and indicates the topography at the site. In general, ornamentation is confined to the main lines of the structure and to the use of paneling and moldings. The railings are simple in outline and are designed with a view to easy construction. Balconies are provided at the tops of the arch piers and abutments.

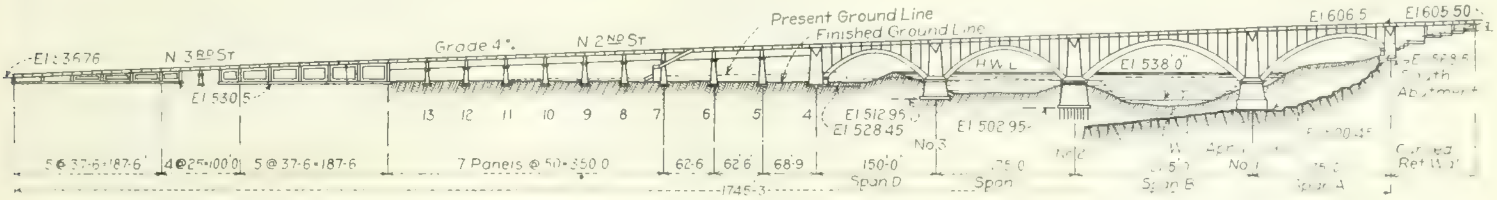


Fig. 1. General Elevation of Main Street Viaduct, Fort Worth, Tex., Showing Types of Construction and Span Lengths.

FOUNDATION CONDITIONS.

With the exception of a small portion of the site, rock lies at too great a depth below the surface to be reached, except at excessive cost. At Main St. bed-rock lies at a depth of from 40 to 50 ft. below the ground surface north of the stream. On the south side the rock crops out at the surface on top of the bluff. About twenty years ago a landslide occurred on the south bank of the stream. The earth and loose rock overlying bed-rock slid toward the river, partly wrecking the old bridge. This slide extended for several hundred feet along the stream. It was probably caused by water seeping down from the bluff and softening the material in the hillside.

The material on the south side of the river consists of loam and clay interspersed with loose rock and boulders brought down by the slide. This material is underlaid with ledges of rock, varying in thickness from 6 ins. up, with thin layers of hard clay or shale between them. The layers are horizontal, and they increase in thickness with the depth. The material on the north bank, to a depth of 10 or 12 ft., consists of a black, sticky, clay-like substance, which has the property of remaining very hard when moist and not exposed to the air, but which disintegrates when exposed to dry air for a few days. Under this surface material there is a very dense yellow clay, underlaid with sand. This sand increases in coarseness with the depth, and merges into gravel near bed-rock. The surface material was tested at a depth of 8 ft., and sustained a load of 3.3 tons per square foot without appreciable settlement.

RIVER CONDITIONS.

The Trinity River, although normally a small stream, is subject to sudden freshets, and carries large quantities of drift. The banks are steep and the run-off is rapid. As an example of the rapidity of the rises, a flood occurred during the summer of 1912, before work started, and another in September, 1913, while work was under way. During the first mentioned freshet a rise of 23 ft. occurred in 24 hours. This rise was gradual compared with the last mentioned flood, where the rise amounted to 16 ft. in about 1½ hours. The first 14 ft. of this rise took place in about 1 hour. As such floods as these are not unusual they render work in the bed of the stream decidedly hazardous.

SELECTION OF TYPE OF STRUCTURE.

Because of the conditions mentioned above it was necessary to adopt a type of structure that would not be injured by such slight unequal settlement as, under the circumstances, might be expected to occur. It was also thought advisable to use, at least for the arch spans, a method of construction that would not require falsework in the stream.

After a careful consideration of various types, it was decided to use, for the main spans of the viaduct, three-hinged, ribbed arches, with structural steel reinforcement designed to support the weight of the forms and the plastic concrete of the ribs and braces during construction. For the approach spans and for the river spans of the smaller viaducts girder spans were adopted.

The three-hinged arch was selected because it would not be strained by unequal settlement, because the stresses are statically determinate, and because the temperature stresses are eliminated. Ribbed construction was adopted as being light and best adapted to the use of hinges, and also because no waterproofing would be required. Structural reinforcement for the ribs and braces was used in order to dispense with falsework, as far as possible.

PRELIMINARY DESIGN.

Before beginning the actual designing, considerable preliminary work was done in order to determine the most economical type of structure for various heights, and also to determine the economical span lengths for each type. Three types were considered, as follows: earth fills enclosed by semi-gravity retaining walls, girder spans, and arch spans.

In this preliminary work sufficient designing and laying out was done to enable the various quantities to be determined with sufficient accuracy for the purpose in view. These quantities were multiplied by estimated unit prices, and the cost per linear foot of structure of each type for various heights and span lengths was obtained. These results were then plotted, and the economical span lengths were determined, as well as the points at which it was theoretically economical to change from one type of construction to another. The information obtained from the plots was followed as closely as circumstances would permit. In some cases, however, the physical conditions determined both the span lengths and the type of structure. For example, arch spans were used over the levee and between the south abutment and pier No. 1 (see Fig. 1). Girder spans would have been cheaper at these points if the height only was considered. It was not permissible to place piers in the levee, and a long span had to be used. It was not thought advisable to divide the span between the south abutment and pier No. 1, on account of the possibility of a recurrence of the slides mentioned previously; in other words, the fewer piers on the south bank of the stream at this point, the better. Consequently, arch spans were used for these portions of the crossing.

The selection of the three-hinged ribbed arch with forms supported from the reinforcement was governed principally by the character of the foundations and by the erratic behavior of the stream. However, estimates were made of the cost of this construction as compared with that of a three-hinged ribbed arch supported on falsework in the usual manner. In making this comparison the cost of the falsework and the rib reinforcement required for this scheme was compared with that of the rib reinforcement of the arches as built. The hinges and such portions of the rib forms as were common to both schemes were not included in the estimate. It was found that the structure on falsework would have cost slightly less than as built. This was caused by the fact that spans *A*, *C* and *D* are too low for economy with the self-supporting type of construction; span *B*, however, is high enough to make this type economical. It was decided to use the self-supporting type for all spans, because of the danger from floods, the unstable character of the soil under span *A*, and in order to avoid the troubles due to settlement of the falsework.

The selection of the self-supporting type was amply justified by events which will be mentioned later under the head of "Construction."

GENERAL LAYOUTS.

After the preliminary designing had been finished, and the data obtained had been arranged for use, the work of preparing the general plans was started.

A direct approach to the south end of the structure was prevented by the court house and jail buildings, which block Main St. at this point. It was desirable, therefore, to make the south approach a double one. One branch, carrying north-bound traffic, connects with

Commerce St., and the south-bound traffic is accommodated by the other branch, which connects with Houston St. Sufficient property has been acquired to allow the street corners to be rounded off so that the approaches will follow easy curves.

Curved retaining walls and railings are being constructed south of the south abutment, where the viaduct proper ends. It is expected that the block now occupied by the jail and other buildings will be cleared by the city and will be parked to form a pleasing approach to the crossing.

The general elevation was laid out to fit the conditions, keeping in mind the data obtained from the preliminary designs. It will be seen by referring to Fig. 1 that a symmetrical structure was not possible, owing to the contour of the ground.

LOADING AND ASSUMPTIONS.

The loading data are shown in Figs. 2 (a), (b), (c) and (d). The 50-ton electric cars and the 21-ton road roller shown were used for the members of the floor system, together with a uniform load of 100 lbs. per square foot on the sidewalks and remaining roadway surface. For maximum stresses in the floorbeams the sidewalks were assumed to be unloaded. The arch ribs and the main longitudinal girders were designed for the foregoing car loading, together with 100 lbs. per square foot on the sidewalks and on the remainder of the roadway. The road roller was also considered in connection with the car loading, with the foregoing uniform live load on the sidewalks and on the remainder of the roadway. A load of 200 lbs. per linear foot of each sidewalk was also used in order to provide for the weight of pipes and conduits which might be carried in the spaces provided for them under the sidewalks. Pier footings were designed for the uniform load per linear foot of each car track given in Fig. 2 (b), together with a uniform load of 100 lbs. per square foot on the sidewalks and the remaining roadway surface.

Impact was allowed for according to the formula: $I = \frac{100S}{L + 300}$, where I is the impact to be added to the live load stress, S is the calculated maximum live load stress, and L is the loaded length, in feet, that produces the maximum stress in the member. This impact allowance is one-third of that required by the original formula submitted by the American Railway Engineering Association for impact on steel railway bridges, and was arbitrarily assumed. The formula was used only for car and uniform roadway loads. Stresses produced by the road roller, which is a slowly moving load, were increased by 25 per cent in all cases. No addition was made for impact to the stresses produced by the uniform sidewalk loading, as it was considered that when this sidewalk load was a maximum it necessarily would be nearly quiescent. The live loads for the piers were not increased for impact, as it was believed that the impact would be absorbed before reaching the footings.

The various conditions of loading for which the arch ribs were designed are indicated on Fig 2 (c). Cases I to IV require no explanation except to say that they served to produce maximum stresses in the ribs of all spans except those of the unsymmetrical arch, span *A*. On account of this lack of symmetry these cases were elaborated on in order to be sure that the maximum stresses had been found.

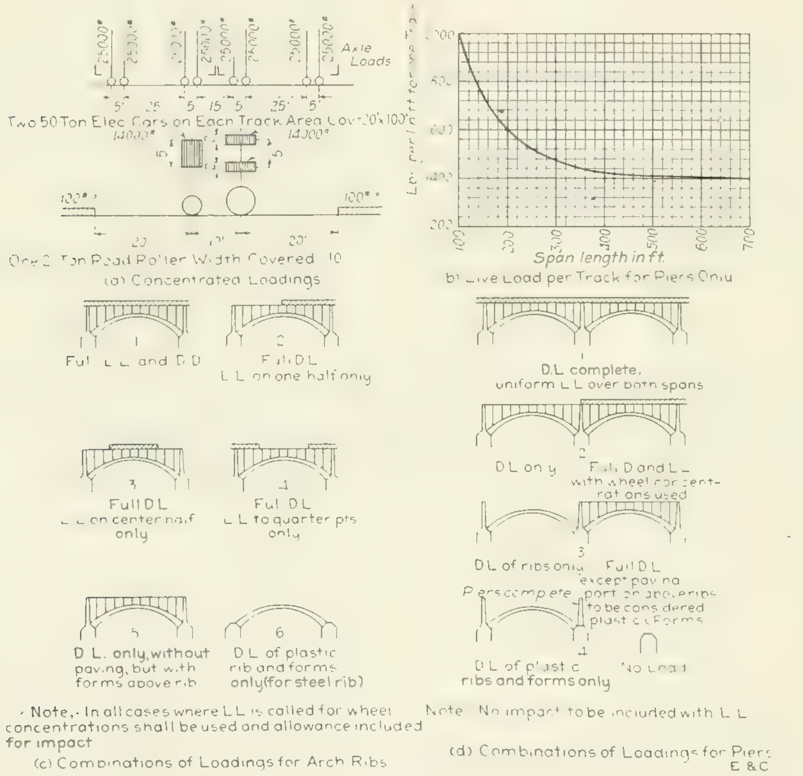

Axle Loads
25000#
5' 25 5 15 5 25' 5'
Two 50 Ton Elec Cars on Each Track Area Cov 20'x100'
14000#
100#
20 10' 20'
One 2 Ton Road Roller Width Covered 10
(a) Concentrated Loadings
Span length in ft.
100 200 300 400 500 600 700
(b) Live Load per Track for Piers Only
1
Full L L and D L
2
Full D L
L L on one half only
3
Full D L
L L on center half only
4
Full D L
L L to quarter pts only
5
D L only, without paving, but with forms above rib
6
D L of plastic rib and forms only (for steel rib)
Note.- In all cases where L L is called for wheel concentrations shall be used and allowance included for impact
(c) Combinations of Loadings for Arch Ribs
1
D.L complete, uniform L L over both spans
2
D L only
Full D and L L with wheel concentrations used
3
D L of ribs only
Full D L except paving
Piers complete
port on above ribs to be considered plastic Forms
4
D L of plastic ribs and forms only
No Load
Note No impact to be included with L L
(d) Combinations of Loadings for Piers
E & C

Fig. 2. Live Loads and Combinations of Loads Used in Designing Arch Ribs and Piers of Main Street Viaduct, Fort Worth, Tex.

Cases V and VI are construction conditions and were elaborated on considerably. Case VI determined the sections required for the structural steel reinforcement, which was designed to carry the weight of the rib and brace forms, and the plastic concrete in these ribs and braces. In order to find the maximum stresses in the members of the steel reinforcing ribs the stresses were obtained graphically for the forms filled with concrete from the haunch, successively to the foot of each post. In Case V the forms of the posts and deck were assumed to be finished and the stresses in the reinforced concrete ribs were computed for the various stages of the concreting of the portion of the span above the ribs. All concrete was assumed to be placed symmetrically about the center line of the span. The post loads were first considered, beginning at the piers and working toward the crown of the arch. The deck was then assumed to be concreted, panel by panel, working from the crown back toward the piers. Stresses in the ribs were computed analytically, at the critical points, for each step as outlined above. By this method of procedure in concreting the stresses in the ribs were kept within the limits set for working conditions in the finished structure. The arch piers were designed for the conditions indicated in Fig. 2 (d). The piers for the girder spans were designed only for full vertical load.

In addition to the above mentioned vertical loads the structures were designed to resist transverse forces due to wind and water pressure. The arch ribs and their braces, in particular, were designed with great care to resist these transverse forces. In general, in computing these transverse forces the water line was assumed to be at the top of the levee. Below this line the pressure due to the current was taken at 200 lbs. per square foot of vertical projection of each arch rib and spandrel post. Above this line the wind pressure was assumed at 30 lbs. per square foot of vertical projection of the structure, up to a line 10 ft. above the top of the roadway. The force assumed for the current corresponds (according to the formula used), to a velocity of about 8 or 9 miles per hour, which is probably not far from the actual velocity at flood stage.

SPECIFICATIONS.

With certain modifications, in regard to unit stresses, "Watson's Specifications for Reinforced Concrete Bridges" were used.

The following is a list of the unit stresses used for the various parts of the structure:

	Lbs. per sq. in.
Tension in steel bars used for flange reinforcement	20,000
Tension in steel bars used for web reinforcement	15,000
Compression in concrete in cross bending, as in beams	750
Compression in concrete, combined direct and bending, as in arch ribs and posts	500
Compression in concrete of arch ribs for stresses due to combined vertical and transverse loads	650
Bond between concrete and steel, for deformed bars	120
Shear in concrete	60
Or a maximum on the section, including shear taken by steel, of	150
Bearing of hinge castings on concrete specially reinforced	800
Compression in structural rib reinforcement due to weight of forms and plastic concrete in arch ribs and braces, 16,000-70 $\frac{l}{r}$, or a maximum of	12,500
Additional compression in structural rib reinforcement, under working conditions, and compression in steel of other compression members = 15 times the corresponding compressive stress in concrete. Possible maximum total compression in structural steel rib reinforcement	20,000
Tension on net section of structural steel reinforcement	16,000
Bearing, tension and compression in cast steel hinges	20,000
(Bearing area of the hinges taken as the projected area of the hemispherical joint.)	
Bearing on rivets	24,000
Shear in cast steel	10,000
Shear on rivets	12,000
	Lbs. per sq. ft.
Bearing on soil at depth of 6 ft. below finished surface	5,000
For each 1 ft. increase in depth more than 5 ft., add	100
	Pounds.
Load on each timber pile	20,000

Structural Features.

The deck consists of slabs carried on longitudinal stringers, which connect to floorbeams. These floorbeams are in turn carried by the four main longitudinal girders of the girder spans, or by the spandrel posts, which rest on the four ribs of the arch spans. The sidewalks are carried on cantilever extensions of the floorbeams outside of the outer girders or ribs. For the girder spans, such stringers as would come close to the girders are omitted and their place is supplied by the cantilevered top flanges of the main girders. Those cantilevered top flanges also provide the necessary compressive area for the girders.

Two ribs or main girders would have been more desirable in some respects than four, as this arrangement would have done away with the continuous girder action of the floorbeams and would have made the reactions on the girders and ribs statically determinate. The heavy concentrated loading and the width of the roadway, however, would have made the floor system extremely heavy, therefore the four-rib arrangement was adopted for this crossing.

The length of floor panels used was 12 ft. 6 ins. from center to center of floorbeams, which gave stringers of reasonable size and brought the loads on the girders and arch ribs at reasonably short intervals. The floorbeams are of uniform thickness throughout, which thickness, 17 ins., is the same as that of the spandrel posts. The posts are purposely made thinnest in the direction of the axis of the structure so that the bending caused by the changes in the length of the deck due to temperature will not over-stress them.

Expansion joints are provided in the girder spans at each pier, and in the deck of the arch spans at the crown and at each pier. The main girders slide on top of the small piers, and the stringers slide in recesses or pockets in the floorbeams. All expansion joints are packed with tar paper and asphalt to form a closed but compressible joint, and all main girder joints are masked by pilasters. Planed steel bed and bearing plates are used under the expansion end of each girder and stringer. These plates have anchorage angles riveted to them and are further anchored with bent anchor bolts passing through holes in these angles. The sliding members and those on which the sliding members rest are also reinforced at these bearing points with loops of steel to provide for the shearing stresses which result from the friction of the plates on each other. In order to reduce this friction as much as practicable the bed and bearing plates are planed in the direction of movement, and the sliding surfaces in contact are heavily coated with tallow. U-shaped copper plates, filled with asphalt, are used in the roadway slabs to close the opening. Similar plates, placed in the reversed position to those in the roadway slabs and with the asphalt filling omitted, are used in the sidewalk slabs and curbs. These copper plates are used at each expansion joint in the structure.

The arch ribs are braced together at the foot of each spandrel post by transverse braces, which are of the same width as the spandrel posts and floorbeams and are as deep as the ribs will permit. These braces are placed in vertical planes.

The arch ribs are of uniform thickness, but they vary in depth, decreasing regularly from the haunch toward the crown. This is contrary to the theoretical shape of a three-hinged rib, which should be deepest at about the quarter point of the span and should diminish in depth toward the haunch and crown. This departure from the theoretical shape was made for the sake of appearance only. As the hinges are concealed in the finished rib it was considered that the ribs would look best if made to follow the lines of a hingeless rib.

Each hinge consists of two steel castings, with ball and socket joints. At the haunches one of these castings is built into the pier, and the other is bolted to the structural rib reinforcement, as are also the castings forming the crown hinge.

All the piers for the arch spans are of considerable width in order to resist overturning forces and to give the appearance of massiveness required by the long spans. They are hollowed out as much as is consistent with strength and economy of forms, in order to reduce their weight and to save material.

The small piers supporting the girder spans consist of four square shafts, battered on the four faces. These shafts rest on a common base and are connected at the top by a cap and diaphragm of T-section.

The retaining walls are of the semi-gravity type. The toe of the section is reinforced for bending stresses, and the reinforcement extends high enough up the back of the wall to relieve the concrete of undue tensile stresses. Expansion joints are provided at intervals of 37 ft. 6 ins., and pilasters are used at these points to mask the joints. The walls have a small coping and are paneled to relieve the appearance of flatness.

The south abutment (see Fig. 1) is founded on rock, as is also pier No. 1, which is on the south bank of the stream. Pier No. 2, on the north bank, is supported on a spread foundation, with a portion of the load carried on timber piles. All other piers and walls are carried on spread footings, resting on the strata previously referred to, at depths ranging from 4 to 18 ft. below the finished ground surface.

The railings and the stairways leading down to the street level at North Second St. are of reinforced concrete, cast in place, except the railing panels and hand-rails, which were cast in molds and then erected.

The stairways, with the exception of the steps leading to the lower landing, are supported entirely from the piers and girders by structural steel cantilever beams incased in concrete. This construction was adopted, instead of supporting them partly on the piers and girders and partly on independent posts and foundations, in order to avoid damage due to unequal settlement. The lower steps were built on independent foundations with a sliding joint between the steps and the remainder of the stairway to take care of unequal settlement.

Provision is made for carrying electric wires and small pipes under the sidewalks by means of ducts leading into the railing posts and up to the lighting fixtures.

In order to reduce the dead weight of the deck as much as possible, the usual ballasted track construction was dispensed with. Anchor-bolts were set into the slab over the stringers, and the rails were secured to these bolts with cast steel clips. Steel bearing plates were provided under the rails at each pair of bolts, which occurred at intervals of 27 ins. The rails were lined and brought to proper level with eccentric washers and shim plates. A fiber pad, ½ in. thick, was placed between the rail and the bearing plate, as a shock absorber.

REINFORCEMENT.

The reinforcement of the arch ribs and braces consists of medium steel structural shapes, supplemented by reinforcing bars. Structural shapes are also used for the main supports of the stairways. All other reinforcement consists of square twisted bars of high elastic limit. These were substituted for the round, mechanical-bond bars called for on the plans, and were made equivalent in cross section to the round bars which they replaced. All bars, except some of the large sizes, were rolled from the heads of rails and were hot-twisted. Cold-twisted bars, from medium steel billet stock, were used for the large sizes, on account of the difficulty of getting rail heads of sufficient volume for this purpose. Tests of the two classes of material showed that they were practically equal in quality.

The rib reinforcement consists of curved lattice girders, to the ends of which are bolted the cast steel hinges. The chords of these girders are made up of four angles arranged in the shape of a cross. All web members are made up of two angles. Three of these steel girders are used in each inner rib and two in each outer rib of each span. The individual steel girders are laced together in the plane of the top and bottom chords and are also connected by transverse frames, in vertical planes, under each post. The transverse braces connecting the four ribs are reinforced by lattice girders which connect to the rib reinforcement. No reaming or painting is called for. The hinge castings are bolted to the steel ribs, and all other connections, both shop and field, are riveted.

At each upper panel point of the steel ribs, clip angles were provided to which were secured the transverse timber beams from which the rib forms were supportd.

A system of lateral rods, for use during erection, was provided in the plane of each chord of the ribs. These rods were used to line up the steelwork accurately, and to hold it in line while the ribs were being concreted. The rods were not removed until after the completion of the work. The transverse braces, mentioned previously, are also reinforced in each face with continuous bars, the function of which is to resist bending in the braces due to transverse forces.

In addition to the steel reinforcement required to resist the calculated stresses in the members, a certain amount of steel is used to prevent the formation of shrinkage, settlement and temperature cracks. This steel is used in the exterior faces of thin walls, in a longitudinal direction in the slabs, and to reinforce the corners where two walls join. All braces, ribs and posts are wrapped with heavy wire closely spaced, to which the longitudinal steel is secured.

CONCRETE PROPORTIONS.

The concrete used in the construction of the viaducts is of three classes: No. 1 concrete, used for floor systems, girders, arch ribs, braces, spandrel posts, railings, stairs and rib seats of large piers, composed of 1 part Portland cement, 2 parts sand, and 4 parts broken stone; No. 2 concrete, used for retaining walls and abutments, girder piers and large arch piers (except rib seats), composed of 1 part Portland cement, 2½ parts sand, and 5 parts broken stone; No. 3 concrete, used only for paving foundations, composed of 1 part Portland cement, 3 parts sand, and 6 parts broken stone. A local sand of good quality was used, and the broken stone was a hard limestone of the same quality as that from the quarries near Jacksboro, Tex. The maximum sizes of stone for the various classes of concrete are as follows: for No. 1 concrete, used for railing, ¾-in., all other No. 1 concrete, 1-in.; for No. 2 and No. 3 concrete, 2-in. The stone was graded below these maximum sizes, and the dust was screened out. A very dense concrete was obtained.

Methods of Design.

There is nothing unusual in the design of the structures with the exception of the methods of designing the arch ribs and braces. Briefly, sidewalk slabs and main girders were designed as simple beams; and continuous members, such as floorbeams, stringers and roadway

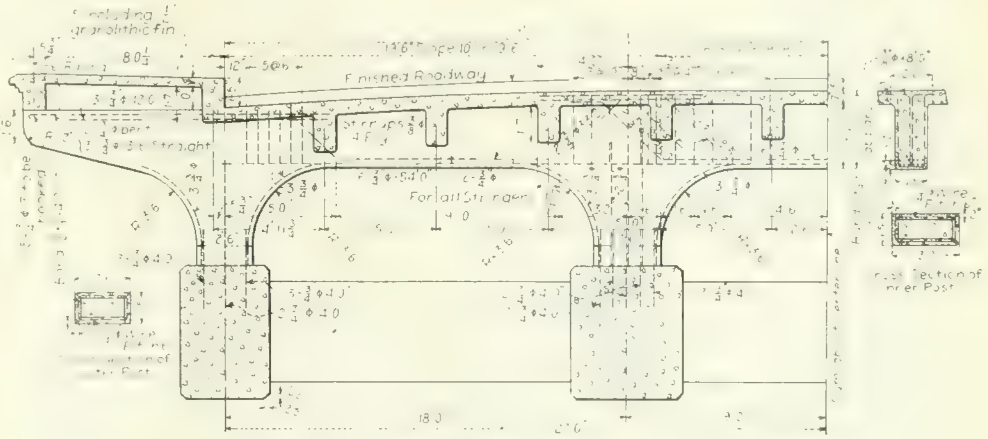


Fig. 3. Cross Section of Arch Ribs and Floor Construction Near Crowns of Arches—Main Street Viaduct.

slabs, were designed for 0.8 of the maximum positive moments, considered as simple beams. In all cases, where members were continuous, steel was provided over the supports to take the negative moments at these points. The quantity of this steel was two-thirds of that required to take the maximum positive moments in the members. The shears and reactions for continuous members, such as floorbeams and stringers, were increased by from 10 to 25 per cent (depending on the number of spans) more than what these functions would have been for simple spans.

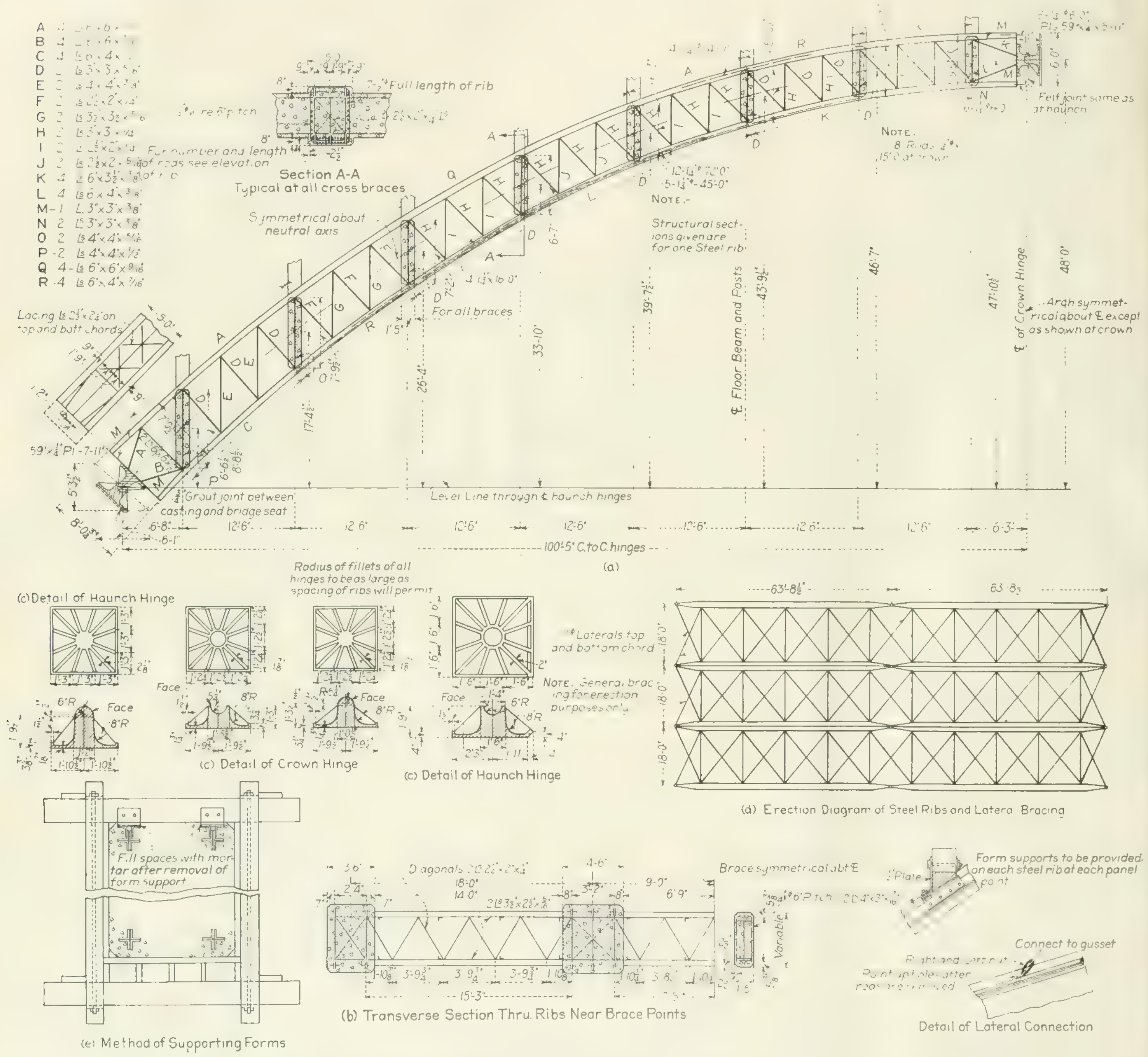

L 4 Ls 6 x 4" x 3/8"
M-1 L 3" x 3" x 3/8"
N 2 Ls 3" x 3" x 3/8"
O 2 Ls 4" x 4" x 5/16"
P-2 Ls 4" x 4" x 1/2"
Q 4-Ls 6" x 6" x 9/16"
R-4 Ls 6" x 4" x 7/16"
Full length of rib
For number and length of rods see elevation
Section A-A
Typical at all cross braces
Symmetrical about neutral axis
Lacing Ls 2½" x 2¼" on top and bott chords
59" x ¼" Pl -7-11"
Grout joint between casting and bridge seat
For all braces
Level Line through ℄ haunch hinges
Note.-
Structural sections given are for one Steel rib
Note.
℄ Floor Beam and Posts
℄ of Crown Hinge
Arch symmetrical about ℄ except as shown at crown
Felt joint same as at haunch
6'-8" 12'-6" 12'-6" 12'-6" 12'-6" 12'-6" 12'-6" 12'-6" 6'-3"
100'-5" C. to C. hinges
(a)
(c) Detail of Haunch Hinge
Radius of fillets of all hinges to be as large as spacing of ribs will permit
Face
6"R
8"R
(c) Detail of Crown Hinge
(c) Detail of Haunch Hinge
Laterals top and bottom chord
Note. General bracing for erection purposes only
63'-8½"
(d) Erection Diagram of Steel Ribs and Lateral Bracing
Fill spaces with mortar after removal of form support
(e) Method of Supporting Forms
Diagonals 2Ls 2½" x 2" x ¼"
Brace symmetrical about ℄
18'-0"
14'-0"
9'-0"
6'-9"
15'-3"
Variable
(b) Transverse Section Thru. Ribs Near Brace Points
Form supports to be provided on each steel rib at each panel point
Connect to gusset
Detail of Lateral Connection

Fig. 4. Details of Design and Erection Features of Longest Arch Span (225 Ft. Center to Center of Piers) of Main Street Viaduct—Structural Steel Reinforcement Designed to Support Forms Without Falsework.

Figure 3 shows a typical cross section of an arch near the crown. This drawing shows details of the floorbeams, stringers, roadway slab and supporting columns.

In order to make clear the methods used in the design of the arch ribs, braces and hinges a detailed account of this part of the work will be given.

It will be noted that the structural steel arch rib reinforcement takes stress in two independent steps: First, as the ribs are filled with concrete the members take certain initial stresses, which, as the concrete sets, remain in the steel. This initial stress in the steel was not allowed to exceed a maximum of 12,500 lbs. per square inch in compression, as given in the list of unit stresses. Second, after the ribs are finished and the construction of the posts and deck is under way, and later, when the structure is carrying live load, stresses are set up in the ribs, which are carried jointly by the steel and concrete in the usual manner. The assumed ratio of the moduli of elasticity of steel and concrete was taken as 15; therefore the maximum possible compressive stress in the structural steel reinforcement of the ribs would be 12,500 lbs. plus 15 times 500 lbs., or 20,000 lbs. per square inch. This is based on the assumption that the ribs and braces are completely filled with concrete in so short a time that it does not begin to set before all the load is in place, and also that the stress in the concrete at the center of gravity of the steel chord is 500 lbs. per square inch. As a matter of fact, the ribs were concreted in sections, and the braces were not concreted until the concrete in the ribs had set for several days. Consequently, the initial compression in the structural reinforcement was much less than that mentioned above. As the center of gravity of the steel chords is some distance in from the face of the concrete the stress in the concrete at this point and therefore the stress in the steel is lower than that assumed. The actual maximum compression in the structural reinforcement is about 16,000 lbs. per square inch.

The lines of pressure for the ribs were worked out graphically for the various positions of the live load combined with dead load and for the various stages in the construction of the deck. In order to allow for the weight of the ribs themselves their dimensions were first assumed, and later these dimensions were revised, where necessary. The neutral axes of the ribs were drawn midway between the extreme pressure lines. This made the neutral axis of the rib a constructive curve, approximating a parabola with its vertex at the crown of the arch. The axis as drawn followed closely the pressure line for full dead and live load. The inner and outer ribs were made of the same vertical dimensions, but of different thickness.

The next step was to find the stresses in the reinforced concrete rib for the various stages in the construction of the deck and for the dead and live load, under working conditions in the finished structure. The quantity of steel required at each point to keep the extreme fiber stress in the concrete down to 500 lbs. per square inch for the worst condition was then computed. The required area of steel in either face of the rib at any point was not allowed to exceed 2.5 per cent of the total cross sectional area of the rib. Where on first trial the required quantity of steel exceeded the above maximum, a re-design was made using a rib of larger cross section.

As mentioned under the head of "Loading" the stresses in the structural steel ribs were found graphically for the various positions of load during the concreting of the ribs and braces, using the rib having the dimensions which had been determined as just described. The sections of the structural steel reinforcement were then determined. This structural steel reinforcement, although designed to carry the ribs and braces during their construction, also forms part of the reinforcement of the finished rib, as previously mentioned. Where the required area of steel in the finished rib exceeded that supplied by the structural reinforcement the deficiency was made up by the addition of reinforcing bars. These bars do not run the full length of the ribs, but stop off where they are not needed. It will be noted that these bars take little, if any, initial stress, such as is taken by the structural reinforcement. Additional bars are placed in the sides of the ribs, running full length. These bars help to resist transverse bending stresses and to prevent surface cracks from appearing.

Figure 4 (a) shows the structural steel reinforcement and the stresses in it for span *B*, the longest span.

The transverse forces of wind and water pressure, mentioned previously, were assumed to be resisted wholly by the ribs and braces acting as a series of portals, in the same manner as the columns and girders of an office building act to resist wind pressure. Figure 4 (b) shows details of ribs and braces and indicates the reinforcement of same. The deck was not given credit for any resisting power, because of the presence of the expansion joints over the haunch and crown of the span.

Points of inflection were assumed in the braces, midway between each pair of ribs, and in the ribs, midway between the braces. The ribs being hinged at the haunches and crown were computed as being free to move at these points. Bars were provided at the haunches, however, anchoring the ribs to the piers and at the crown, anchoring the two halves of the rib together. These bars were placed in the plane of the neutral axis of the rib, and tended to resist transverse, but not vertical movement of the ribs. The stresses in the ribs and braces were computed at each section for the moments, shears and direct thrusts in the members. The maximum stresses at each point in the ribs due to transverse forces were combined with the maximum stresses due to the vertical loads, and the ribs were proportioned accordingly.

The design of the hinges naturally received considerable attention. At first, a hinge was studied which consisted of two castings having semi-cylindrical bearings and a pin. This type has a number of advantages, but its use was finally abandoned on account of the difficulty of setting the hinges on the piers with sufficient accuracy. Unless the axes of the pins are placed exactly at right angles to the vertical plane through the longitudinal axis of the rib eccentric stresses will result in the rib which may be too large for safety. It was finally decided to use hinges composed of two ribbed steel castings, having a hemispherical ball and socket joint, as shown in Fig. 4 (c). This joint was machined, and, by allowing movement in all directions, it made great accuracy in setting the castings unnecessary. The joint also made it possible to adjust the structural rib reinforcement properly in vertical planes with the temporary adjustable lateral rods provided for that purpose. This type of hinge reduces to a minimum the possibility of eccentric stresses in the ribs.

In proportioning the hinge castings, much the same method was followed as in the design of a column base. A section was taken through the diagonal rib of the hinge, at the junction of the rib with the body, or shaft, of the casting, and the tensile, compressive, and shearing stresses on the section were computed. A section was also taken through the center of the hinge, and the stresses on this section were computed, on the assumption that the reaction on the base of the casting produced moments at right angles to this section, instead of radially, as had previously been assumed. The resultant of the radial and direct compressive stresses at the circumference of the shaft of the casting was also investigated.

The camber of the arch spans was computed for full dead and live loads, with impact, combined with temperature and an allowance for shrinkage. The rise of the structural ribs was increased by the amount of the camber. The total calculated camber for the longest span was about 3½ ins.

In the design of the main piers considerable attention was given to the question of protection against scour. Pier No. 2 was given particular attention because of the fact that it is only a short distance below a power dam having a fall of about 15 ft. The bottom of the footing course was placed at about 5 ft. below the bed of the stream. Oak piles were provided, extending about 15 ft. below the bottom of the footing. The sheet piling for the cofferdam was driven about 8 ft. below the bottom of the footing and this was left in place. The banks of the stream at this point were also protected by a large quantity of riprap. These precautions, together with the fact that the material in the river bed at this point is a stiff clay not likely to erode, were believed to afford ample protection against scour.

Several different designs and estimates were made for pier No. 2 before a satisfactory solution was reached. The following were considered: First, a pier similar to pier No. 1 (see Fig. 5), founded on bed-rock; second, a pier having its base at about the level of the bed of the river, with the vertical loads carried on eight cylinder piers, two under each line of arch ribs; third, a pier resting on piles driven to rock; and fourth, the pier as built, having moderately spread footings, but with a

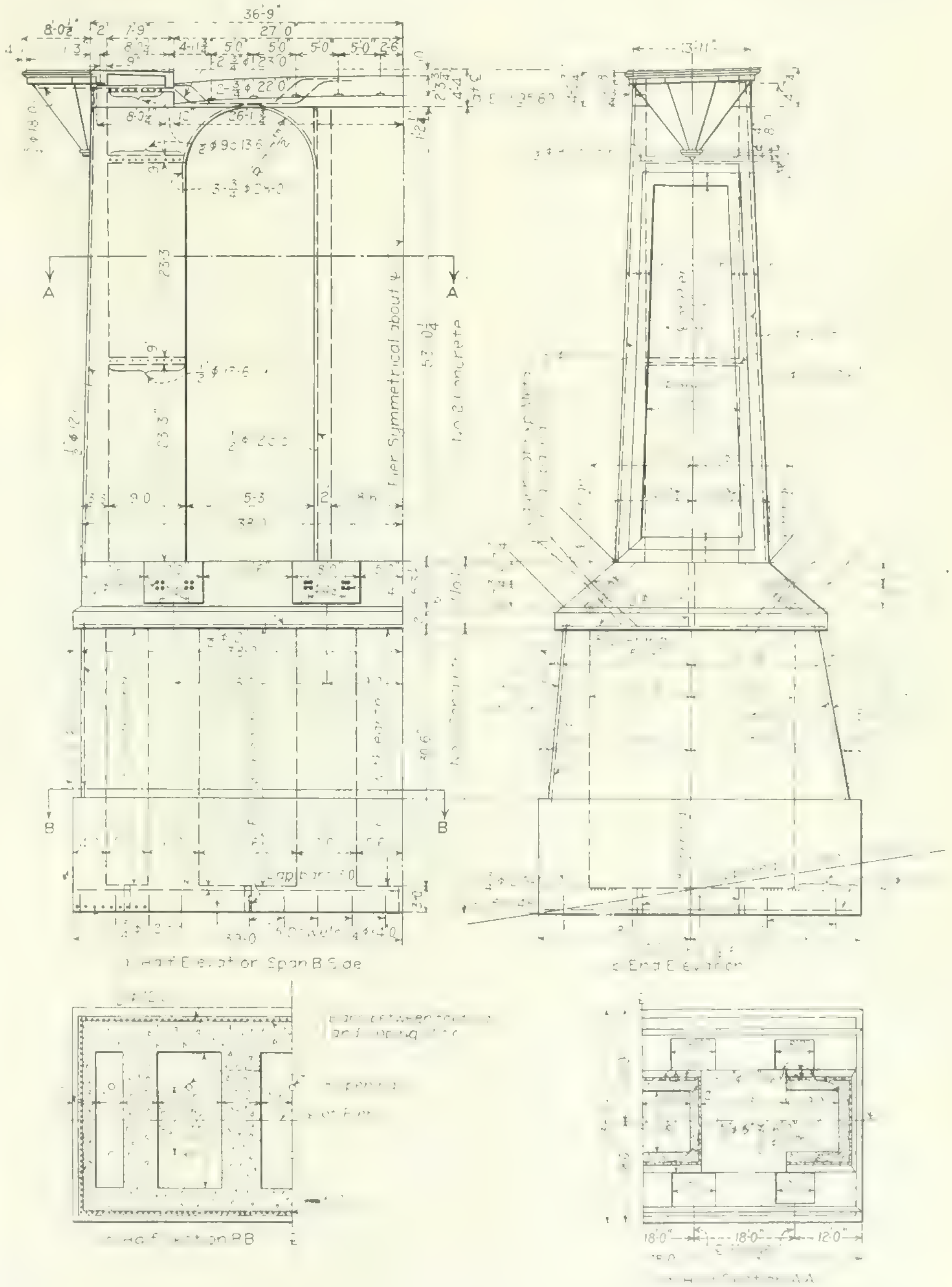


Fig. 5. Elevations and Cross Sections of Pier No. 1 (South Pier of Longest Arch Span) of Main Street Viaduct, Showing Type of Divided Pier.

portion of the load carried on piles which do not extend to rock.

The first scheme was abandoned because of the cost, which would have made that of the structure exceed the appropriation. The second scheme was considerd inadvisable because of the difficulty of taking care of the unbalanced horizontal thrust. As the vertical load would have been carried down the cylinders to rock, the friction between the pier base and the material under it could not safely be counted on to resist the horizontal thrust. There then remained to resist this thrust only the pressure of the earth against the body of the pier and against the cylinders. Computations indicated that this resisting pressure would be insufficient unless the body of the pier was extended to a considerably greater depth. This would have made the cost too great. The third scheme was rejected for practically the same reasons as those given above for the second scheme, and also because, after investigation, it was considered doubtful whether piles could be driven to rock through the mixture of sand and gravel overlying it. The fourth scheme proved to be the cheapest and most feasible of those considered; therefore it was adopted, with the provisions mentioned above to protect the pier from scour.

The small piers were designed for full vertical load only, using the unit pressures mentioned previously.

Rankine's theory of earth pressure was used in the design of the retaining walls. The weight of the earth fill was taken at 100 lbs. per cubic foot. A superposed load of 100 lbs. per square foot was assumed, to take care of the roadway and sidewalk loads. For convenience in computing the pressures, the unit weight of the fill was considered to be increased by the ratio, $\frac{d'}{d}$, where d is the actual depth of fill, and d' is the actual depth plus the depth of the imaginary fill required to produce the same unit vertical pressure as the superposed load. In the foregoing case, $d' = d + 1$ ft. For the higher sections, this increase is negligible, but for the lower ones it is worth taking into account.

In the Main St. Viaduct the cost of the hinges amounted to about 3½ per cent of the total cost. This is more than it should have been, owing to the high price paid for the steel castings. Even at this price, when all the advantages of the three-hinged arch are considered, the money paid for hinges is well spent. The ribbed arch has two great advantages over the barrel, or solid arch. These are lightness, with consequent saving in cost, and the fact that water-proofing is not required. The latter, alone, is enough to recommend it to those who have had trouble with this feature of arch construction.

Construction Features.

Work on the Main St. Viaduct started early in December, 1912, and it was finished in March, 1914. The climate of Fort Worth is such that concreting can be carried on at all seasons of the year. The only interruptions were those due to rains, which were infrequent.

CONTRACTOR'S PLANT AND EQUIPMENT.

The general contractor's plant and equipment consisted of a central mixing plant; two distributing towers, with hoists, chutes, etc.; an electric locomotive and cars for transporting concrete; derricks and clam-shell buckets for handling excavation and materials; a pair of driver leads suspended from the boom of a derrick; and the usual equipment of smaller tools and appliances. The sub-contractor for the structural steelwork had a steel stiff-leg derrick, a derrick car; two gin-poles, a two-bent timber gantry traveler, and the necessary hoisting engines and minor appliances. With the exception of one hoisting engine all the general contractor's equipment was electrically driven, current being obtained from the local power company and transformed at the site. The sub-contractor's equipment was operated by steam.

While the pier excavations were under way the mixing plant was being built near pier No. 3 on the downstream side of the structure. This consisted of an elevated hopper divided into two parts, one for rock and one for sand, a measuring box for sand and one for stone, and a mixer capable of handling a batch of a little more than 1 cu. yd. of concrete. Behind the mixing plant was a stiff-leg bullwheel derrick for unloading materials and for supplying the hoppers of the mixing plant. Materials were brought to the site on cars, on a spur track which crossed the line of the viaduct alongside of the mixing plant.

Concrete was discharged from the mixer into steel hopper cars drawn by an electric locomotive running on a narrow-gage track. The concrete was carried in these cars to the two distributing towers, where it was hoisted and conveyed through the chutes to its destination. The larger of these towers was stationary and was about 200 ft. high. This tower served the portion of the viaduct between pier No. 4 and the south abutment (see Fig. 1), except where concrete was discharged directly into the footings of pier No. 3 from the mixer. The other and smaller tower was built so that it could be moved when required. It served the portion of the structure between pier No. 4 and the north abutment. For the retaining walls the concrete was carried in the hopper cars to the north end of the walls where it was switched back on a trestle midway between the walls, the track being parallel to and about 6 ft. above the tops of the walls. From this trestle the concrete was passed through chutes into the walls.

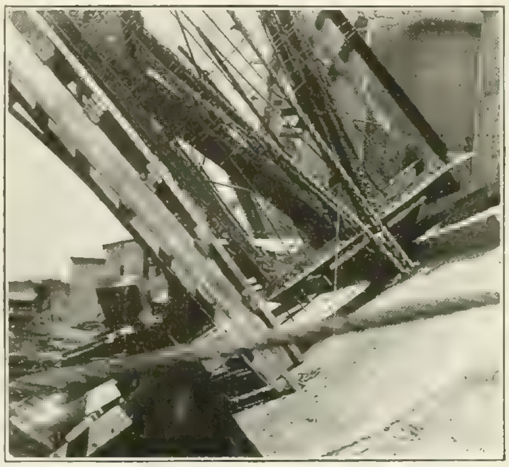


Fig. 6. Haunch Hinge of West Rib of Span D of Main Street Viaduct, Showing Reinforcement at Hinge.

CONSTRUCTION METHODS.

Steel forms were used where there was sufficient duplication to make their use economical. They were found to be especially advantageous for the girders and floor system, which had been laid out with the view of making the work as simple and giving as much repetition as possible. For example, all floorbeams were made alike, so far as the dimensions of the concrete were concerned; all panel lengths, and consequently all stringers of each kind, were alike. The wall forms were made up of squares and rectangles of such size that they could be handled readily by two or three men. These forms were stiffened by angles and were bolted together by bolts passing through the flange angles. They were braced by timber verticals and shores. The grades of the walls, the coping and any irregular portions were formed in wood. Sufficient deck and girder forms were provided to make two of the 62-ft. 6-in. girder spans. These forms were reinforced in order to prevent bulging and deflection between panel points.

The resulting surface finish was in general very good, and it required little working after the forms were removed to produce the desired results. On removing the forms the surface was bush-hammered, and all fins and lips left at the junction of the form sections were removed. In some cases where the forms had been insufficiently braced untrue surfaces were corrected by bush-hammering. Where necessary, the surface was rubbed down with carborundum blocks and was washed with neat cement grout, which was rubbed into the work. As a result of this treatment the surfaces present a neat and uniform appearance, which is very pleasing. Steel forms were used for the railings. The panels and hand-rails were cast on the ground and then erected; the posts and foot-rails were cast in place. Particular attention was given to the surface finish of the railings. All surfaces which would be exposed in the finished work were rubbed down with carborundum blocks as soon as possible after the removal of the forms. The work was then treated with a thin coat of neat cement grout, well rubbed in, and the surplus grout washed off. This process was repeated until the surface pores were filled and the work presented a smooth uniform surface.

After the main piers were finished up to the tops of the skewbacks, as indicated in Fig. 5 by the lines *X-X*, the hinges were set in pockets provided for that purpose. The space of about ¾ in. between the base of the hinge casting and the back of the pocket was filled with neat cement grout, and the pocket was filled with concrete up to the line *Y-Y*, leaving only the socket of the hinge exposed. After the concrete had become thoroughly set the erection of the structural steel reinforcement was commenced. This was done before finishing the piers above the lines *X-X* in order to facilitate the handling of the erection equipment.

Two methods were used in erecting this structural reinforcement. Spans *C*, *D*, and the south arm of span *A* were raised with derricks and gin-poles, without the use of falsework. For span *B*, a two-bent timber gantry traveler was used. This traveler also raised the north arm of span *A*. Span *D*, which is the shortest and lightest of the four, was raised by a stiff-leg derrick placed on top of the skewback course of pier No. 3, and by a gin-pole. The derrick handled the south halves of the ribs, while the north halves were raised by the gin-pole. After this span was finished the derrick was moved to the top of the skewback course of pier No. 2 where it was used to raise the south half of span *C*, and to erect the gantry traveler. Span *C* is considerably heavier than *D*, and consequently in raising the ribs the derrick had to be assisted by a gin-pole. The north half of the span was raised at the same time as the south half, by the derrick and the other gin-pole. The half ribs of both these spans were necessarily handled in one piece.

Low and comparatively light falsework was used for span *B* and for the north half of span *A*. This was built at about the level of the coping under the skewbacks of the piers and it served to carry the traveler and such bents as were required to support the sections of the ribs. Each half rib was raised in two sections, and field-riveted.

When the steel had been erected the ribs were carefully lined up in vertical planes with the adjustable lateral rods provided for that purpose, see Fig. 4 (d), and the field connections were then riveted. The next step was to place the reinforcing bars and to wrap the ribs and braces with heavy wire. The forms were then built in place and supported from the structural reinforcement, in the manner indicated in Fig. 4 (e).

Span *D* was concreted in the following manner: Radial bulkheads were provided in each rib at distances of 22 ft. from each haunch hinge (measured along the rib) and also at points in each rib, 10 ft. from the crown hinge. The transverse braces were also bulkheaded off, so that concrete would not flow into them from the ribs. Chutes were arranged in such a manner that concrete could be discharged in any one of the haunch or crown sections by changing a series of gates, it being possible to change these gates at a moment's notice. Concreting was started in the haunch sections of the downstream rib. Four batches of slightly more than 1 cu. yd. each were deposited in each haunch section, alternating batches being placed between the two haunch sections. One batch was then deposited in each of the crown sections to keep the rib from being distorted. The same order was followed with each of the other ribs, except that more batches were used for them at each lift, as the inside ribs are thicker than the outside ones. When all the ribs had received the first batches of concrete the process was repeated until the haunch and crown sections had been filled. Lagging was carried up the back of the ribs as the concreting progressed to hold the concrete, which was necessarily mixed quite wet in order to work well around the reinforcement. After setting for about four days the bulkheads in the ribs were removed, the surface of the concrete was roughened, and the closure sections of the ribs were concreted in about the same manner as the haunch sections. The transverse braces were not concreted until the rib concrete had set for several days.

In order to keep account of the distortion of the ribs while concreting was in progress sash weights were suspended from the steel brace reinforcement close to each rib, at four points along the rib. One weight was placed at the brace on each side of the crown hinge, and one at each quarter point of the span. These weights, which were suspended by small wires and which carried scales, were wired to the weights. A stake was driven in the ground alongside of each weight, and a nail in the stake acted as a pointer on the scale. The initial reading was taken at each point, and another set of readings was made after each round of concreting. At first a slight settlement of the crown points was observed, followed by a slight rise. The distortion was less than had been anticipated, amounting to a maximum of about ¼ in.

TABLE I.—QUANTITIES OF MATERIALS AND COST OF VIADUCT.

Item No.	Description.	Quantity.	Unit price.	Cost.	Percentage.
1	Grading	4,720 cu. yds.	$ 0.35	$ 1,652.00	0.43
2	Foundation excavation	15,227 cu. yds.	1.00	15,227.00	3.96
3	Rock excavation	444 cu. yds.	2.00	888.00	0.23
4	(a) Concrete No. 1 (1:2:4)	10,611 cu. yds.	10.25	108,762.75	28.16
	(b) Concrete No. 2 (1:2½:5)	14,880 cu. yds.	6.85	101,928.00	26.40
	(c) Concrete No. 3 (1:3:6)	438 cu. yds.	6.25	2,737.50	0.71
5	Railings	3,875 lin. ft.	2.00	7,750.00	2.01
6	Structural steelwork	1,537,400 lbs.	0.05	76,870.00	19.90
7	Steel reinforcing bars	1,375,150 lbs.	0.035	48,130.25	12.46
8	Steel castings	205,460 lbs.	0.07	14,382.20	3.72
9	Iron castings	11,173 lbs.	0.04	446.92	0.11
10	Anchor-bolts and T. P. casings	21,311 lbs.	0.06	1,278.66	0.33
11	Steel dowels	98	3.00	294.00	0.08
13	Rip-rap	836 cu. yds.	1.50	1,254.00	0.32
14	Manholes	2	50.00	100.00	0.03
15	Removing old bridge	....	....	2,500.00	0.65
17	Timber piles	194	10.00	1,940.00	0.50
	Total	...	....	$386,141.28	100.00

The concrete in the ribs and braces was allowed to set for several days before the work of building the forms for the posts and deck of the span was begun. This portion of the work was concreted in the manner indicated under the head of "Loading." The posts were concreted, beginning at the haunches and working toward the crown; then the deck was concreted from the crown back toward the haunches, with the exception of the middle section over the crown, which was placed last in order to provide for the expansion joint at the crown. In the meantime the piers had been finished to their full height in order to insure stability and to provide for the connection of the deck to the piers.

The concreting of the other spans was handled in practically the same manner as that just described. When the concreting of a section was started it was carried through continuously, by working day and night if necessary, so that the work was made as nearly monolithic as possible.

Difficulties Encountered.—There was some difficulty in the early stages of the work, in sinking the foundations of the main piers. Pier No. 1 gave the most trouble, the unstable character of the soil on the south side of the stream being responsible for this. Extra heavy timber sheet piling and a large number of heavy shores of timber and steel were used. In order to give the material on the hillside south of the pier the least possible chance to slide, the excavation was made in four sections. The first section excavated was the downstream quarter of the pier, this excavation being about 20 ft., measured up-and-down stream. After rock was reached the surface was carefully cleaned off and several drill holes were put down to test the rock. The surface of the rock was found to be very rough, with a slight drop in elevation away from the stream. The drill holes showed that the layers of rock were very thick and had only minute seams between them. There had been some apprehension that the pressure of the bank behind the pier might cause the pier to slide on the rock before sufficient weight could be added to prevent it. With this in mind, preparations were made to cut a dowel in the rock so as to bond the pier and the rock. The fear of sliding was dispelled when the extremely rough character of the rock was noted, and the dowel scheme was abandoned. The pier section was concreted up to the top of the 13-ft. course, and the next section, which was the third quarter from the downstream end, was excavated and concreted to the same height as the first. The upstream quarter was next finished, and lastly the second quarter from the downstream end. All longitudinal reinforcing bars in the portion of the pier below the top of the footing course had to be spliced, on account of the method of construction adopted. Care was taken to bond the sections of the footing course by vertical re-entrant joints extending the full height of the 13-ft. 6-in. course. Above the top of this course the pier was built as a monolith in the usual manner. In concreting the footing sections it was not thought advisable to remove all the shores as the concrete was carried up; consequently, some of the steel members from the old bridge, which had been used for shoring, were built into the pier.

At pier No. 2 the only difficulty experienced was in driving the oak piles. These were about 20 ft. long, and were driven to refusal by using a drop-hammer, the driving through the compact mixture of sand and gravel at this point being very difficult. A bearing test of the material in the bottom of the pit, after the piles were driven, gave very little settlement under a load of about 8,000 lbs. per square foot, with a loaded area of about 4 sq. ft.

In September, 1913, a freshet did some damage to the falsework of the traveler. Had the arches been under construction on falsework in the usual manner much more serious damage would undoubtedly have resulted.

COST DATA.

There are given in Table I the quantities of materials, the unit prices bid by the successful contractor, the total cost of each item, and its percentage of the total cost.

The cost of the viaduct, per linear foot, was $244.60; the cost, per square foot of horizontal projection, was $3.66; the cost, per square foot of vertical projection, was $6.34; and the cost, per cubic foot of volume, between finished ground line and crown of roadway, was $0.091. The total estimated cost of the viaduct, including paving, lighting and engineers' fees, was $428,882.

The cost per square foot of vertical projection is based on the area of the projection of the viaduct between the finished ground line and the top of the roadway. For the horizontal projection, the extreme width over the copings or stringer moldings was taken. In computing the cost per cubic foot the volume included between vertical planes through the copings and between the finished ground line and the top of the roadway was taken. The total cost on which the above unit costs are based is the cost of the structure based on the contractor's unit prices and the quantities as given in the table, to which has been added the cost of the paving, lighting, and engineers' fees.

PERSONNEL.

The work was designed and its construction supervised by Messrs. Brenneke and Fay, consulting engineers, of St. Louis, Mo. The writer, as principal assistant engineer for that firm, was responsible for the design of the viaducts and exercised executive supervision over the work. L. H. Faidley had charge of the detailed work of preparing the plans, and William Holden was in direct charge as resident engineer.

The contract for the viaduct was awarded to the Hannan-Hickey Bros. Construction Co., of St. Louis. The Virginia Bridge and Iron Co. was the sub-contractor for the structural steelwork and for its erection.

Pulling Steel Sheet Piling With a Steam Hammer.

Contributed by W. F. Schaphorst, New York.

It seems that an effective and economical method of pulling steel sheet piling has at last been discovered. With the advent of the steam pile driving hammer the driving of the piling became a simple matter as it was possible to drive it through materials impregnated with boulders. But pulling has been so difficult that it was common to hear engineer say, "The cost of pulling would have been so great that we left the piling in place." The methods of pulling hitherto employed have varied from prying the piling out with a long, fulcrumed lever, to starting it with hydraulic jacks and finishing with derricks.

A method now successfully employed by several contractors consists in the utilization of the steam driving hammer, the hammer simply being turned upside down, hitched to the sheet piling, and the driving process reversed. The upward blows readily jar the piling loose, and its removal is then a relatively easy matter.

To emphasize the advantages possessed by this method the following example is cited: Three derricks were so arranged on a job in New York as to strain simultaneously a piece of steel sheet piling which had been driven into the earth to bed-rock, a distance of 50 ft. But under the combined action of the three derricks, with the assistance of a workman hammering on the piling, the pile could not be loosened. A No. 5 "McKiernan Terry" hammer was then attached in its pulling position, and when the strain was turned on the pile was pulled out readily. If the piling is not too greatly distorted at the bottom, due to driving it against boulders or rocks, a No. 5 hammer will pull out whatever a No. 7 hammer will drive. To emphasize further the pulling power of the hammer the writer has seen a pulling yoke of soft steel, 1½x4 ins. in section, broken during pulling operations.

One of the present difficulties is the tendency to disruption at the point where the hammer is attached. Where a pin is placed through the web of the piling there is danger of shearing the comparatively thin web. Obviously, due to the jerky pulling action of the hammer, all members are subjected to heavy stresses, but the contractors who have used the method appear to be well satisfied with the results accomplished. The writer is informed that a hammer will soon be placed on the market designed expressively for pulling sheet piling.

WATER WORKS

Plant and Methods Employed in Laying the Flexible-Jointed Narrows Syphon of the Catskill Aqueduct.

Contributed by Stephen W. Symons, 388 Henry St., Brooklyn, N. Y.

One of the most interesting operations in the laying of the Narrows Syphon of the Catskill Aqueduct, is that of caulking the flexible joints in the large cast iron pipe. The pipe is 36 ins. in diameter and in sections 12 ft. long, each of which weighs approximately 9,000 lbs. The total length of the syphon will be 10,000 ft. It is being laid in a trench 60 ft. deep and is covered with about 8 ft. of sand to guard against damage from the anchors of vessels. It was found necessary to flexibly couple the pipe, in order to permit of its being lowered from a lighter within a special steel lattice work, as well as to take up the inequalities of the trench. The joint employed is of the cast lead type, spherical in form, the bell end being turned on the interior, to a true sphere and highly finished with a band of steel shrunk on the outside. The spigot has deep grooves to retain the lead and a turned collar to bear in the bell. A sketch of the joint is shown in Fig. 1. It is in the caulking of this joint, after the lead has been poured, that the most interesting part of the work occurs.

Owing to the special form, it was found impractical to caulk in the usual manner because of the necessity of deflecting the joint, both while laying the pipe and after it was laid, which would be almost certain to destroy the tightness of the caulking.

Caulking the pipe from the bell end, after it was in position, would also have been both expensive and difficult, as well as insecure, owing to the very strong tides to be met with in that part of the Narrows and the added cost of retaining the services of a diver.

The joint eventually adopted was worked out from a suggestion made by a workman who had seen lead shot forced into small joints.

As can be seen from the sectional illustration, Fig. 1, a series of 32 holes, in two rows, were drilled and tapped around the periphery of the bell end of the pipe. After the joint has been poured full of hot lead, small pellets of cold lead were introduced and forced in by means of a screw plunger, as described later, to make up for the shrinkage of the lead in cooling.

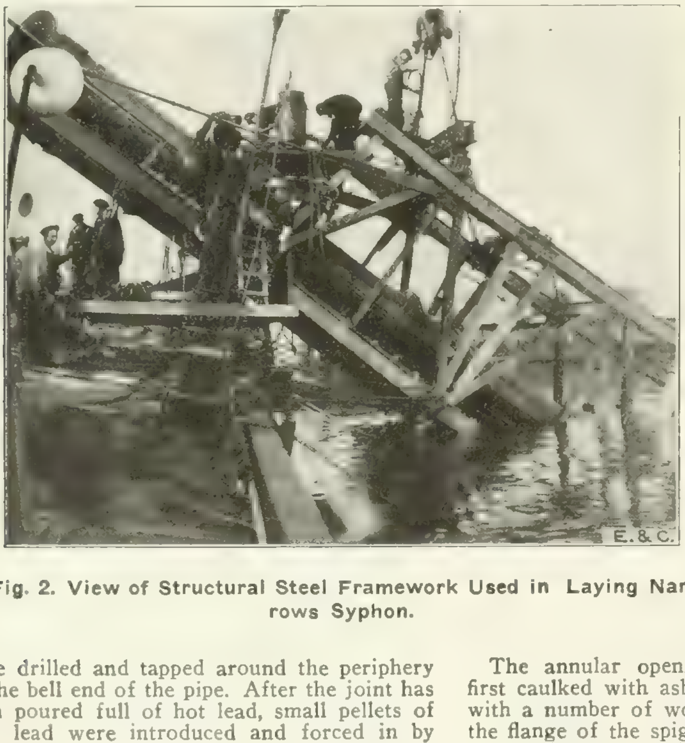


Fig. 2. View of Structural Steel Framework Used in Laying Narrows Syphon.

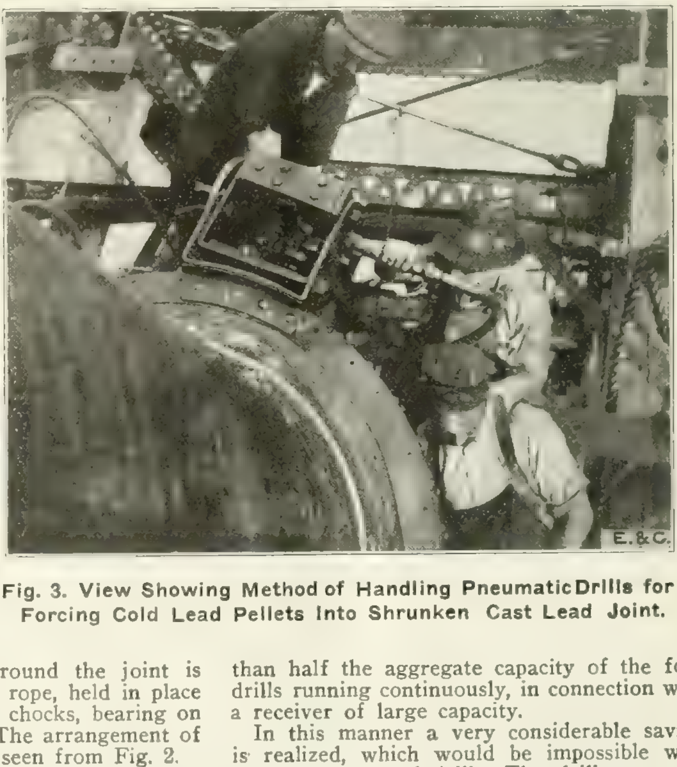


Fig. 3. View Showing Method of Handling Pneumatic Drills for Forcing Cold Lead Pellets Into Shrunken Cast Lead Joint.

METHODS OF LAYING PIPE.

The work is being carried on by the Merrit & Chapman Derrick & Wrecking Co. starting from the foot of 79th St., Brooklyn, and crossing the Narrows to Tompkinsville, Staten Island.

Figure 2 shows the structural steel framework carrying the pipe, in place on the lighter "Comptroller." This framework extends down to the bottom of the channel and is curved so that the pipe, on leaving it, will lie flat in the trench. A pneumatic pontoon is attached at one end to supply a certain amount of buoyancy. The framework will accommodate 12 lengths of pipe. After the work has progressed further, the position of the pipe will be changed. Instead of coming over the lighter, as shown in Fig. 2, it will come up underneath it.

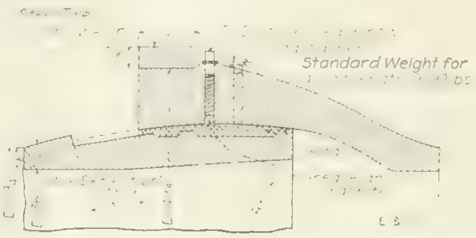


Fig. 1. Sketch Showing Elements of Flexible Joint Employed in Laying Narrows Syphon of Catskill Aqueduct.

The operation of laying the pipe is continuous, each section being hoisted to the top of the framework and lowered into place with the spigot end in the bell end of the previous pipe. The joint is then poured, caulked and tested and the lighter with the framework warped further out into the channel ready for the next length of pipe. The lighter is held by 10 anchors, each being supplied with 1,000 to 1,200 ft. of wire rope.

POURING THE JOINT.

A removable wooden staging is erected over the joint to accommodate the crew, melting pot and blow torch.

The annular opening around the joint is first caulked with asbestos rope, held in place with a number of wooden chocks, bearing on the flange of the spigot. The arrangement of the staging can be clearly seen from Fig. 2.

The discharge pipe from the melting pot is inserted in a fire clay mold at the top of the joint, everything is made fast, and the joint is ready.

The lead is heated by means of a gasoline torch operating under 80 lbs. air pressure. The lead is heated to 800° F., carefully tested for temperature and measured and the pot tapped. The total amount of lead for each joint is 350 lbs.

Immediately after the joint is poured, the wooden chocks are knocked out, the melting pot swung onto a hook conveniently placed near by and the wooden platform removed. The whole operation taking about two hours, from the time the pipe is placed in position.

CAULKING EQUIPMENT.

Pneumatic drills of the type ordinarily used for drilling metals, and similar portable work were adopted as the most reliable means for driving in the screw plugs.

A saddle was rigged up of two semi-circular sections of angle iron to fit snugly over the steel band shrunk over the bell end of the pipe. This saddle carried four frames, each of which carries a drill. The drill frames allow of movement, in relation to the saddle, both longitudinally and radially. This movement being controlled by means of a hand wheel on the dead handle of the drill, for radial adjustment and by means of a clamp and short groove, for the longitudinal adjustment. This longitudinal adjustment being necessary in order to swing the drill from one row of the holes to another. The frame holding the drill is pivoted at one end and provided with a long lever, by means of which it is fed to and from the work.

The drills used are of the angular four-cylinder type, fitted with square socket to accommodate the screw plugs. They are termed by their manufacturers, the Ingersoll-Rand Co., "No. 11 C." A system of compound gearing gives them a free spindle speed of 150 r.p.m. with great power; this being computed as about 995 ft.-lbs. The drills are controlled both forward and reverse by turning the throttle handle. The air consumption is approximately 55 cu. ft. of free air per minute, but the operations are so intermittent that it is possible to use a compressor of a little less than half the aggregate capacity of the four drills running continuously, in connection with a receiver of large capacity.

In this manner a very considerable saving is realized, which would be impossible with any other type of drill. The drills are also found admirably adapted to the heavy work owing to their sturdiness and high overload capacity.

The compressor is an old style Rand. It is rated at 98 cu. ft. of free air at 140 r.p.m. The air pressure carried while the drills are in operation, varies from 80 to 60 lbs.

OPERATION OF CAULKING.

The drill frame is clamped over the end of the pipe, which is well greased to allow of its being rotated. Two men operate each drill.

The holes in the row furthest from the end of the pipe are numbered consecutively 1, 2, 3, 4, the same numbers applying to the outside row of holes. The drills are adjusted over the holes numbered 1—the word is given and No. 1 plug is withdrawn, then Nos. 2, 3 and 4. A helper hands four pellets to each drill runner who inserts them in the holes with the screw plug on top of them. When all is ready the screws are run in and run out again, beginning with No. 1 and ending with No. 4 hole; the holes are again "loaded" and the operation repeated, this time from No. 4 to No. 1 hole and so on until four pellets have been forced into each hole. A mixture of graphite and grease is then forced into each hole, in the same manner, and permanent screws of a different type fitted with soft lead washers are run in.

The second row of holes is handled in the same manner, except that sufficient graphite mixture is forced in to insure thorough lubrication of the entire surface of the joint. A noticeable expansion of the lead from the bell end can be seen, after the first row of plugs has been driven in. The methods of handling the drills can be seen from Fig. 3.

Driving the pellets into the row of holes farthest from the bell end first forces the lead to expand towards the bell end and further insures a thoroughly tight joint.

Each pellet measures 9/16 in. x 1¾ ins. and weighs about 3 ozs., a total of 128 pellets or approximately 24 lbs. being driven into each joint. The pressure within the joint is estimated at 22,000 lbs.

The whole operation takes about half an hour, though the actual time for driving one set of four pellets and running the plugs out again averaged 30 seconds.

TESTING THE JOINT.

The joint is tested under the most severe conditions. The joint is first deflected to 5°, the maximum it is designed for being 10°. A testing machine is then lowered into place.

This, as can be clearly seen in Fig. 4, is composed of two diaphragms, held together by tie rods and provided with rubber cup leathers. One diaphragm is adjusted on each side of the joint and water under 100 lbs. pressure is introduced.

No leakage has been recorded up to the time of the writer's visit, testifying to the thoroughness of the work and the practicability of this type of joint. The joint showed a smooth, well-greased surface where it was deflected.

The total number of sections will amount to about 840. They are being laid at the rate of four a day, so that it will take the better part of a year to complete the work. During the winter the work will, in all probability, be suspended, on account of running ice.

The contractors, the Merrit & Chapman Derrick & Wrecking Co., are handling this work in a highly efficient manner, as can be judged by the performance set forth in the foregoing. The writer is indebted to the Merrit & Chapman Co. for assistance in taking the photographs here reproduced and in gathering the data.

Four motor buses seating 20 passengers each have been ordered for use in passenger transportation around Balboa and Ancon by the Canal Commission. The extreme length of each car will be 20 ft. 10 ins.; width, 72 ins.; height, 9 ft. 10 ins.; wheel base, 144 ins.; and width of tread, 59 ins.

Data and Discussion on Pollution of Public Water Supplies Through Connections to Industrial Supplies.

Occasionally in localities where the public water supply is of good quality there occurs an epidemic of typhoid fever. A careful epidemiological study reveals the facts that the milk supply is not used in common, that the sanitary conditions are good, that private wells are not used and that the only source common to all is the public water supply. But the source of the supply is satisfactory and analyses of samples of the water have shown it to be free from pathogenic bacteria of the colon group. From what source then does the infection come? In a number of cases it has been traced to industrial connections at factories and shops, maintaining for their private use polluted water supplies. The present article records some experiences with industrial connections, discusses methods of preventing pollution by industrial connections, and gives some legal opinions regarding the responsibility for the pollution of water supplies. The matter given is from a paper by L. H. Van Buskirk, Assistant Engineer, Ohio State Board of Health, before a recent conference of local health officers in Ohio.

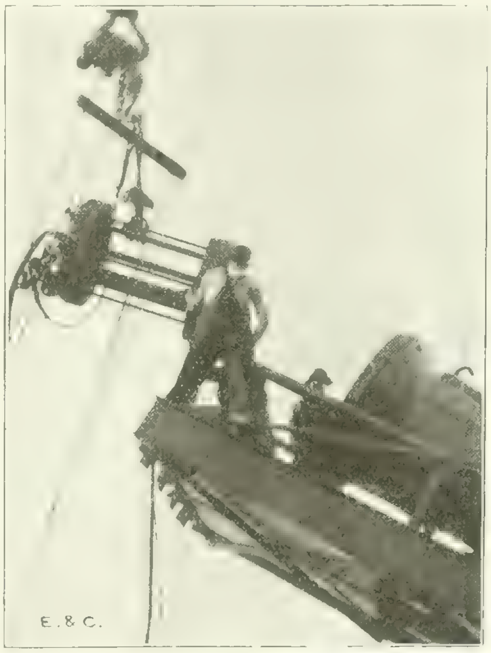


Fig. 4. View of Hydraulic Testing Machine for Testing Deflected Flexible Joint for Watertightness, Narrows Syphon.

With the development of cities due to the installation of new factories there has been a gradual increase in the number of industrial connections. In many instances but one source of supply is used, and the city water is utilized for fire protection as well as for the general manufacturing processes. In the larger plants in order to reduce insurance rates it is often found advisable to install a secondard supply. The source of this supply depends, of course, upon the location of the plant, but is generally taken from some river, creek, lake, pond or hydraulic or transportation canal which source may or may not be seriously polluted, but certainly is of such characteristics as to be unsuitable for drinking purposes and should not be discharged either into the city mains or to the private main supplying drinking water within the factory. The saving to the factory on the double water supply is from 33⅓ per cent to 50 per cent of the premium on the fire risk and, in fact, some companies will not insure a factory which is not provided with two sources of supply. It will be seen, therefore, that the larger industrial plants are greatly in need of the two supplies. If two sources are provided it is evident that where only one system of piping has been installed, there must be some point where the pure city supply and the impure factory supply must be connected. Therein lies the danger.

Many superintendents of water works when confronted with the proposition state that it is impossible for any of the polluted supply to enter the city mains owing to the fact that a gate valve is provided, which is kept closed, and also that the city pressure is higher than that maintained by the factory. He fails to realize that gate valves may leak or that the city pressure may be lowered due to a break or heavy consumption or that the factory fire pumps are tested frequently by inspectors from fire underwriters at which times the pressure on the factory side may be considerably higher than that on the city side.

EXPERIENCE WITH INDUSTRIAL CONNECTIONS.

An epidemic of typhoid fever occurred in Van Wert, Ohio, in December 1913, which was traced to an industrial connection at the Cincinnati Northern Railroad shops. On Saturday, Nov. 15, 1913, the pumps at the pumping station of the Van Wert water supply were stopped and were not started again until Sunday afternoon. From Monday until Wednesday of that week enteritis was epidemic in all parts of the city, between 500 and 600 cases being reported. On Dec. 1, 1913, an outbreak of typhoid fever occurred. No typhoid had been reported during November 1913. The incidence of the disease was sudden. During the first two weeks of December, 20 cases and 1 death were reported and in the second half of the month 8 additional cases with 1 death. During January 1914, there were five cases with one death with the following month entirely free from typhoid. Careful studies of the outbreak were made by the local board of health and by representatives of the Ohio State Board of Health. The report upon the investigations showed that the public water supply which was obtained from deep wells was safe for domestic uses, and that it was not probable that it could be the source of infection. It was ascertained that the Cincinnati Northern Railroad company maintained a connection between their private supply and the city water main. The private supply is obtained from Town Creek below the city, through which it passes. The creek receives the sewage from about 50 outlets thereby being seriously polluted. The Cincinnati Northern Railroad maintains two pumps, one pumping against a pressure of 110 lbs. and the other to a tank against 25 lbs. The city pressure is 65 lbs. A single gate valve is placed on the line between the city supply and the discharge side of the pump working against the pressure of 110 lbs. The city main discharges into an elevated tank, owned by the railroad. It is well established by the facts as observed that the water from Town Creek pumped by the railroad company was discharged from the tank to the city mains, this being made possible by the lowered pressure on the distributing system, resulting from the temporary interruption of pumping. This permitted the supply to be contaminated thereby causing the epidemic which resulted. The necessity for the correction of the existing conditions was evident and the connection between the two supplies was discontinued. The city main now discharges to the elevated tank in such a manner as to make it impossible for the tank to drain into the city mains.

The liability of a single gate valve to leak, thereby endangering the quality of a public water supply has long been realized and many attempts have been made to use check valves in combination with gate valves. This arrangement has not proved to be an entirely safe one. One of the best examples is the typhoid epidemic at Circleville, which occurred during January and February 1914. In this case a careful study by the local board of health and representatives of the Ohio State Board of Health determined that the source of the infection must be the public water supply. The public water supply which is owned by a private company is obtained from a horizontal well which is located near Big Darby Creek. Examinations made at different times by the Ohio State Board of Health previous to the outbreak indicated that the water supply was safe. Analyses of the water at the time of the outbreak confirmed those results previously obtained. The 43 cases included in the outbreak were with one exception in the southerly half of the city. Three deaths were reported. No satisfactory explanation was found until Jan. 31, 1914, at which time the local board of health learned of a connection between the city water mains and the private supply of the American Straw Board Company, located in the southwesterly portion of the city. The straw board company maintains an intake to the Scioto River which stream is grossly polluted by the sewage from Columbus, located on the Scioto River 25 miles above Circleville. The private supply is used for industrial purposes and for fire protection. The city water enters the private system through a check valve and gives added fire protection. Frequently the pressure of the private supply exceeds that of the city supply and the check valve was installed in order to prevent the entrance of the polluted water into the city mains. In addition to the check, two gate valves one on either side of the check are provided. Both of these valves were open and when the connection was examined it was found that the check valve was leaking badly. The valve was removed and repaired and the gate valve on the polluted side was tightly closed. The outbreak was sudden both in onset and decline. The distribution in the southern portion of the city showed no peculiar grouping and all other possible sources other than the public water supply were eliminated. It is interesting at this time to note that a suit has been filed in the Pickaway County courts against the Circleville Water Company by a man whose wife contracted typhoid fever and died. The suit is in the courts at the present time. A complete report of the outbreak at Circleville was published in ENGINEERING AND CONTRACTING of Aug. 19, 1914.

In 1903 at New Bedford, Massachusetts, trouble was experienced due to leaking check valves. A fire occurred at one of the large mills provided with a private water supply of salt water. The salt water pumped by the fire pumps at the mill passed through leaking check valves to the city mains. Such a large amount of this water reached the mains that it entirely disabled the fire steamers of the city, which were assisting at the fire. If the mill supply had been fresh water the leaking valves would not have been detected and with a polluted supply the damage that might have been done is impossible to estimate. In New Bedford periodical inspections of all connections between private supplies and the public water supply are made. Such an inspection occasionally reveals a case where a check is not in operation.

In 1911 a small outbreak of typhoid fever occured in Springfield, Ohio. Many of the cases were found among the employes of the International Harvester Co. It was ascertained that this company had access to two supplies, one obtained from the city and the other from a small creek. The two supplies were separated only by a gate valve with the polluted water at a higher pressure than the city supply. A study of the situation led to the conclusion that the polluted creek water passed through the gate valve, entered the mains which were supposed to contain only city water which supply was used for drinking purposes by the employes, thereby causing the infection.

A similar case was observed in Toronto, Ontario, where check valves supplying an office building failed to operate. In the same city a small connection installed by an employe of an industrial establishment between the public water supply and a polluted supply so contaminated the public water supply that an epidemic of typhoid fever resulted.

In 1913 the Bureau of Health of Philadelphia, investigated a typhoid epidemic which of the city water by industrial connections. Intermittent contamination appeared in the city mains, which upon investigation was found to be due to what are termed "Dual Water Systems," that is, piping systems which could alternately receive water from the city main and water from some other source, as for example from Frankford Creek or the Delaware and Schuylkill Rivers through the private pumping plants. Check valves were found to be in the piping systems but in many cases they failed to operate properly. Absolute separation of all such systems was required and no future installations of this type were permitted. The result was that the intermittent contamination disappeared from the city mains. There was an increase in the typhoid rate for Philadelphia during April and May 1913. The larger number of cases were confined to the district along the Delaware water front. This district is supplied with filtred water which is also furnished to other portions of the city which were entirely free from typhoid.

When industrial connections are installed it is very frequently found that the gate valves as well as any check valves which may be installed are covered and within a short time the exact location of the same is not known. This condition existed in Auburn, N. Y. An examination of all of the connections in Auburn revealed the fact that many of the check valves were leaking and that the polluted water from the private supplies was being forced into the city mains. An attempt was made to prevent any connection between the two supplies. This was met with strong opposition by both the insurance men and the factory owners. Duplicate check valves of an improved type were then installed. These are placed in suitable chambers and regularly inspected. A description of the so-called sanitary check valve together with the method employed in testing the same was given in ENGINEERING AND CONTRACTING of May 20, 1914.

Mr. H. E. Jordan, superintendent of filtration, Indianapolis Water Co., pointed out the reasons for the installation of the private supply and the methods generally in use in connecting the private supply to the city mains, in ENGINEERING AND CONTRACTING of March 5, 1914.

Three instances of the danger of cross connected systems were mentioned. The first which has no sanitary significance excepting indirectly, is that of an establishment which used unpurified canal water. The canal was drained for repairs and while such were being made the city water was furnished to the plant. When the repairs were completed, the valve to the canal was opened, but the city supply was not shut off. The result was, that the city water which was of high pressure not only supplied the plant but also flowed through the open valve and wasted to the canal. Similar instances might be cited where the negligence of employes in leaving valves open had the opposite result, in that the polluted supply was forced into the city mains.

Another case was that of a connection in a western city. The connection between the private and public supplies was provided with two valves, both of which were to be closed excepting at such times as the city water was being used. A water tank on the private system was used to receive fresh water as well as water from ammonia washers. It was thought that the city pressure was always above that of the private supply, but at times of heavy consumption such was not the case. The mixed water, therefore, passed into the city mains and frequent complaints as to the color and odor of the supply were received. Owing to the character of the pollution no serious results followed. Had the private supply been obtained from a polluted source typhoid probably would have resulted. The people, however, are entitled to a safe supply of water and one that is usable. A water having a high color and objectionable odor cannot be considered as satisfactory and a supply should be protected against such pollution.

In Winnipeg, Manitoba, a cross connection between the fire service system and the domestic supply of the city caused an epidemic of typhoid. The connection was removed and the fever disappeared.

While repairing the pumps of a private water supply used in a certain building in Muncie, Ind., the city water was turned on. The contractor who was to make the repairs completed his work and desired to test the same. The open valve on the city main was forgotten, however, and the private supply was pumped into the main. A similar case was that of a private supply stored in reservoirs and used over and over. The water comes in contact with a product of manufacture and has a decided taste and odor. Owing to the fact that the valves connecting the private with the public water supply were not closed the consumers in the neighborhood of the plant received a water which had a high color and a decided taste and odor.

The Massachusetts State Board of Health ordered, some years ago, the absolute and complete separation of the city mains from all other sources of supply. The following regulations were passed and are still in force:

Preamble: No fire service pipe shall be laid into the premises of any corporation, firm or individual having connected therewith, directly or indirectly, supplementary or secondary fire service consisting of fire pump, cistern, tank, standpipe or other apparatus, excepting where such fire pump, cistern, tank, standpipe, etc., are supplied with water from the city water works system and subject to the following regulations:

1. All water for fire service pipes shall be metered; meter to be furnished and set by city at the owner's expense. No charge shall be made, however, for water used exclusively for the extinguishing of fires.
2. All main pipes for fire services shall be furnished and connected by the city at the expense of the owner.
3. Where a standpipe, tank or cistern is used it shall be constructed in such a manner as to shield and protect the water from all possible pollution.
4. Provision shall be made in its construction for means of access to the interior of it by the superintendent or other agents of the Water Department for the purpose of inspection and so as to allow for its cleaning as required by the water department.
5. It shall also be fitted with a pipe for the purpose of drawing off all the water at such intervals as required by the Water Department.
6. Said drawoff pipe must be connected with a sewer or drain in a way that might lead to the contamination of the water from such source.
7. All expenses not mentioned herein incurred on account of fire services shall be borne by the corporation, firm or individual owning the protected premises; and,
8. The Water Board shall have the power from time to time to prescribe whatever other rules they may deem necessary.

Mr. R. J. Thomas of Lowell, Massachusetts, superintendent of water works states that where the health and lives of the people are in danger, reliance should not be placed on any contrivance that operates either automatically or by hand. The safest plan is not to allow any connection directly or indirectly between the pipes of the public water supply and the pipes, tanks or pumps of the private fire service system containing a polluted water. Following the investigation of the local health department at Philadelphia, the board of health passed resolutions under date of June 20, 1913, as follows:

Whereas: It has come to the knowledge of this Board that it is the practice in this city to install in certain instances water piping systems whereby water from city mains and from other sources can be alternately used in such piping system; and,

Whereas: It has been found that the city mains in localized sections are now subject to periodic contamination; and,

> Whereas: Systems of piping which possess the possibility of allowing contaminated water to enter the city's distribution system have a tendency to be prejudicial to the public health; therefore, be it
>
> Resolved, That an actual physical severance shall be maintained between piping connected to the city mains and piping carrying water from any other source and that the Director of the Department of Public Health and Charities is hereby authorized and directed to cause the severance of all such dual systems in use, and to prevent the construction of any future system of like character.

There was some divergence of opinion in Philadelphia as to the theory of the typhoid epidemic. Dr. W. H. Frost, of the United States Health Service, and Mr. F. Herbert Snow, at that time chief engineer of the Pennsylvania Department of Health, reviewed the records and corroborated the findings of the local officials. The conclusion reached was that the probable cause of at least 72 per cent of the typhoid cases in Philadelphia was due to the pollution of the city service mains. A careful survey of the city revealed 77 industrial connections. Sixty-three of these connections were discontinued in 1913 and 14 were being disconnected at the beginning of 1914.

The Baltimore County Water & Electric Company of Baltimore County, Maryland, provides the following agreement, which is entered into by the above named company and any applicant for private fire protection:

> Any fire protection system supplied with water from the company's service shall be supplied exclusively with such water, and no connection will be allowed with any other system drawing its supply from any other source, whereby the company's water supply may be contaminated by the failure to close valves or leaking check valves, etc.; and no auxiliary or secondary suction pipe to any underwriter pump taking water from the harbor, streams or other source whatever will be permitted. Any fire protection system using water from the harbor, streams or other source than the company's service shall be kept separate from any such system supplied from the company's service.

EXPERT COMMENT ON INDUSTRIAL CONNECTIONS.

Much has been said and is being said at the present time by the fire underwriters exploiting the use of the double check valve stating that absolute protection is thereby afforded. Mr. William C. Lounsbury, superintendent of filtration, of Superior, Wisconsin, does not believe that two check valves are better than one. On the contrary he feels that sometimes two check valves are twice as bad as one because when two check valves are installed there is a greater feeling of safety which is not warranted by the facts. The apparent safety is not assured because of having two inspections a year.

Not only is there danger due to the leaking of check valves, but one must not forget that in testing the pumps the pressure is frequently raised considerably above that of the city supply. Mr. E. T. Lochridge, engineer of water works, Springfield, Massachusetts, emphasizes this particular fact and states that there is a constant menace in the testing of pumps. Ordinarily the factory men state that they simply turn the fire pump over, but on inspection of the pressure gage it is found that the pressure often exceeds that of the city mains. The mill people should be required to so arrange their fire system that there is no possibility of any impure water getting into the city mains for use by the people at the mill or by residents in the vicinity of the mill.

During the past few years much has been done to improve the character of these connections by the manufacture of better and safer valves. The old fashioned check valves are unsatisfactory and may permit the city water supply to be polluted frequently. It has been noted that the body of a check valve as ordinarily made of cast iron is hardly large enough to permit the valve to operate and the least formation of tubercles on the inside of the body is liable to arrest its opening or closing. It has been pointed out that a composition check valve would not be very expensive and would seem to be a point in the right direction in solving the trouble arising from check valves.

Mr. J. Walter Ackerman, chief engineer and superintendent of water works at Auburn, N. Y., who presented a paper in 1914 before the American Water Works Association on the sanitary check valves, believes that they provide a greater factor of safety against pollution than the old installation, and that the installation of such valves is a decided improvement. It is his opinion, however, that where there is no such connection that the installation of the same could not be considered as an improvement of the supply and that it should rightly be considered as a possible source of contamination. This is particularly true owing to the fact that few people realize the danger which is attached to the use of such supplies. The care of the connection is, therefore, not to be overlooked.

METHOD OF PREVENTING POLLUTION BY INDUSTRIAL CONNECTIONS.

Information concerning the opinion of water works men about the country has now been added to that of specific cases where epidemics have occured due to industrial connections. The question of how to protect the public water supply against pollution from industrial connections now confronts us. Few methods of solving this difficulty have been proposed and from the above facts it would seem that the only logical conclusion to reach would be that of eliminating any connection whatever direct or indirect with the polluted water supply. In order to provide fire protection for manufacturing establishments where no connection is permitted an independent or duplicate sprinkler system could be installed. The cost of such an installation would seem to be prohibitive. The fire underwriters also claim that such an installation is unsatisfactory owing to the fact that where the sprinkler heads are placed close together that the discharge of one may cool the one next to it to such an extent that it would fail to operate. This system, however, would certainly afford absolute protection to the people against contamination of the public water supply. Another system which could be installed is that of an elevated or storage tank into which both the city water and the private supply could be discharged. In this case it would be necessary to provide a free discharge of the city water in order to eliminate any opportunity of back flow to the city mains. The only additional cost in this case is the construction of a tank, excepting in a few instances where the city pressure would be insufficient to discharge the water into the tank. This cost would be small, however, even in cases where duplicate pumping would be necessary and in fact would be an advantage in affording more ample fire protection. Certain individuals interested in fire protection argue against the installation on account of the fact that the city pressure is not sufficient at all times to fill the tanks. When such conditions prevail it is certain that the demand at a time of fire would be such as to make the supply entirely unreliable and inadequate. It would seem that there is no logical reason why such an installation should not be provided in the majority of cases, even when it is necessary to install a water tank upon the roof of the building owing to the lack of ground space.

The double check or sanitary check valve is especially designed in order to protect the city water supply against the polluted water of industrial connections. The moving parts of the valve are largely constructed of bronze with large clearances and the clapper is faced with a medium hard rubber closing on a seat of ample width to prevent injury to the rubber. The valve of the body is designed so that the clapper can be swung out through the bonnet opening, thereby providing easy access to the interior and affording convenient inspection. There can be no question that the valve is an improvement over the old fashioned check valves, but as noted above there is still some danger that the valve may not seat properly thereby permitting some of the polluted water to enter the city mains. It has been observed that, when the pressure is not increased quickly upon the valve it does not seat properly and some water will pass into the city distributing system. It would seem reasonable, therefore, to require that no physical connection be produced between the two supplies and that where two sources of supply are required provision be made for keeping them entirely separate.

LEGAL OPINION REGARDING RESPONSIBILITY FOR POLLUTION OF WATER SUPPLY.

The above discussion would not be complete without giving briefly some of the legal opinions in regard to the liability of the municipality or water company when furnishing a polluted water supply to the people of any community. Dillon on Municipal Corporations, Fifth Edition, Section 1316, in discussing contamination of the water supply states that

> The obligation of a water company is not to provide water that is chemically pure, but water that is ordinarily and reasonably pure, and in the performance of that obligation it is only held to the exercise of reasonable diligence. If it is liable for impurity of the water, or for contamination which renders it unfit for domestic use, it must be on the ground of actionable fraud or negligence without contributory negligence on the part of the consumer. If the water company knows, or from the situation ought to have known, that the water it is distributing in a municipality is dangerous for domestic use from causes not ordinarily discoverable by the exercise of reasonable care, it owes the duty to its customers of disclosing that danger, and a failure so to do, knowing that such customers are liable to use the water through ignorance of its character, has been said to be a fraud in law, rendering the company liable to legal damages to any person injured by such fraud without any fault on his part, and has also been said to be a failure of duty amounting to actionable negligence to which the same liability is incident.

A cause of action for damages resulting from the impurity of the water sounds in tort in whatever way it may be regarded and knowledge, or its equivalent, on the part of the company, and want of such knowledge, or its equivalent, on the part of the consumer damaged, is essential to legal liability in the one case as well as the other.

> After having secured a proper source of supply, the company is bound to exercise diligence in the effort to preserve the water from pollution, and deliver it to the public in no worse condition than that which it is taken from the source of supply. If it neglects to perform this duty, or if by reason of the contamination of the source of supply from causes over which it has not control, the water is unfit for domestic or other uses, the company may, at the suit of a taxpayer, be restrained from collecting water rates, because it is inequitable that it should collect these rates when the consideration therefore has failed.

In 1910 a damage suit was brought in the courts of Minnesota, against the city of Mankato. Judge Jaggard in giving his decision has sounded the keynote to the problem of the protection of the public health as it would seem that it should be viewed not only by the courts, but also by the people at large. The complaint placed against the city of Mankato charged that the defendant city negligently allowed the supply of the water works system to become polluted with poisonous substances and large quantities of filth and sewage to escape into and saturate its water supply. By reason whereof plaintiffs intestate contracted typhoid fever and died as a consequence. The municipality used as one means of its defense the consideration that it was exercising a governmental function and, therefore, was not liable under the law. The court, however, held that the municipality was liable for its negligence in its private or corporate capacity and was not exempt because it was carrying out a governmental function. In the opinion of the judge the following is interesting. He states that:

> It is obvious that a sound public policy holds a city to a high degree of faithfulness in providing an adequate supply of pure water. Nor does it appear why its citizens should be deprived of the stimulating effects of the fear of liability on the care and energy of its officials; nor why a city should be exempt from liability while a private corporation under the same circumstances should be held responsible for its conduct and made to contribute to the innocent persons it may have damaged.
>
> Public policy requires the conservation of human life, the preservation of public health and the establishment of public sanitation on a firm and certain basis in the law.

CONCLUSION.

In conclusion, the dangers incident to the connection between private water supplies of polluted character and the safe public water supply cannot be overestimated. The means whereby fire protection may be afforded have been mentioned and the liability of either the company or city, which owns the public supply in case the supply has become polluted through its negligence has been shown by the opinions handed down by courts where such cases have been heard. It is interesting to note the different view points held by the courts at the present time from those held 20 years ago. It appears that formerly the rights of property were paramount over the rights of individuals. Recently, however, the courts have changed the tenor of their decisions and are attaching more importance to the responsibility of the company or city in the protection of the public health.

The fear of prosecution and the collection of damages should not be the impelling motive of local officials in the protection of their water supply against dangerous pollution. It should be their first aim to maintain the highest standard of purity possible in their water supply in order to protect the lives and health of the people. There is a distinct danger of having a water supply polluted through connections which may exist or which may hereafter exist between the public water supply and private supplies of polluted character. The only safe policy, therefore, is to insist upon a complete separation of the public water supply from any and all private supplies.

Method and Cost of Constructing a 6-Mile Water Main, of 3-in. Screwed Pipe, for New Orleans Lake Shore Land Co.

Contributed by Arthur M. Shaw, Consulting Engineer, New Orleans, La.

The following data in regard to pipe laying are given as of interest on account of the considerable length of comparatively small pipe, laid under conditions which made it possible to obtain an accurate cost record of the labor involved. The New Orleans Lake Shore Land Co. owns about 7,000 acres of reclaimed lands which are inside the limits of the City of New Orleans but beyond the terminus of the city water mains. About 400 men and 130 horses and mules are employed on the property at points tributary to the central camp at Citrus and the furnishing of suitable water for the laborers and stock required the construction of a water main from the nearest city connection to the main camp, a distance of 6⅓ miles. It was estimated that a 2½-in. pipe would furnish all the water required, with a mean pressure at the end of the existing mains of 45 lbs. per square inch, but in order to take care of a possible increase in demand and also to provide for a probable decrease in efficiency of the pipe from rust, a 3-in. pipe was selected. Owing to the rapid deterioration of steel in this locality, genuine wrought iron pipe was used. This was furnished with extra-long, heavy, recessed sleeve couplings.

A trench of sufficient depth was dug by plowing a double furrow with an ordinary mold board plow and cutting out the center with a "middle buster," a double mold board plow used in the sugar section. A small amount of hand work was necessary in cleaning out loose material and cutting down high points. The pipe was unloaded from cars at a switch near one end of the line and distributed alongside of the trench by wagons. No part of the cost of trenching or distributing the pipe is included in the following.

Two pipe laying gangs were organized, one gang working from each end. At the start, each foreman was instructed to put on as many men as he could work to advantage as it was an object to get water to the camp as early as possible. One gang was started with four men and the other with six. Short pieces of boards were laid across the trench to support the pipe while it was being assembled. After the gangs had been working a few days, a time study was made and it was found that each crew could make up a joint in exactly four minutes though they were completing only about 65 joints per day, the remainder of the nine hours being taken up in going to and from the work, placing cross pieces and pipe, removing protection sleeves, clearing away weeds and briars to permit the use of pipe tools at the joints, adjusting wrenches, etc. Through the study which was made, it was found that much of the work that was being done by the pipe laying gang could be done to better advantage by additional laborers, working under the same foreman. To secure a higher efficiency, the following instructions were issued:

> Each foreman will see that his gang is made up of six laborers; four of these men to work as continuously as possible at making up joints. The two additional men will place cross-pieces across the trench at proper intervals, place the pipe on these cross-pieces to approximate line and grade, examine all pipe for foreign material that may have gotten into them, remove all protection sleeves (excepting the few that can not be started off without the use of a wrench), lower the completed sections into the trench and clear away all obstructions near the joints that are to be made up.

Before reorganizing, the cost of labor and supervision amounted to $.007 per lineal foot with an immediate saving after reorganizing of about 30 per cent. The average cost after reorganizing was $.0043 per lineal foot. The best day's work for one gang before reorganizing was 70 joints while the same gang laid 101 joints on the first day after the instructions were received. The best record was made on the last day when one gang made up 100 joints in six hours beside cutting and threading one length for the closure. This shows an average of 3 6/10 minutes per joint, with no allowance for lost time or for cutting and threading the short length. The cost per lineal foot for the last day's work was $.00305.

All joints were made up with red lead and were turned up as tight as possible by two men using a 48-in. chain pipe wrench. Thirty-six-inch Stillson wrenches were used at first but it was found that these did not give sufficient leverage and resulted in greater loss of time in adjusting to fit the pipe. Gang No. 1, which did the most of the work and which made the highest daily average, made a record of 100 per cent perfect joints. The line laid by Gang No. 2 showed leaks at five different joints when the city pressure was turned on but these leaks were close together and it was necessary to cut the line at only one point when the defective joints were taken down and relaid.

Flange unions were placed in the line at frequent intervals and plugged Tees were inserted at all points where it was thought possible that future camps might be established. Right angle turns were made by using elbows but all smaller angles were made by heating and bending the pipe. Though some of these bends were made on a radius as small as 10 ft., there was no apparent tendency of the pipe to crush or to open at the weld.

The recessed sleeves and the fully protected threads made it possible to start the joints with a minimum loss of time. Especial care was taken to insure a clear pipe but on flushing out after a connection with the city mains was made, the discharge showed a large amount of rolling mill scale, shell chips from the adjoining shell road, one small snake, "and various articles too numerous to mention."

After the line was completed, it was permitted to discharge at full capacity for one hour into a measured tank. From this record, it was found that the rate of discharge was fully 30 per cent above the original calculations though in making these calculations, all uncertainties were heavily discounted. Under present conditions, all service is direct from the main but it is contemplated that as demands increase, it will be necessary to supply the main camp from a local pressure tank, filling this from the main, with an automatic valve which will permit constant flow from the main until the tank is filled.

GENERAL

The Business Engineering Problem In Water Power Development With the Sulution for a Specific Case.

The paper which follows is an unusually clear presentation of the business engineering problem—the problem of first importance—of water power development. This paper was read by W. V. N. Powelson before the American Association for the Advancement of Science, Dec. 31, 1914. It is reprinted with only a few omissions:

COMMERCIAL PRACTICABILITY IS KEYNOTE OF WATER POWER DEVELOPMENT.

I think it will be conceded that nobody would waste time and money on an undeveloped water power even though it could generate reliable power if he knew it could not when built yield an adequate return upon the investment. But because capital believes there is offered, in individual cases, the chance of such adequate return many are spending time and money in investigating and constructing water powers. *Confidence in the commercial practicability of undeveloped powers is, therefore, the keynote of water power development.*

There is no way in advance of the construction of the works and the actual marketing of the power to fix with mathematical certainty what the return on the investment will be, and the element of chance, therefore, necessarily involved in accepting estimates, can never be completely eliminated. In many undertakings general rules may be applied which will predetermine within narrow limits the probable financial results, but water power undertakings are peculiar in that it is almost impossible to gage the commercial practicability of an undeveloped power by the application of a general rule. Each case must stand by itself and be examined in the light of its own peculiarities.

NATURAL LIMITATIONS ON MARKET FOR WATER POWER.

In this connection I would call attention to the fact that a water power is a factory fundamentally the same as all other factories producing something for which there is or may be a demand. But a water power as a factory is differentiated from all other factories by two very remarkable limitations that natural laws have placed upon the marketability of its product,—limitations which had they been placed by legislation upon all other factories would have made the present industrial development of the world impossible. They are none other than:

(1) That the thing manufactured may not be transported to or consumed at any point at a greater distance than about 200 miles from the place where made, and,

(2) That the thing may not be delivered to a customer or even produced except at the instant when the customer desires to consume it.

INFLUENCE OF INITIAL MARKET ON SIZE OF DEVELOPMENT.

Water powers—excellent water powers from a physical standpoint and economically administered—have failed financially because they were built too large for a market thus circumscribed by natural laws. The fact that people pay more attention to a warning written in a legislative enactment than to one implied in a natural law would indicate that the effect of the natural law, though not in any degree obscure, has, nevertheless, not been generally understood. There are numerous examples of water power development having been undertaken without, apparently, paying great attention to the natural limitations placed upon the market; and the result in many cases has been disastrous to the original investors.

The reason a physically excellent water power well administered may thus fail financially is because the principal part of the cost to manufacture power from water is made up of the fixed charges on the investment—from 70 per cent to 90 percent of the total cost to manufacture. This part of the cost goes on indefinitely whether the plant is operated or not. The operating expenses, depending largely upon the size of the plant, vary from 10 per cent to 30 per cent of the total cost to manufacture. These expenses at a given plant, if it be kept in operation, are not subject to much increase or decrease even with very wide differences of output from the plant. It may be stated, therefore, as a close approximation, that the total cost to manufacture at a given water power plant is fixed and independent of the volume of its output. In other words, whoever makes the decision to develop a particular water power site according to a particular plan or design assumes, in effect, the responsibility of paying a fixed annual sum, sometimes very large, for the right to dispose of all the power that plant is capable of manufacturing; and this sum, largely the "hire" for the use of the money, must be paid whether the power can be sold to others or not.

Now, it may have been truly shown that many water powers have been commercially successful, and that the particular plant under consideration would be capable when fully loaded of manufacturing power at a unit cost as low as at any of the successful installations. But while this circumstance is of interest and has possibilities of great value, the important thing in making the decision to build is not so much the determination of the cost to manufacture a unit of power as it is the relationship which will exist between the total annual cost to keep the plant operating (including fixed charges) and the total aggregate sum which the available customers can afford to pay for power.

NATURE OF RISK INVOLVED IN DEVELOPING WATER POWER.

I repeat that whoever builds a water power plant contracts in effect to take and pay for the entire block of power which that plant is capable of producing; and, in doing so, assumes the risk involved in the chance that he may not be able to re-sell it for an aggregate sum as much as he paid for it. But in taking the chance of losing he does not acquire the sporting chance of making a "killing." While no limit is placed on his losses except by the exercise of his own foresight and skill, his profits in most States are now subject to regulation and control by public service commissions. This, of course, is as it should be; but the statement of the fact serves to emphasize the peculiar necessity, in water power development, for the exercise of an unusual degree of foresight in planning and skill in execution, for the reason that because of public regulation of prices a fair general average of profit may not be struck by averaging the losses in certain developments with extraordinary profits in others.

The skill, or may I term it the science, of water power development lies in the ability, first to skilfully appraise the market, and then, to so plan the development as to type and size that the total annual cost, including fixed charges, to deliver the necessary power will not exceed the amount the available customers can afford to pay. In other words, a water power skilfully conceived and designed must show in almost every detail the influence upon it of its market, and any water power conceived or designed without due regard to the peculiarities of its market runs great danger of financial failure.

CONTROLLING INFLUENCE OF MARKET ON DECISION TO BUILD.

Wherever we have running water we have a natural dissipation of energy—and this applies to tides as well as to streams—and wherever we have this natural dissipation of energy we have a potential water power and can, by the expenditure of time and money, create power and make the energy available for useful work. But can the output be sold for a sum at least equal to the cost to produce the power? This is the question that is uppermost in the minds of experienced men, and the controlling factor is always the market. Because at Niagara Falls the market takes all the power offered at around $20 per horse power year, and could take large additional blocks at that price, it does not necessarily follow that a power in another part of the country could be profitably developed even though it could afford to offer its output at $12 per horse power year at the plant. If no market exists one must be created. The price to prospective consumers if they can be found, must be made low enough to overcome the disadvantages of the proposed location. These disadvantages usually include an inferior labor market and higher freight rates as compared with other available locations.

There has been criticism that some water powers in the hands of experienced water power men remain undeveloped; but this may be a fact holding much of value to the public in that it suggests added facilities for public use when the market demands them; and therefore, in interpreting the fact that a water power in private hands remains undeveloped, we should look at its market conditions before concluding that its undeveloped state is contrary to the public welfare.

THE STRATEGY OF WATER POWER DEVELOPMENT.

It frequently happens that where a good water power site is available its market, if fully analyzed, would be found too small to make it commercially practicable to take full advantage of the natural resource. In cases of this kind the danger is that those who are approached to provide the money for the enterprise may not understand, or be properly advised, as to what can be done on the engineering side. From an engineering point of view the temptation to build a large water power, which per se is excellent and capable of manufacturing power when fully loaded at a low unit cost, is sometimes so strong that it results in an emphasis of the purely engineering side to the great detriment of the enterprise as a going concern. Sometimes the results have been fatal to the credit of the enterprise.

Engineers who have been responsible for the financial results of the operation of public utility enterprises do not find it difficult to keep in mind the fact that in new water power enterprises every extra $1,000 spent must earn net an extra sum of about $100 per annum. When the market is smaller than the total power developed the initial effect of spending this extra $1,000 is the same on the commercial value of the enterprise as if the already deficient market were reduced. If $1,000 is spent for a purpose not essential to the furnishing of an adequate and reliable service—whether this money is used to pay for construction not essential to the main purpose, or for inefficiency, extravagance or errors—the effect upon the initial success of the enterprise is the same as if, having built its lines to supply all the existing market, a part were arbitrarily withdrawn, of such magnitude that it would have yielded annually about $100 over and above the operating expenses to serve it. In large enterprises an expenditure for such purposes of an extra $250,000 might not be felt in the rate of dividend distributed; but in one of the smaller projects the saving of such a sum might make the difference between success and mediocrity, if not between mediocrity and failure.

I attended an engineering society meeting, not very long ago, where a very excellent paper was presented dealing with the recent development of a large hydro-electric system, and I listened to a discussion in which an engineer criticised the use of wooden poles in certain branch lines. He gave several reasons why steel poles should have been used, among them that they were modern and up-to-date and would last longer. He apparently gave no thought in his discussion to the commercial side of the enterprise. I listened with some impatience because I happened to know something of the difficulties which that particular enterprise had encountered in financing its extensions, and I knew that excellent business judgment had been shown in the selection of wooden poles, because a reliable service, and a kind of service that the customers reached by them would be glad to buy, could be delivered over them at a minimum of cost. I could not help asking myself the question: If the same kind of engineering judgment which was so soundly exercised in adversity had been used in the early stages of that enterprise, when the pot was full of money, whether the financial troubles subsequently encountered could not have been, in a measure, averted?

Sometimes it seems wise to throw away in the beginning a thing of value in order to obtain later on a thing of greater value, and, therefore, it sometimes seems wise to spend on a water power development somewhat more than is necessary to accomplish the immediate purpose in view, particularly when such extra expenditure conserves the opportunity of economically increasing, later on, the capacity of the plant to meet a growing market. But when appropriating the extra sum for this sometimes very sensible purpose, its commercial effect upon the initial enterprise must be understood. Since its effect is equivalent to a reduction of the existing available market, one must be sure that the reduction does not proceed so far as to leave the remaining market unable to support the investment.

SMALLER DEVELOPMENTS NOT NECESSARILY WITHOUT INTEREST.

Resourcefulness and the practice of good judgment and economy is probably more essential to the success of a small hydro-electric business than to a large one because an error, which would be considered of minor importance in a large system, might involve serious financial consequences in a small one. Therefore, if we are to look at the science of water power building as the skilful cutting of our cloth to suit our market, some of the smaller developments are not without interest.

I recently designed, built and put in operation a hydro-electric system in eastern Tennessee for the Tennessee Eastern Electric Co. While this system is not large at present, the physical structures are excellent and well adapted for their purposes, and have been so designed that the system is capable, at reasonable cost, of very considerable expansion to meet a growing market. The central idea in this development was to equip to deliver an adequate and satisfactory service with the least possible investment not inconsistent with the construction of safe and durable structures; and at the same time to keep fully open the door to economical future expansion. As the primary purpose of this paper is to emphasize the necessity for the complete control in water power work of the commercial considerations over the engineering features, I will not attempt to include in this paper a detailed description of the work. I will confine my remarks to those matters in connection with the design and construction which seem, in some degree, to differentiate this enterprise from others, and I will begin by some observations on the business side of the construction.

DIFFICULTY OF INTERESTING BANKERS IN WATER POWER DEVELOPMENT.

To balance correctly two financial forces both of which are guessed at is, of course, harder than when one of the forces is known. As the existing market in East Tennessee was small it was, of course, essential closely to estimate the gross revenue from the available customers; but before this information could be translated into returns upon the investment, the amount of this investment had to be known or assumed.

Bankers, while sometimes willing to accept promotion estimates of the cost as representing the best judgment of the engineer making them, are not, as a rule, willing to go into an enterprise which, on the face of it, would fail financially if the cost should greatly exceed the estimates. Often bankers are not willing to go to the expense of investigating a new water power scheme unless it appears on its face that the scheme will pay board on the money invested, even though the work should cost double the estimate. Now, I do not know of any new undeveloped water power project where one may double a skilful estimate of cost and still leave the enterprise initially solvent. This entirely prudent attitude on the part of bankers—and I may say reasonable in view of the past history of the business—may be responsible for keeping some water powers, in the hands of promoters, a little longer in an undeveloped state.

BANKERS REQUIRE ENGINEER TO ASSUME FINANCIAL RISK IN TENNESSEE ENTERPRISE

To meet this kind of an objection, and to get money to go into the Tennessee Eastern enterprise, I was required by the bankers to enter into a construction contract which practically guaranteed the cost of the works. It was agreed that if the cost of the hydro-electric system, complete and in operation, should exceed the promotion estimate, the engineer should pay the excess cost up to the amount of his fee for designing and managing the construction of the works (which fee was included in the estimate) plus the entire amount of all the engineering charges against the cost of the work. In other words, if the cost in operating condition of hydro-electric plant, lines and substations should exceed the promotion estimate, the engineer would be liable to receive nothing for his own time and services, and, in addition, would be liable to pay out of his own pocket the entire cost of all the engineering.

But on the other hand, it was agreed that the engineer should receive the saving if the works were built for less than the promotion estimate, and he was given full executive control over all the work including the purchase of materials, employment and discharge of all men, and the methods of construction. He negotiated all important contracts and disbursed over his own signature all money expended in creating the works and in the acquisition of lands and rights-of-way. His task was to secure the necessary rights and to build in the shortest space of time a work in strict accordance with specifications approved by the consulting engineer of the bankers, and he was given an absolutely free hand to do it in his own way. The consulting engineer for the bankers in passing on the promotion estimate reported that the work could probably not be built for less than the estimate and the chances were would cost more

The result, however, was satisfactory both to the investors and to the engineer, for the final cost of the work was less than the promotion estimate, and the work as executed was fully approved by the consulting engineer for the bankers, and the development was placed in regular operation in October, 1913, the dam site having been purchased in August, 1912.

In principle this kind of a contract was a substantial safeguard to the investment, though it might have been improvident for the engineer. The hazards of under water work on rivers subject to great and sudden floods are so great that the engineer could never feel entirely sure of where he was coming out until the dam and power house foundations were above water. Having full power to hire and discharge everyone connected with the work from the top to the bottom, except only the inspecting engineer for the bankers, he was able to surround himself with able and loyal men, to maintain good discipline, and to substitute team play for friction in the organization.

Of course, I need hardly say that "overhead" expense was reduced to a minimum, and that nothing was too much trouble for the staff in hours or out if a dollar was to be saved. I will cite an example, quite unimportant in itself but it illustrates the principle and is typical of the methods. Contracts were made with many farmers to cut and haul chestnut poles of 8-in. tops to the location of particular post holes marked in the fields. This helped in obtaining pole line rights-of-way, but it involved a multiplicity of detail that could have been avoided by making a contract at an increased cost with a responsible pole dealer to deliver the poles f. o. b. cars at convenient points. The work was organized and each farmer had his particular work cut out for him. But, making a contract with an East Tennessee farmer to do a thing on time and getting it done on time are quite different things. Men on horseback had to ride the line to see the farmers frequently, and to encourage them to stop plowing so as to keep inviolate the sanctity of their contracts. It was lots of trouble getting poles of satisfactory dimensions at the holes before the erecting gang came along, and the pole line foremen were at times almost in tears; but the net result was that the erecting gang was never actually delayed, and on a 40 mile line the average cost of first class 35 ft. 8 in. top chestnut poles, alongside their holes ready for framing, was $3.70 each.

I could give many other examples of how money was saved, or rather not spent, in consequence of the staff taking on work and trouble; but further illustration seems unnecessary, for I think it will be conceded that economical administration and the exercise of vigilance and good judgment, at least to the extent of the capacity of the staff, were automatically secured by the form of contract with the engineer.

ORIGIN OF ENTERPRISE. DEFECTS IN ORIGINAL SCHEME.

The idea which afterwards germinated in the creation of the system now operated by the Tennessee Eastern Electric Co. was brought to me by a citizen of Greeneville, Tennessee, whose father, Judge J. C. Park. had an option on a water power site near that town on the Nolichucky River, and had for years been trying to finance it. His idea was that it would pay to develop a water power on his site and to supply the market in Greeneville. An examination of the territory disclosed the fact that the dam site under option was not the best site available and even at the best site (which was afterwards acquired), the cost of the construction made it commercially impracticable to build a water power if the Greeneville market was the only one that could be secured. Subsequently, in order to insure an adequate initial market, the public utilities in Greeneville, Jonesboro and Johnson City were acquired.

THE DAM SITE.

The best site available was quite remarkable. It was situated about seven miles south of Greeneville, Tenn., on the Nolichucky River. The bottom of the river was solid ledge rock of Knox dolomite, free from boulders and covered with sand of a maximum depth not exceeding 2 ft. It was a very easy matter to push a ¼-in. iron rod down through the sand and obtain the clear ring of the rock, which appeared practically level all across the river at a depth between 6 and 9 ft. below low water. The river was but 220 ft. wide, and the banks were of solid exposed rock sloping at an angle of about 45° to a height on one side of over 100 ft. and on the other side between 70 and 80 ft.

POWER AVAILABLE.

With a dam raising the water 70 ft. it was estimated that the storage available would balance the minimum flow of the river during the driest year likely to be encountered to about 600 cu. ft. per second, and during any but the driest year to substantially greater volume. The character of the market indicated a weekly load factor of about 40 per cent, so that during the very driest year it was estimated there would be available at all times without recourse to steam around 9,000 hp. on a 40 per cent weekly load factor, and during the other years substantially more. The characteristics of the stream and the steam power available in the existing public utility plants acquired were such that had the initial market been sufficient it would have been wise to build initially a plant having installed about 16,000 maximum wheel horse power.

INITIAL TERRITORY SERVED.

An examination of the territory disclosed that a 40 mile transmission line from the plant would reach Greeneville, having a population of about 5,000, Jonesboro with a population of about 1,500, and Johnson City at the the end of the line with a population of about 10,000, the latter town having a street railway system. There were other towns within a reasonable distance of the plant, but their markets did not seem to justify their inclusion in the original scheme. They were left to be reached later as extensions of a going and successful concern, under which circumstances it was expected money could be obtained on better terms than for the original promotion.

CENTRAL IDEA OF PLAN OF DEVELOPMENT.

An examination of the existing markets in the three towns mentioned indicated that it would be unwise to make an initial development of the whole head available. The problem presented was to design a development the cost of which could be supported by the existing market, but so built that no substantial part of the initial development would be wasted in enlarging the plant, later on, to the ultimate capacity of the site. It was considered to be an advantage if the design could admit the increase by reasonable increments as new market developed. I will describe briefly the peculiar features that were introduced in the design in order to accomplish this purpose.

THE DAM.

The existing market indicated that the initial height of the dam should be about 34½ ft.; but, in order that it might not be necessary, later on, to uncover the river bottom with all the hazards incident to such work, it was thought wise to put in initially a base for a dam of the ultimate height (70 ft. head) and to carry it above water, and this was accordingly done.

The dam, of concrete gravity type, was designed with steps on its profile, and along its crest was placed a ribbon of sheet lead about 3 ft. wide of which 18 ins. were imbedded in the concrete of the dam as built and the other 18 ins. was rolled up and protected from adhesion of concrete by a wooden box, the purpose being, when the dam is raised, to open this wooden box, straighten out the lead roll and cast the new concrete around it. It is expected that this lead seal will form an efficient cut off between the old concrete and the new. Certainly this kind of a seal will reduce the leakage along the line of contact to a minimum; but in order to prevent such leakage as may occur from creating a hydrostatic pressure tending to separate the concrete at the surface of contact between the old work and the new, drain boxes running the length of the dam were built into the curved profile, and it is intended that drain pipes shall lead from these boxes and from other boxes to be placed at the angle of each step on the profile of the dam. These drains it is expected will wholly prevent the building up of any hydrostatic pressure between the old work and the new; but, as an added precaution, some old steel cables that were available were laid in the concrete of the initial dam and brought to the surface in such a way that steel rods may be hooked into this cable and the new concrete cast around them. The initial development has been so executed that all the additional concrete required to increase the head to 70 ft. can be laid in the dry at any ordinary future time and without the necessity of uncovering any portion of the river bottom. The construction plant has been retained at the site ready to do this on short notice.

SLUICE WAY THROUGH DAM.

The specifications required that the dam should be provided with a sluice gate so as to make it possible to draw down the pond. This was accomplished by leaving a clear space or slot about 6 ft. wide between the dam proper and the head gate structure, from the top clear to the rock bottom of the river, except for a reinforced concrete connection about 2 ft. thick and of ogee form. This connection serves as a seat for a regulating gate and to carry off its discharge when opened. The seat of this gate is 5 ft. below the top of the dam, and the purpose of the gate is to permit regulation of the flow so as to protect the 5 ft. pin type flashboards with which the dam is fitted. The gate is 6 ft. wide and if fully opened would, when the water is flush with the top of the flashboards, present a clear opening 10 ft. deep and 6 ft. wide. The balance of the 6 ft. slot below the seat of this gate was fitted with oak stop logs, 10 x 10 ins. in section, going clear to the bottom of the river. This slot was fitted with two grooves about 3 ft. apart for stop logs so as to admit of replacements of logs without drawing down the pond.

This form of sluice seemed to be best suited to accomplish what we had in mind. It was very cheap to build; it had no part which was not readily accessible for replacement and repair; and it was perfectly reliable if, for any reason, it should be necessary to draw down the pond because, with a suitable log pulling device, additional stop logs could be pulled out as the pond lowered thus obviating having to pull the logs out under a great head.

Besides these advantages it was very useful for bypassing water during the construction of the dam, and gave a very excellent account of itself during the final closure. When we were ready to make the final closure the water was pouring through the slot about 14 ft. deep. With a frame sliding in the stop log grooves we had no trouble in quickly sliding logs one after another into their proper place. Within two hours time all the logs had been placed from the bottom of the river to the top of the dam. This type of construction was preferred over the usual metal gate closing an opening through the dam at great depth.

HEAD GATE STRUCTURE.

The head gate structure was so designed that when the head is raised from 39½ ft. (with flashboards) to 70 ft., the same head gates, screens and hoists will be used, and will be placed at a higher level so as to operate with no greater head against the gates than in the initial development.

The penstocks when the head is raised will be connected with new openings higher up. The penstocks for the two wheels initially installed and nearest the dam are 9 ft. in diameter, but the head gate structure has been designed for 12 ft. penstocks for the two wheels furthest from the dam and not initially installed. The wheels are all to be of the same size, but for the purpose of equal regulating qualities the wheels furthest from the dam will require larger penstocks with reduced water velocities.

POWER HOUSE

The Nolichucky River is subject to very sudden and great floods, and although the river has a natural slope of about 6 ft. to the mile, it has been known to rise in flood at the site of the dam to 35 ft. above its low water mark, at which time the estimated discharge was around 50,000 cu. ft. per second. The water reached this height from a low stage in less than 12 hours. This is very great from a drainage basin of only 1140 square miles. Under these circumstances considerable spillway capacity was required, and due to the narrowness of the gorge it was not considered practicable to make the power house itself a part of the dam. The power house was accordingly placed immediately below the dam facing the stream so that the axis of the nearest wheel was but 50 ft. from its head gate.

Because of the flood conditions, the generators had to be set 35 ft. above low water. The vertical type of unit was adopted with the center of the wheel placed 19 ft. above low water.

The power house is designed for four units of 4,000 maximum wheel horsepower each under 70 ft. head. The generators are 2,500 K. V. A. capacity, wound for 2,300 volts, 60 cycles.

The power house foundations are of concrete and the superstructure of brick. Brick was used because it was considered cheaper than concrete. About 450,000 brick were burned at the site.

POWER HOUSE EQUIPMENT.

The feature of the power house equipment which is, I think, novel is in connection with the selection of the size and type of generating units. While the existing market was small, there were excellent reasons for expecting increases of substantial amounts. If such increases should require raising the dam for a 70 ft. head, we did not wish to suffer the losses incident to buying generating units for a 34 ft. head which would not be useful under 70 ft. head and which in consequence might have to be scrapped in a short time—possibly within two or three years. We were very anxious to keep the initial investment down, but our anxiety did not lead us to contemplate with indifference the possibility of throwing away a substantial sum of money within a short time.

TABLE I.—GUARANTEED EFFICIENCIES AT SPEED 164 R.P.M.

	Head							
	First runner				Second runner			
Percentage load—	34′	36′	38′	39.5′	55′	60′	65′	70′
Full load ....(1)	80 %	79.5%	79 %	79%	81.5%	82 %	82%	81.5%
Seven-eighths ....(⅞)	82	82	81.5	81	84	84.5	85	84.5
Three-quarters ....(¾)	80	80	79.5	79	83	83.5	84	83.5
One-half ....(½)	72.5	72	71.5	71	74	75	76	75

The suggestion was made to the makers of water wheels that we wished to put in wheels that by a simple change of runner would operate satisfactorily either in range from 34 to 39 ft. head or in range from 60 to 70 ft.; the speed under both conditions of head to be the same so as not to change the frequency of the current supplied by the generators, which would be installed initially of full size. Of course, if this could be done without too great a sacrifice in efficiency, it would make it possible to install initially the same generating unit that would be ultimately required, with the single exception of the runner. The idea was well worked out by at least two of our water wheel makers, and it was found that the sacrifice in efficiency was small.

A small reduction in the efficiency of the unit under the 34-39 ft. head would not, it was thought, affect the net earnings of the company because by the time so much of the capacity of the initial installation had been sold as to make a small sacrifice in efficiency felt, the work of raising the dam would undoubtedly be under way. The fact that there might be a small reduction in efficiency in the wheels when operating under the 70 ft. head would not cut any figure until the full available capacity of the ultimate development had been sold, and then only during the period of the year when there was no waste water running over the dam. At these times the third and fourth wheels, last installed and designed for the 70 ft. head and having presumably the highest efficiency, would take the greater part of the load, and the two units first installed would be used to pull peaks and as a spare. In our judgment the possibility of a small decrease of 1 or 2 per cent in efficiency under the 60-70 ft. head did not cut a figure in the practical earning capacity of the company. As a matter of fact the curves of performance for the runners under 60-70 ft. head, furnished by the makers and based on Holyoke test No. 2229, showed maximum efficiencies running between 88 per cent and 89 per cent.

The guaranteed efficiencies were as in Table I and, it will be observed, are practically the same under considerable variation of head when drawing down the pond of the ultimate development.

The order for the generating units complete was placed with the Allis-Chalmers Mfg. Co. for several reasons, but principally because that company was in a position to make a fixed sum bid under satisfactory specifications on the complete unit—generator, exciter, water wheel and governor—erected, tested out, and ready for regular operation on the line. To a person who had in effect guaranteed the cost of the plant this kind of a clean cut proposition at an acceptable figure was attractive. He avoided the uncertainty of the erection costs, particularly when wheels and generators are made by different manufacturers, and he could require a single guarantee of efficiency from water to switchboard output. The units were promptly put in service after assembly, and have given satisfaction.

The novel feature of the unit is the scroll casing for the wheel which casing is made of plate steel. The casing is of circular cross section and decreases in diameter as water leaves it to enter the turbine gates. It is built up of conical sections, lap jointed, riveted together. It is very economical in material and low in friction losses, and being circular in section the deformation under water pressure is a minimum. The casing is held together on the side of the water exit by a speed ring of cast steel. The discharge of the unit is controlled by gates of the outside wicket type. The cases were first assembled in the shop and then knocked down and shipped in four sections. The inlet of the spiral is 9 ft. in diameter. The spiral was set, riveted up and then concreted in up to the center line. This installation is, I believe, the first use of a case of this type and the idea has since been patented. I understand that cases are now being constructed of this type with an inlet of 13 ft. diameter, for use under 100 ft. head giving about 8,500 hp.

The weight of the rotor is taken on a bearing of the Allis-Chalmers type mounted on top of the generator housing. The runner is made up of steel vanes and cast iron central hub and cast iron outer ring. The operating mechanism is all external and subject to easy inspection and repair.

The exciters are belt driven from a pulley driven by spur wheels on the main shaft. This plan was used because it was a positive and reliable way to get up excitation for the generators and saved a substantial sum over any other scheme. Later on, when the business grows, it is intended to use motor generator sets for the continuous excitation and the belt driven exciters for starting up. The driving spur wheels on the main shaft have removable wooden teeth, and the noise of the gears is not excessive. The exciter system has worked well.

PLANS TO INCREASE CAPACITY OF PLANT

There are several ways to get additional capacity to serve an increase of market, and the method adopted when the time comes should be governed by the amount and character of the prospective increase of market. The runners now installed are guaranteed to deliver 1,900 hp. at 34 ft. head and 2,300 hp. at 39½ ft. head (flashboards on the dam)

With new runners the wheels are guaranteed to deliver at least 3,200 hp. under 60 ft. head and 4,000 hp. under 70 ft. head. The head on the wheels with flashboards off will be fairly constant because the water on the crest will rise substantially the same amount as the tail water for all ordinary stages. Big floods when they come last but a few hours of a single day. The hydrograph of the river indicates that the head of the initial development will not be reduced below 30 ft. during more than about 24 hours per year on an average, so that the reduction of head from backwater is not a factor of importance.

If a small increase in capacity is needed, the installation of a third unit with the assistance that could be given during low water by the Johnson City steam plant would probably be the most economical way to supply it. A third unit under the initial head would add about 2,000 hp. to the capacity. If a larger increase is necessary, the dam can be raised, and the runners changed in the two wheels now installed, and no additional units need be placed. This would add about 4,000 hp. to the capacity. The makers agreed to change the two runners for approximately $1,500 each so that the expense to change is small. As still more capacity is required, a third and fourth unit designed for 70 ft. head may be installed, each of which would add about 4,000 hp. to the capacity. Thus we may expand at the first step from the present 4,000 hp. installed either to 6,000 hp. or 8,000 hp. If the first step is to be to 6,000 hp. the second must be to 12,000 hp. and the third to 16,000 hp. If the first step is to 8,000 hp. the second will be to 12,000 hp. and the third to 16,000 hp.

The penstocks, wheel cases, and all parts of the power house equipment were designed and built for pressures incident to the ultimate 70 ft. head.

TRANSMISSION LINE.

The current is stepped up from 2,300 volts to 44,000 volts and is transmitted on a line of 35 ft. chestnut poles of 8 in. top spaced 35 to the mile to substations at Greeneville, Jonesboro and Johnson City. The pole line was not equipped with a ground wire because experience with low height transmission lines of this type in a nearby territory indicated almost no trouble from lightning. Subsequent experience with the transmission line of the Tennessee Eastern Electric Co. has confirmed this judgment. Although the territory is subject to extremely severe electrical storms, there has been a minimum of lightning trouble on this line. The transmission of electricity has gone on uninterruptedly over this line in a storm when the brilliant flashes of lightning succeeded each other with almost incredible rapidity and it did not seem possible that any line could stand up under it. During severe lightning the only effect seems to be to cause a more or less continuous discharge of the electrolytic lightning arrestors that are placed at the hydro-electric plant and at each substation.

The insulators are of the ordinary 45,000 volt Thomas pin type mounted on metal pins.

Across the mountains over in the flat land of North Carolina some of the companies with high steel tower lines transmitting at very high voltages have had a most serious time with lightning. I am not clear why our line built without a ground wire should be so little affected by lightning, but I have a feeling that being relatively so low in height it is not conspicuous to lightning in a very rolling farming country in which there are so many scattered tall trees. I do think it would be a distinct addition to our knowledge of the subject if the conditions under which these two systems are operating could be so analyzed as to show why one is so susceptible to lightning disturbances and the other so little affected.

CONCLUSION.

In conclusion I think I may fairly say that the fact that the Tennessee Eastern Electric Co. has been able from the start to meet all its fixed charges and to pay regularly the dividend on its preferred stock is due in some measure to the skilful application to the conditions as they existed in Eastern Tennessee of the principles discussed in the first part of this paper. No dividends have as yet been paid on the common stock but their payment is, I believe, largely a question of the skill that may be displayed in creating and supplying additional market.

Methods and Some Costs of Mine Shaft Sinking in Very Tough, Hard Rock.

Some general data of value on methods and costs of hard rock shaft sinking in the Ducktown, Tennessee, copper basin are given by Wm. Y. Westervelt, consulting mining engineer, New York, in a paper before Section D of the American Association for the Advancement of Science. Extracts from this paper are as follows:

No water difficulties being encountered, sinking would have presented no peculiar problems had it not been for the fact that the rocks of the district (the ancient graywackes and mica schists of probable Cambrian age) were so extremely hard and tough that shaft sinking in them could ordinarily be carried on only at a very slow rate of progress, while the necessity for rapid exploitation of the newly discovered ore made imperative the completion of the shaft at the earliest possible moment. The difficulty with the rocks was not only their extreme hardness due to silicification and pressure, so that holes could be drilled in them but slowly, but that they were equally tough and resistant to blasting because of micaceous and horn-blendic crystallization. The result was that an excessive number of but slowly drillable holes were required to effect even a moderate cut and an average rate of progress of 25-ft. per month of actual sinking time was until recently all that could be counted upon.

Fortunately five levels, the lowest some 600 ft. beneath the surface, were accessible in the main mine so that by drifting out to the shaft location at each of these levels it was possible to upraise on the line of the shaft at five underground points at the same time that the sinking from the surface was progressing. By this expedient the shaft was actually completed and in operation to the seventh level, a depth of 629 ft. beneath the shaft collar, in the 13 months' time between September, 1909, and October, 1910—a monthly average of over 40 ft. all inclusive.

No workings existing below the seventh level, further sinking had to be confined to work in the bottom of the shaft. Consequently, though every facility then available was employed, the 13 months between October, 1910, and November, 1911, were consumed in sinking the 216 ft. (from the bottom of the sump previously left 15 ft. deep below the seventh level, to the bottom of a sump made 31 ft. below the ninth level) and in equipping the shaft for operation to the lower level—a monthly average of less than 17 ft.

During the past summer, sinking below the ninth level was resumed with much improved facilities. The principal improvement was the substitution of Jackhamer drills for the 3-in. reciprocating compressed-air drills previously used. Between Aug. 22 and Nov. 7 (when sinking was discontinued for station cutting at the tenth level), the shaft was sunk 120 ft., from a depth of 31 ft. to 151 ft. below the ninth level, or at a rate of nearly 50 ft. a month and about double the previous best record for progress during actual time of sinking. It is planned to continue the sinking of the shaft to a total depth of nearly 1,200 ft. beneath the surface, to break off an eleventh level 300 ft. beneath the ninth level and to leave some 40 ft. in the bottom for a sump in which sinking can be conveniently resumed whenever desired. The sinking, the breaking off of stations at the tenth and eleventh levels, the timbering and the installation of regular hoisting facilities to the eleventh level will all be completed, it is hoped, early in July, 1915. Should this be accomplished but eleven months will have been required to sink and equip over 300 ft. of shaft and a rate of nearly 30 ft. per month, as compared with the previous 17 ft. per month, all inclusive, will have been attained.

The sinking and reaming from the surface to the ninth level was done with four 3-in. reciprocating compressed-air drills mounted on two shaft bars. These machines were used to drill holes from 5 to 7 ft. deep and made about 5-ft. advance per cut. The present sinking below the ninth level is being done by six Jackhamers drilling holes from 2 to 4 ft. deep and making about 2-ft. advance per cut. The principal advantage in the use of the Jackhamers, as already indicated, is the much greater speed attainable. Minor advantages however are found in a much smoother finished and more easily aligned shaft, and in less violent blasts which occasion correspondingly less damage to the timber of the overhead protecting pentice and leave the shaft walls more solid.

The first 8 ft. below the shaft collar was filled ground. The next 63 ft. was reaming work about a small prospect shaft. The next 99 ft. was unassisted sinking largely in hard rock. Reaming about upraises then carried the work down to the seventh level. The remaining 200 ft. from the seventh to the ninth level was unassisted sinking, as is the sinking now in progress from the ninth to the eleventh level.

For the determination of the location of the upraises from the various levels, a traverse over 2,000 ft. long from the shaft collar into the old mine and out to the shaft at each level was required. In order to avoid the possibility of any serious error in so vital a matter, seven complete traverses were made and checked with each other to within a few inches. The upraises on the center line of the shaft were made about 5 ft. in diameter so that several feet of error in location might have been made and the upraise still have been contained within the 7x14-ft. area of the shaft's cross section. As the contour of the surface made it advisable to elevate the shaft collar 8 ft. above the natural level, the ordinary mine timbering in the near surface soft ground was continued up above the surface for some 20-ft. and made to serve as a head frame to support the sinking hoist sheave. The latter was a Bacon winze hoist operated by compressed-air and served to hoist to the surface the rock excavated down the first 170-ft. Below this depth the first upraise delivered the rock to the level beneath and so out through the old mine. This sinking hoist also handled all supplies for timbering down to the seventh level.

Frame timbering of 12 x 14-in. sets covered by 2-in. lagging was used only to the solid rock 84-ft. beneath the shaft collar. In the solid rock 8 x 10-in. dividing timbers, set in hitches and dividing the shaft into two hoist and man and pipeway compartments, were all that was required in addition to the usual complement of cage guides, manway platforms, battice between hoist and manway compartments, ladders, etc.

All work has been carried on in two shifts per diem of 9½ hours each. During the sinking from the surface to the seventh level a hoister and a lander were kept on top and eight men on the sinking or reaming work in the bottom. The upraises were made with two telescope feed-hammer drills in each upraise, operated by two men and a steel boy per shift, and the usual complement of trammers to remove the broken rock.

The sinking from the seventh to the ninth level was done from the seventh level by the use of a hoist placed at the latter. The 1,000-lb. capacity steel buckets were dumped into a chute (after closing a trap over the hoistway beneath) and thence directly into the tram cars which were themselves discharged into the regular skips which hoisted to the surface. The men working in the bottom of the shaft were protected from the fall of either a main hoisting skip or a part of its contents, by a pentice placed across the shaft under the two hoistways. This pentice consisted of closely set 12 x 14-in. timbers hitched into the rock, covered by 4-in. lagging and loaded from 12 to 15 ft. deep with waste rock. Similar arrangements are now installed at the ninth level in connection with the sinking to the eleventh level and in order to avoid any interference with the regular tramming at and the hoisting from the ninth level, the hoistway and chute for the sinking work is confined to the manway compartment of the shaft.

The entire shaft work has been in the immediate charge of our Mine Captain A. Bennett while the surveys were made and the details of the engineering features were worked out by Resident Engineer J. H. Taylor.,

The determination of costs per unit on the sinking work now in progress below the ninth level awaits the completion of this work but it is evident from the weekly reports that a marked reduction in cost as well as in time is now being made as compared to the sinking between the seventh and ninth levels. Costs down to the ninth level are submitted below. They include all outlay up to and including that for mine captain and resident engineer whose salaries were included in proportion to the amount of their time required on the shaft work. The working is known as the Gordon Shaft after the chairman and technical managing director of the company.

GORDON SHAFT COSTS—FIRST 860 FT. OF DEPTH.

		Per ft.
Preparation of ground and temporary structure	$ 760.03	
Piping	5,005.48	
Head frame	2,245.01	
Hoisting plant	20,607.70	
General equipment cost of shaft 860 ft. deep (largely sufficient for shaft when sunk to depth of 2,700 ft.)	$28,618.22	$ 33.28
Sinking, 338 ft.	17,691.11	52.38
Upraising, 412 ft.	6,877.40	16.67
Reaming, 475 ft.	12,905.86	27.18
Station cutting at 9 levels	15,495.57	*1,721.73
Cutting hitches in 774 ft. of shaft	3,285.76	4.24
Timbering, 860 ft. of shaft	9,645.71	11.18
Total cost of 860-ft. shaft (including general equipment largely sufficient for shaft when sunk to depth of 2,700 ft.)	$94,519.63	$109.90

*Per level.

ROADS AND STREETS

Method and Cost of Constructing a Rolled Concrete Road in Oregon.

In the article on page 203 of the issue of ENGINEERING AND CONTRACTING for March 3, 1915, the name of the state should have been Oregon instead of Washington as given. Henry L. Bowlby was formerly state highway engineer of Washington.

The Old National Road and Its Reconstruction.

The reconstruction of the old National Road has an historic as well as practical interest. In a paper before the Ohio Engineering Society C. H. Moorefield, of the U. S. Office of Public Roads, discussed the history of the road and his paper is given here in part. Further data on construction features by J. P. Beck of the Universal Portland Cement Co. are given in the latter part of the article.

THE OLD NATIONAL ROAD.

One of the leading political questions in this country during the early years of the nineteenth century was concerned with the building of public roads and canals by the Federal Government, and large appropriations for such internal improvements were made during the administrations of Presidents Adams, Jefferson, Madison and Monroe. One of the most important of the projects undertaken during this period was the construction of an improved road from Cumberland, Maryland, west to the Mississippi River. This road was first designated by Congress as the "Cumberland Road," but has since come to be very generally known as the "National Road" presumably, because it was the most important road building project ever undertaken by the National Government.

WORK EAST OF THE OHIO RIVER.

The earliest act of Congress relating to this road was in 1802 and simply provided that 5 per cent of the revenue received from the sale of Ohio public lands should be set aside for public road improvement and that two-fifths of this amount should be devoted to constructing a road from the Potomac River west to the Ohio River. In 1805, Congress authorized the building of the road from Cumberland to the Ohio River and fixed the width of the right of way at 4 rods, the width of roadway at 20 ft., the maximum grade at 8¾ per cent and provided that the surface should be made of stone, earth, gravel or sand or a combination of these. Later, in Ohio, the width of right of way was increased to 80 ft.

Wages.—It is interesting to note that this act also fixed the wages of the commissioners who were to select the route at $4 per day, the wages of the surveyor, who was to have charge of the preliminary engineering work at $3 per day, and the wages of the surveyor's helpers at $1 per day. President Jefferson approved this act, March 29, 1806.

Construction.—The first contract for construction was let April 11, 1811, and the road was completed from Cumberland to the Ohio River at Wheeling about ten years later. The total length of this section is 131 miles and the total cost of construction was $1,706,845.20, or at the rate of $13,029.35 per mile; more than twice as much as the commissioners had originally estimated. The entire section east of Wheeling was surfaced with broken stone put down in two courses. There were no road rollers in use at that time, and it was consequently necessary to compact the stone by admitting traffic upon it. Since the bottom course consisted of relatively large stone and was almost a foot thick before compacting, traffic over it in springless wagons must have been rather uncomfortable, to say the least. Besides, it is said that the engineers in charge of the work had a truly satanic way of erecting barriers which were frequently shifted in order to prevent honest travelers from using any part of the surface until it had become compacted.

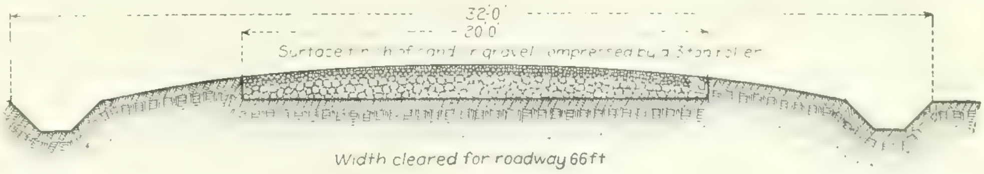

32'0"
20'0"
Surface finish of sand or gravel compressed by a 3 ton roller
Width cleared for roadway 66ft

Fig. 1. Typical Cross Section of the Old National Road.

The specifications provided that the stone for the bottom course should pass a 7-in. ring, and that for the top course, a 3-in. ring. The top course was 6 ins. thick before compacting, making the total uncompacted thickness of the road surface about 18 ins., though this thickness was not constant throughout the distance.

Data.—The following data apply to the section from Cumberland to Wheeling: The total length of the section is 131 miles; width of grade, 30 ft.; width of surface, 20 ft.; construction was begun in 1811; practically completed in 1821; first appropriation for maintenance, 1823; last appropriation for maintenance, 1837; total cost of construction, $1,706,845.20; cost per mile of construction, $13,029.35; total expenditures for maintenance, $1,133,993.08; estimated average age of road at the time of last appropriation for maintenance, 16 years; average cost of maintenance per mile per year, including bridge repairs and renewals, $541.

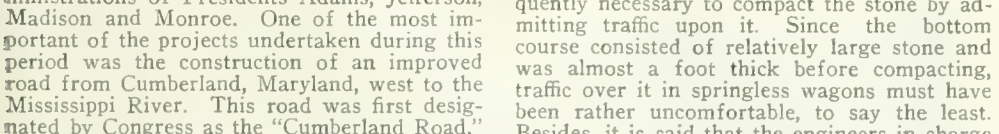


Fig. 2. Typical Cross Section of the Reconstructed National Road.

WORK WEST OF THE OHIO RIVER.

The first appropriation for continuing the National Road west of the Ohio River was made by the 18th Congress in 1825 on the day of adjournment and the final appropriation for completing the road in Ohio, and continuing it in Indiana and Illinois, was made in 1838. The section in Indiana was constructed east and west from Indianapolis and was practically completed before the Government discontinued their appropriations, but in Illinois, no surfacing whatever was done. Congress provided that only grading should be done on this section, in order that the Government might later put down a steam railroad on the grade if they so desired.

The Ohio section of the road is 231.5 miles long and the total amount of the appropriations for constructing it was $2,064,929.39, which is at the rate of $8,830 per mile. The lower cost west of the Ohio was probably due, to a large extent, to the fact that much less grading was required than on the section east of the Ohio.

Data.—The following data apply to the section in Ohio: The total length is 231.5 miles; width of grade, 30 ft.; width of surface, 20 ft.; construction was begun in 1825; construction was completed in 1838; total cost of construction, $2,064,929.39; cost per mile of construction, $8,830. No appropriations of any consequence were made for maintenance.

For the section in Indiana, 155 miles in length, the total amount of the Federal appropriations was $1,136,600, and for the section in Illinois, 160 miles in length, the total amount was $605,000. The total length of the National Road is about 677 miles, and its total cost to the Federal Government, including preliminary surveys and reconnaissances, was $6,824,919.33.

After 1838, the National Road was definitely turned over to the states through which it passes and since that time, so far as I am informed, it has never even received honorable mention in a federal appropriation act, and up to 1912 no further appropriations were made for the improvement of any public road except in connection with Government property.

MODERN RECONSTRUCTION WORK.

In August, 1912, Congress appropriated a half million dollars to be expended under the joint supervision of the secretary of agriculture and the postmaster general in the improvement of post roads. Out of this appropriation, $120,000 was allotted for improving a section of the National Road in Ohio.

The section of road on which it was decided to use this fund extends westward from Zanesville, and is approximately 24 miles in length. The improvement consists in regrading the old road to a width of 34 ft. and to a maximum grade of 7 per cent, and supplying a concrete pavement 16 ft. wide along the central portion of the grade.

Fig. 3. One of the Old Stage Coaches Used on the National Road.

The dimensions of the pavement are: width, 16 ft.; thickness at center, 8 ins.; and thickness at sides, 6 ins.; making the volume of concrete per lineal foot, 9⅓ cu. ft., or about 1,825 cu. yds. to the mile. The subgrade is flat. Expansion joints of tarred felt are generally placed 30 ft. apart at an angle of 30° with the center line.

The entire section of 24 miles was let in one contract which was awarded by the Ohio State Highway Department about the middle of April, 1914, and the contractor began grading operations early in May. The first concrete was placed June 17, and the work was discontinued November 14 on account of unfavorable weather, after nearly 15 miles of the pavement had been laid.

CONSTRUCTION METHODS.

Present Condition.—The road is still in fairly good condition when it is considered that practically no attention has been paid to its maintenance since it was turned over to the various states and later to the counties. Many of the original stone bridges are well preserved.

The class of houses along the road distinguish it from other roads. They are substantial, many being of stone. Some of the old inns, which were built at intervals of about 15 miles to serve travelers at the end of each day's travel, are still in existence.

Pavement Construction.—Work was started from both ends, by grading gangs operating a traction engine, grader, rooter, roller, steam shovel, and 50 teams. Bridge and culvert builders followed soon after, succeeded by gangs laying track along one side of the roadbed. As soon as trains were running, concrete mixers were put in operation.

Preliminary crowning of the concrete surface was done with a strike-board made of three 1 x 6-in. boards bolted together. The lower edge is shaped to the desired crown, shod with a 3/16-in. plate and additionally reinforced by two small angles. Long iron hooks, fitting into eyes, serve to move the board, which is held erect by means of ½-in. round steel handles. After the surface has been struck off two or three times, it is brought to a still better crown by means of a template similar to, but lighter than, the strikeboard. Two men operate the template by lifting it a few inches, letting it fall and then moving it forward about 2 ins. after delivering each blow.

All curves over 12° are elevated on the outer edge to a maximum of 8 ins. The super-elevation is calculated for a speed of 30 miles per hour. This elevation is accomplished by rotating the section of roadway about its horizontal center line so that the cross-section remains the same, the outer edges of the road being elevated and lowered at the subgrade, respectively.

Steel forms were used and have proved very satisfactory. Three complete paving outfits are in operation. One mixer with a batch capacity of 9 cu. ft. and two 15 cu. ft. mixers were used. Although each crew of 35 men is rated as capable of laying 600 ft. in a day, there has been no time when all were working at maximum capacity, so that the best day's run to date has been 1,520 lin. ft. (for all the outfits). Wheeling to the mixer is done with a double set of barrows, one set being loaded while the other set is being wheeled and dumped into the mixer.

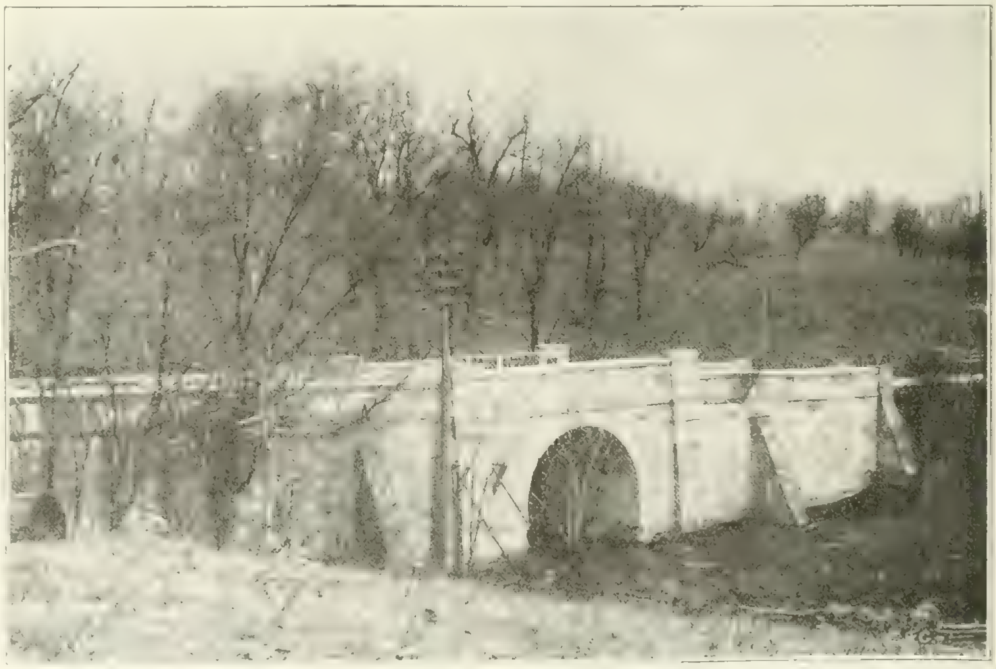


Fig. 4. Old Stone Arch Culvert on the National Road Near Zanesville, Ohio.

Water.—Water for mixing and curing was supplied by pumping stations set at 4-mile intervals. These stations pump 2 miles in either direction, through 2-in. mains. The sand and gravel were washed, screened and remixed to the proper gradations. At one end of the road, gravel is used for coarse aggregate; and at the other end, crushed stone, the mixtures being 1:1½:3 and 1:1¾:3 for the gravel and crushed stone, respectively.

Industrial Railway.—The contractor has had a private switch built from the railroad at each end of the road. The materials are unloaded to stock piles by clamshell buckets, from where they are loaded to elevated bins opposite. A 3-ft.-gage industrial railway serves to haul materials. Cars are run under the hoppers, and loaded as required.

A train, consisting of an engine, six cars, a second engine, and two more cars, can be operated over a maximum grade of 5 per cent. On steeper grades the last two cars are dropped, the two engines run up with the six cars, and the last engine backs down and gets the two remaining cars. A complete train can be loaded in an average of 15 minutes. Cement is loaded by hand directly from the railroad cars to flat cars on the industrial railway, and hauled to site along with the other materials.

Very little difficulty has been encountered with cars jumping the track or with spreading rails. That the industrial railway has proved an economy, is shown by the fact that the cost of hauling, 12 cts. per ton-mile, is about half the estimated cost of hauling by teams. As the length of haul increases, the cost will be further reduced.

Traction Engine Hauling.—A railroad crosses the highway about two miles from the west end. This 2-mile stretch was supplied with material by means of trains consisting of a traction engine and trailer cars. The cars were pulled into the railroad yard, loaded by clamshell buckets directly from the stock pile, and hauled to the site. The one tractor, hauling four or five 2-cu. yd. cars over this portion of the road, which is practically level, supplied all the materials for the single mixer.

Inspection.—The federal government had three engineers on the work at all times, while the state had eight inspectors who hand in daily reports, which are compiled on cost-data sheets by the government engineers.

This is the largest and most thoroughly organized concrete road job that has ever been carried on by the Ohio State Highway Department; and some valuable data will be available, it is anticipated, as the contractor is co-operating with the engineers in the compilation of all cost figures.

PERSONNEL.

The contractor is the H. E. Culbertson Co., of Cleveland, with whom are associated Frank L. Shoemaker, contractor, and H. A. Johnston, and G. S. Allen, of the Globe Construction Co., all of Kalamazoo, Mich. C. H. Moorefield, senior highway engineer in the U. S. Office of Public Roads, is the government representative; and R. N. Waid is division engineer for the Ohio State Highway Department.

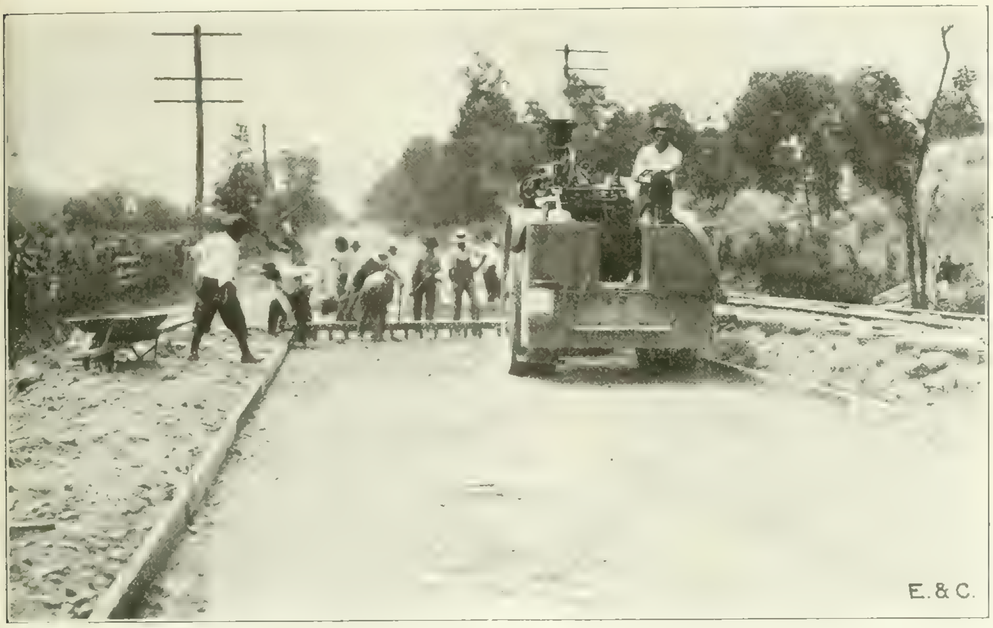


Fig. 5. Preparing Subgrade in the Reconstruction of the National Road—Note the Type of Grading Template Used.

Diagram for Computing Property Assessment in Street and Alley Improvement.

To the Editors: The accompanying graphic diagram was worked out by the writer and used as a standard, in making the assessments for street and alley improvements in Marion, Ind.

It has been customary to assess back from the improvement, on either side, 132 ft., or to the alley and to give the first half, or 66 ft., nearest the improvement, 70 per cent of the total assessment. The method used to facilitate their work involves the construction of a diagram, Fig. 1, which is drawn in the following manner:

1st. Draw to some convenient scale a Base Line, equal in length to the distance back from the street or alley to be assessed (in our case 132 ft.).

2nd. Erect a perpendicular at the extreme end of the Base Line, equal in length to the Base Line.

3rd. Bisect the Base Line and erect a perpendicular at this point (using same scale) the length of which is 70 per cent of the length of the Base Line (in our case 92.4 ft.).

Now we have the three point problem to describe a circle whose circumference passes through these three points, namely: the top of the perpendicular at the extreme end of the Base Line, the top of the perpendicular erected at the middle point of the Base Line, and the end of the Base Line next to the improvement.

After describing this curve connecting the three points, divide the Base Line into any convenient number of equal parts, that will best serve condition (in our case 11 ft., 22 ft., 33 ft., 44 ft., 66 ft., and 132 ft.) and erect perpendiculard or ordinates at the several division points. Measure these ordinates lying between the Base Line and curve using the same scale as used in measuring the Base Line.

Take any ordinate and divide the length of that ordinate by the length of the Base Line to obtain the percentage of total assessment for the parcel of ground represented between the ordinate and the street or alley improved. With proper additions or subtractions the percentage of the total assessment can be obtained for any parcel of ground lying within the territory to be assessed. By multiplying the price per lineal foot by the number of feet frontage and by the proper percentage, the assessment against any parcel of ground lying within the territory to be assessed is obtained.

Care must be taken in drawing the diagram, yet a small error made in scaling the ordinates would change the various assessments only a few cents. However, the method above described is more satisfactory than approximating or guessing the amounts for each parcel of ground as is usually done.

In a considerable experience in the past thirteen years as city engineer and four years as a member of the Board of Public Works in our city in making various assessments this plan has been used. Quite frequently very complex problems come up for the board to settle and to make plain to the property owner. When all property fronts on the improvement the work of making assessments are very simple, but this is not so when the lots run lengthwise with the improvement and are promiscuously divided.

Very truly yours,
T. E. Petrie, City Engineer.

Single Gutters for Modern Pavements: A Possible Economic Development.

With a view to bringing out a discussion of the relative advantages and disadvantages of single gutter construction for modern street pavements the following brief for the single gutter type of construction was presented by W. G. Kirchoffer of Madison, Wis., in a paper before the Illinois Society of Engineers and Surveyors.

When roads and streets were first made in ancient times, it was necessary to make them of soft materials such as were found at the locality, gravel or broken stone. Their only means of drainage was to the side of the road, so naturally they crowned the center. Later, when street pavements were introduced, it was a logical following that two gutters should be made at each side of the street. Such construction was a practical necessity with the materials with which the street pavements were made. But, today, with our hard materials, such as concrete, brick, asphalt and creosote blocks, such construction is not essential or necessary. We are not advancing with the times when we stick to this old method of building streets, especially a city pavement.

The use of two gutters is an antiquated idea. Why should the water and filth from a street be separated into two quantities? There is no logical reason for it. The crowning of a street does not even serve the purpose of dividing the traffic, which is essential. The new form of street that should be adopted, if progress along this line is to be made, is a street with a single gutter in the center. The proposed construction would be to build a pavement with the surface the highest at the curbs and with a continuous even slope from each side to the center of the street.

Some of the advantages of a pavement constructed in this way are as follows:

(1) The capacity of the pavement to carry storm water is many times that of a pavement constructed in the old way. (2) It will keep the dirt and filth in the center of the street where it was made and where it can be easily cleaned or washed away. (3) With this construction, it will be easier and more convenient to establish street grades to conform to existing conditions than it is with the present method of street construction. (4) It will be more economical in the cost of catch basins and sewers, as one or possibly two catch basins will take the place of four or more. (5) No need of deep gutters with costly gutter covers for sidewalks, which are an obstruction to the street. (6) Lower curbs or none at all in residence sections, except such as might be formed of sod. (7) Greater convenience in driving up to the curb. No mess of water, filth, papers, cigar stubs, etc., to alight into from a carriage or auto. (8) More sanitary because storm water, or water from street washing would be more concentrated and therefore wash the street cleaner. (9) The appearance of the street will be improved from an aesthetic point of view. (10) Less crown (or anti-crown in this case) will be needed. (11) Street will be more easily cleaned, as the debris will be concentrated in one windrow in place of two as now. (12) This form of street pavement will tend to divide traffic to right and left hand side of the street. (13) Great advantages on boulevarded streets where four gutters are now necessary.

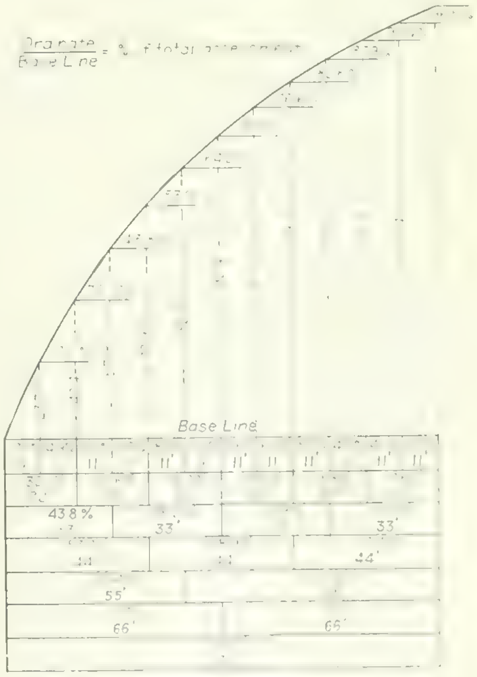


Fig. 1. Diagram Used in Making Assessments for Street and Alley Improvements in Marion, Ind.

The possible disadvantages of this form of street pavement are: (1) A narrow street with street car tracks. The gutter would be between the rails, which would cause debris to acumulate in the wheel grooves. A wide street with car tracks would have two gutters, one on each side. (2) During heavy storms the water in the center of the street might be too deep to walk through, but this condition often occurs where two gutters are constructed.

This idea of a single gutter is not original with me; it is often used in alleys and driveways with good results. I have been advocating this form of street for the past two or three months and hope to see some of the pavements constructed next season, built along these lines.

The Educational Field for State Highway Departments.

The field for educational work by state highway departments was outlined and practical methods proposed by J. H. Pratt in a paper before the last meeting of the American Road Congress. A portion of his paper is given here.

The educational work that can and should be carried on by highway departments readily divides itself into three groups:

(1) Educational work as it relates to the employes of the highway department.

(2) As it relates to county and township road officials.

(3) As it relates to the people of the state.

EDUCATIONAL WORK AS IT RELATES TO THE EMPLOYES OF THE HIGHWAY DEPARTMENT.

There is very great need in many highway departments for the engineers connected with them to be in closer touch with each other and the head of the department. It seems to me that at least once a year there should be a general meeting of all the state engineers and superintendents to be held at some suitable and convenient point in the state, where they would have the opportunity of bringing before the meeting problems that have come up in connection with their individual work and upon which they desire information and assistance. General instructions should be given at such meetings by the state highway commissioner or engineer as to the general policy of the department and the character of the work that they wish to accomplish. I believe that by so doing, the efficiency of the work of the department will be increased and the engineers and superintendents themselves will take a more lively and a keener interest in seeing that the work accomplished is of the very highest order and that the part of the organization under their administration is the most efficient.

For such a conference there is no reason why all the engineers connected with the department should not get together, because they can be ordered to attend by the commissioner, and such attendance should be considered as part of their official duties, and all expenses incurred by the engineers should be borne by the highway department. It is not a bad idea to have in attendance at such a conference some engineer of national reputation to address the members.

The state highway department will find that it is necessary to train and educate young men in order to develop a corps of engineers of sufficient magnitude to carry on the work that is required of the department. A student just out from college, although having received the best training in the highway engineering department, is not a competent highway engineer, but is capable of becoming one. He can work well under more experienced men, but is not in a position to take charge of road work at the beginning of his career, and he cannot develop into a competent highway engineer without working under and coming in contact with more experienced men. The meetings referred to above are of very great importance and benefit to this type of man, and are of very material assistance in training him for the work that will be required of him.

EDUCATIONAL WORK AS IT RELATES TO COUNTY AND TOWNSHIP ROAD OFFICIALS.

The educational field of the highway department, in connection with county and township road officials, will have to be co-operative. As the state highway department has absolute control only over state roads, and as the county and township road commissions have control over the balance of the roads, there is very great need in many instances for a highway department to carry on educational work in the counties and townships.

In the first place, the highway department must be able to show that they have something to give to the county that is better than the county has in connection with its road work. First of all, they must bring the county and road commissioners to a realization that it is just as necessary that they have a competent engineer in charge of their county road work as it is for the state in state work, and if the state roads have been built in a creditable manner, there is not much difficulty in demonstrating this point to the county officials. It is harder, however, to convince the county and township officials that it is necessary to have men trained in road construction to act as superintendents of their roads. It is in the appointment of superintendents and foremen that politics has played too great a part in road work, and to the detriment of the resulting road. These men should be absolutely under the control of the highway engineer, and, as stated above, should be men who are familiar with and trained in road work.

Meetings of Foremen.—These men need to keep up with the advancements made in road construction and maintenance, and in order to keep them abreast of the times, I believe that road institutes should be held in the counties at certain intervals, at which time various subjects relating to road location, construction and maintenance should be taken up and discussed. The county superintendent of roads or county road engineer, if there should be one, should hold these meetings once a month or once in two months, when he will go over with his foremen and supervisors different phases of the road work and give them an opportunity to bring up any questions or problems that have come up during the previous month in regard to their work. The state highway department should have general supervision of these foremen's institutes.

It will be found that such institutes will react very favorably on the foremen, and will cause them to take a much greater interest in their work and make them realize that they are a part of an organization which is building up their county or district. One particular feature that is constantly needing development, and regarding which supervisors and foremen need constant instruction, is in connection with the maintenance of their roads, and at these institutes instruction can be given as to how to repair temporarily serious breaks on bridges, culverts or the surface of the road, so that the road is made passable until the superintendent can be notified and a force of road men detailed to make the permanent repairs.

Those connected with the construction of public roads are like any other set of men, in that if they can be made to have a personal interest in their work, they accomplish more and with better results. I believe this personal interest of the road men is of as great or greater value in connection with building roads as in any other kind of work, inasmuch as the question of the disposal of dirt and rock in grading is so dependent on the road men themselves that they can very often waste a lot of dirt and also a great deal of time unless someone is standing over them constantly directing each individual man's work.

The highway department should supply books of instruction for the superintendent, foremen and supervisors, and if used in connection with the institutes they will very materially increase the value of the institute and the efficiency of the men. I have found that the information which it is desired to convey to the road engineers, superintendents and foremen is perhaps better supplied by short pamphlets on the different subjects than by trying to bring it all under one book.

Yearly Meetings.—At least once a year state highway department should call an open meeting in each county, to be held at the office of the county or road commissioners, for the purpose of affording instruction relative to matters pertaining to road and bridge construction and maintenance, and one of the state highway engineers should be detailed to conduct the meeting. Upon receipt of such notice from the state highway department, the county commissioners shall call such meeting on the date set by the state highway department and shall be present themselves and notify the county engineer, the road officials of each township and the county road superintendent or district road superintendents to be present at such meetings in person. Each of the road officials thus notified to attend shall be paid the regular per diem allowance and expenses in the usual manner for the actual time in attendance at such meeting. If the above is incorporated as part of the official duties of the state highway department, it becomes obligatory upon them to call these meetings and also makes it obligatory upon the county officials to attend.

Once a year there should be held a good roads institute, either in the office of the state highway department or, preferably, at the state university or other state institution, where a course in highway engineering is given. At such an institute, which should be held for at least a week, all county and township engineers and superintendents should be obliged to attend as part of their official duties. The program for the institute should be worked out by the state highway department in co-operation with the state educational institution, if the institute is held at the latter place. It will be found that as these institutes are carried on from year to year, they soon become clearing houses for all road problems of the state in which they are held.

Road officials should be encouraged to subscribe to one or more road magazines. I believe it will be found very efficacious for the counties to subscribe for these magazines and have them sent to their road officials.

EDUCATIONAL WORK AS IT RELATES TO THE PEOPLE OF THE STATE.

In some states the educational work that a highway department can carry on in connection with informing the people of the state as to the road situation, is the most important phase of educational work to be done. As we all know, the status and life of a state highway department are dependent upon the people, and such a department can only live and develop as it is able to show to the people that it is efficient and of economic value to the state.

Where we have the three sets of road officials—state, county and township—in charge of different portions of a state's system of roads, there is more or less conflict between the county and township officials and the state officials, and this is apt to engender a feeling of antagonism against the state department. This will always be the case until our people, as a whole, realize that the welfare of the state must come before that of the county; the county before that of the township; the township before that of the community, and the community before that of the individual family. At the present time, in many states we are apt to consider things in reverse order to what I have just mentioned. We cannot afford to develop a county at the expense of the state.

Lectures.—I believe that a state highway department should show to the people of a state the work it is doing, what it has accomplished and what it expects to accomplish. This can be done very effectively by illustrated lectures to be given at the county seats, and by the publication of reports, giving a description of the work done during the previous year. These should be illustrated, and in this connection it will be found that co-operative work with counties can be very advantageously carried on by illustrating in the reports the best work that has been done in several of the counties, giving in connection with the illustrations cost of the construction work. It will be an incentive for county officials to try to see that they get the best results at the least cost.

Bond Issues.—In many states, counties and townships have been authorized by the legislature to issue bonds for road construction. In some states the state highway department has the supervision of the location of the roads which shall be built after the bond issue. In other states the whole control of the expenditure of the bond issues is left to the local authorities. In this case the state highway department could only act in an advisory capacity. They should, however, try in every way to give assistance to the local road officials, not only in the location of the road, but in its method of construction. This will be accomplished largely by educational methods. This can be brought about by consultation of engineers of the state highway department with the local road officials. In giving advice regarding the location, they should explain in detail their reasons for the location made, and show how, in the end, it makes a cheaper and better road. They should assist in the determination of suitable surfacing material and advise the local officials as to the most suitable and economical material available for their use.

Earth Roads.—In constructing a system of improved roads in any state, there will probably not be over 50 to 75 per cent of the roads that will have hard surfaces, and the balance will come under the head of dirt roads. In some states 60 per cent of the roads will be dirt roads. For this reason it is a good policy for a state highway department to give serious consideration to the care and upkeep of the dirt road, and they should call the attention of local road officials to this and give them instruction as to the maintenance of such roads. Circulars can be prepared and distributed to advantage amongst the people of a state, describing the system of improved roads and calling attention to the dirt roads leading to them, and how, by a little thought and care, these dirt roads may be kept in hard, good condition the greater portion of the year. I do not believe any of our state highway departments are giving sufficient thought and consideration to the dirt road, and I am confident that a great deal of good can be accomplished by these departments giving more heed to this kind of road and instructing road officials as to their construction and maintenance.

It is just as necessary that men skilled in road work have supervision of the construction and maintenance of the dirt road as the dirt road. I do not believe it is putting it too strongly to say that one-tenth to one-fifth of the time and labor expended in all our states in public road work is absolutely wasted, and this is practically true of the amount expended in connection with the dirt road. The state highway department should consider it one of their duties to give such instruction as may be necessary to enable the people to save this enormous amount of money that is now being wasted each year.

Traffic Provisions.—With the advent of the automobile traffic conditions on the public roads have been very materially changed, and not only is it necessary for the state highway department to make a thorough study of these new traffic conditions and the effect of these new vehicles on the public road, but it is also necessary for the department to give instruction and advice to the users of these vehicles, as to the effect of such traffic on the roads and why it is necessary to legislate in regard to their use. The passage of laws regulating traffic will not be sufficient to control it for a great many years unless the users of the road are educated as to the need of such traffic regulations. Therefore circulars should be prepared and distributed, discussing the speed laws, method of passing vehicles, the rights that the users of vehicles have on the public roads, and the license fees or tax required of all users of the roads. I believe that as we are able to inform our people in regard to the public road, that it belongs to all the people and not to any one class of users, and that the laws and regulations regarding the use of the public roads are passed in order to make the road of greatest service to the greatest number of people, that such regulations can soon be enforced with but little difficulty.

Safety Provisions.—The new traffic conditions have increased the dangers of a traveler on the public road, and I think the highway departments should begin to take up a plan of educational work that has been inaugurated, by the railroads, that is, "safety first." Pamphlets should be supplied to users of the road, cautioning them in using the road to give first consideration to the safety of other users of the road, and therefore be careful in passing other vehicles and in rounding sharp turns. If all would co-operate and have the public's interest at heart, the accidents that occur on our public roads could be reduced to a minimum. Each year there are an enormous number of accidents at railroad crossings, some of which are due to carelessness of the driver, others to the bad condition of the crossing, and some due to negligence of the railroad. Here again is an opportunity for the state highway departments to do very efficient educational work. Have warning notices posted at railroad crossings. Have cards for distribution, cautioning all users of the road to take extra precautions in crossing railroad tracks. The greatest good, however, can be accomplished by working out a standard plan of crossing for a railroad, when an overhead or underground crossing is not possible. Do not approach a railroad crossing on a grade of over 4½ per cent, and if possible, for 15 ft. each side of the rails themselves have the road level. Then keep the road-bed smooth and hard and the space between the tracks flush with the rail.

In order to carry out this, it will be necessary to obtain the co-operation of the local road officials and the railroads. But as it is right in line with the "safety first" movement of the railroad, little difficulty should be encountered in obtaining their co-operation.

Road Days.—In many states the governors are issuing proclamations for civic days, and usually one of these days is known as Good Roads Day. Here the state highway departments have a splendid opportunity of getting in direct contact with those people that have the welfare of the state at heart. The departments can assist the communities in arranging programs for good roads days and furnishing lectures as far as possible.

Model Roads.—One other phase of educational work that is, perhaps, as important as any thus far discussed, is that of constructing a sample of model road in those sections of the state where there are no good roads and the people are not aroused to their need of them and the beneficial results that can be derived from them. The construction of a quarter to a half a mile, or even one or two hundred yards of good road in such a community will often be the means of arousing the community to a realization of what they need, with the result that they soon work out a plan by which they can obtain a system of good roads.

The Financing of Permanent Road Construction.

The following summary of road construction work as affected by financial considerations was made in the opening address of President W. A. McLean before the American Road Builders' Association.

PERMANENT ROADS.

The term "permanent" as applied to roads is somewhat misleading, and is not always appreciated by the general public. In the full sense of the word, there is no such thing as absolute "permanency." It is merely a relative term. But it is important, in making safe provision for financing road undertakings, that the matter be clearly understood. For all practical purposes expenditure for the purchase of road allowance may be regarded as permanent; earthwork and certain drainage of an adequate kind may be regarded as permanent; substantial concrete culverts and bridges may be regarded as permanent; heavy road foundations may be permanent. But there is no such thing as a permanent road surface. Traffic and natural disintegration cause the wear and decay of any road surface that can be employed, and adequate provision should be made for the repair and renewal of the surface.

To meet the immediate needs of traffic throughout the United States and Canada, a large amount of construction must necessarily be carried on that cannot be considered of a "permanent" kind. To attempt the task of immediately building, for all traffic, roads that would have a maximum of permanence would be as impossible as it would be economically unwise. A large part of the farm traffic can, for the present, be best served by roads of moderate cost, lightly surfaced with broken stone or gravel, but carefully graded and drained. In many localities even good earth roads (but well graded and drained) maintained by use of the log-drag must be depended upon to meet the needs of traffic, owing to sparse population or the absence of local gravel, stone, or other suitable surface material.

The most unfortunate results have, however, arisen in the treatment of main roads on which, though expensively built, an effort has been made to maintain a heavy bituminous or other high-class surface on a totally inadequate foundation.

Much discussion has taken place during the past year on the subject of road foundations, and has arisen largely from those who attended the International Road Congress in London last year, as a result of their observation of practice in Great Britain and in Europe. European practice in all classes of permanent road construction has undoubtedly in the past tended to greater mass in the foundation than has been generally adopted on this continent. If past practice abroad has proven the need for the massive foundation, it would seem that, on this continent, the use of light foundations should be critically considered, with a view to the adoption of a greater depth of stone and the more general use of Telford or equivalent foundations, particularly for main roads, on which heavy traffic is assured. In the construction of strong foundations there is opportunity for permanency, which will at the same time reduce the cost of repair, for a large outlay may readily arise from attempts to maintain a good surface on an insufficient and yielding foundation.

FAIR DISTRIBUTION OF COST.

A fundamental necessity in creating a system of roads is that the cost shall be fairly and equitably levied on those who benefit. Failure to do so has done much to retard road-building in the past. If the general public feel that the cost of roads is borne in a reasonable degree by those who should contribute, much opposition will vanish. If the farmer feels that he is being asked to build roads for motorists of the cities, he is naturally opposed to proposals for road development on such a basis. Out of this has grown much of the opposition in some localities to the construction of trunk and state roads. A close study of the farmer's viewpoint by advocates of trunk roads will throw light on the road situation as a whole, and will indicate that a successful road policy in any province or state should make provision for the improvement, if not of all roads, at least of those more directly serving farm traffic. Broadly, trunk roads run from city to city, and are commonly parallel to the steam railway. The market roads, on which rural traffic most frequently concentrates, radiate from the stations, villages and shipping points, and are, in general, at right angles to the trunk roads so often advocated for motor traffic.

Trunk roads are a necessary adjunct of any system of roads. They are desirable, and should be built. They frequently form part of a system of local market roads, but must be more substantially built to serve the more severe traffic.

It is difficult, however, for even the most patriotic farmer to rest satisfied with beautiful pictures and illuminative newspaper descriptions of the splendid roads of his own state—roads he never sees—while he has still to drive through the mud axle-deep to his local market or shipping point, with nothing being done to remedy that condition. Rural residents of every good farming community want good roads, and are willing to meet a reasonable outlay for them—nor are they opposed to trunk roads if the cost is levied upon the proper source.

A farming community, insofar as is consistent with its prosperity, can fairly be asked to contribute such amount per mile of road as would properly meet the needs of local traffic. For more expensive construction for motor traffic the remainder of the cost should be met from a source representing the contribution of cities or other communities benefited.

Market roads without trunk roads are commonly opposed by cities quite as much as the farmers oppose trunk roads when provision is not made for market roads. Upon a plan of road improvement which includes both, all the people can agreeably unite.

It is not intended to convey the impression that all roads can be built at a stroke, and that a durable road can be at once built to every farmer's gate. There must be a starting point. For this purpose certain roads must be selected for the immediate improvement, others to take their turn later. A study of local traffic conditions will indicate the roads on which traffic seeks to concentrate, and, commencing with these, the general system can be developed from year to year.

There should be no conflict of interest between the two classes of roads. The one is a necessary adjunct of the other in a complete system of roads. The great need is that the value of both should be recognized and adequate measures taken to develop both concurrently; but there should be no effort to substitute one for the other.

BOND ISSUES.

Much difference in opinion and practice exists with respect to the issuance of bonds for road construction. At one extreme are those who oppose all bonded debt for public roads, while at the other are those who advocate bonds maturing in 40 and 50 years. It is probable that, as in most cases of widely divergent opinion, the true solution is in a moderate middle course.

The primary construction of a great system of roads has, in all countries, required large initial expenditure, such as can only be procured by distributing the repayment over a term of years. The construction of main roads, and even good market roads, is as a rule carried on in very disjointed sections, and at a sacrifice of workmanship, if the cost is provided by annual levy only. The necessary initial outlay can, as a rule, be sustained only by borrowed funds.

It may be asserted as a further truism that the term for retiring the bonds should not exceed the useful life of the work. Again, repayment in the briefest possible period is favorable in that the total interest charges are reduced.

In considering the matter, the road structure may be divided into several portions: (1) The system of drainage, (2) the earth sub-grade, (3) the foundation, (4) bridges and culverts, and (5) the wearing surface.

Judging the future by past experience, it may be estimated that long-term bonds for certain portions of the work are justifiable. An effective system of open and under drains, deep cuts, extensive fills, and an adequate width of earthwork; a Telford, concrete or other heavy foundation; concrete or heavy steel bridges and culverts are all of long durability, and may justify long-term debentures. The road surface, on the other hand, has a comparatively short life, and will seldom justify a debt of more than five or ten years' duration. Adequate maintenance is in all cases essential.

The method of finance as regards the issuance of bonds may thus be based on the life, not of the surface only, but of the several portions of the structure; the bonds for surface costs to be retired in not more than five or ten years, while the long-term period may be applied to what may be more truly termed the "permanent" portion of the work.

It might be logical to approach the matter on the basis of a general estimate, meeting a proportion of the cost, approximately 50 per cent, by long-term bonds, the remainder, or 50 per cent, covering surface costs, to be retired, according to the life of the pavement, in from five to ten years.

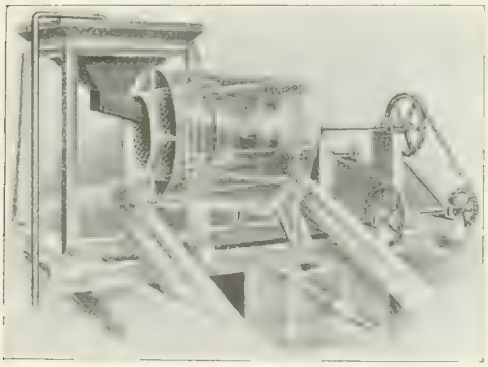
To go even further on the ground of safe finance, and to pay something for immediate benefit, a portion of the cost might be met out of the annual levy; but that as a rule is difficult, and may tend to reduce the amount available for adequate maintenance. It need not be added that to meet the cost of maintenance by the issue of bonds should be regarded as a poor method of finance.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A Compact Sand and Gravel Washing and Screening Plant.

The sand and gravel screen illustrated is designed primarily to reduce the first cost of plant construction. This is accomplished, it is claimed by the makers, by the fact that these screens are combined so that no more space is required than for the old fashioned single screen. The amount of framing, the number of platforms and lengths of shafting are all reduced. It cuts off one-third in the elevation of the plant and the screen is on a level with the top of the bins. In operation, the material to be washed and screened is introduced into the hopper together with water and falls upon the upper end of the inclined large size screen. The material passing this screen is conveyed by a cone-shaped skirt or auxiliary section to the rear end of the second size screen and the process repeated. Sand and water are finally conveyed into an ordinary sump box. This type of screen was developed for private use and is just being placed on the market. It is manufactured and sold by the Biesanz Stone Co., Winona, Minn. This company designs and installs plants using this screen.



A Compact Sand and Gravel Washing Plant.

A Grab Bucket Designed for Heavy Service.

The accompanying illustration shows a 1-cu. yd. type A-1, two-line "Andresen-Evans" grab bucket at work excavating rock which had been blasted from a bridge pier at Pekin, Ill. The bucket shown in the illustration is built for exceptionally heavy service and weighs 4,000 lbs. The rock handled on this job ranged from small spawls to pieces having extreme dimension of 3 to 4 ft. and weighing up to four tons. The bucket was also used to pull all of the stub piling, old logs, the "Wakefield" sheet piling and the formwork below water. This type of grab bucket is made in sizes ranging from ¾-cu. yd. to 10-cu. yds. capacity by the Andresen-Evans Co., Railway Exchange Building, Chicago, Ill.

Grab Bucket Excavating Rock Fragments.

The New Ten-Ton Knox Tractor.

(Contributed.)

A ten-ton tractor of peculiar design is illustrated by Figs. 1 and 2. This tractor is made by the Knox Motors Co., Springfield, Mass., and in principle is entirely different from what might be called a short wheelbase truck. The chassis proper is that portion which supports the transmission, motor, body, etc., and is carried on light springs (less than one-third as stiff as those on a five ton truck) to absorb road vibration. It will be seen in Fig. 2, that the frame does not extend to the rear axle and that the rear axle is entirely isolated from the chassis proper. The cantilever springs supporting the chassis proper rest at their rear ends in slideways under the rear axle. The rear axle is driven along by the driving chains while the strut rods maintain it in line, it being at liberty to move up and down equally or unequally as to either of its wheels without motion of the chassis proper. The rear axle rotates in the rear bracket of the strut rods and as the springs supporting the trailer platform are fastened to the rear axle itself, the trailer platform is at liberty to remain parallel to the body of the trailer under all circumstances and at the same time give the full support to the front end of the trailer by means of the circle plate. A draw bar device with springs is attached to maintain the trailer platform in a horizontal position when running without the trailer.

It will be seen by the above that the tractor proper, including the power plant, front wheels and body, is really pushed along by the rear axle through the distance rods, or strut rods, thus the trailer really becomes the power driven vehicle with a front wheel drive. This also explains why this particular type of tractor will climb over obstructions which can not be negotiated with a touring car, or with a truck, for most of the load is on the driving wheels, which are pushing a heavy load. In the Knox system, the driving wheels are pulling a heavy load and pushing a very light one ahead of them, this light load then acting simply as a steering feature.

Beginning with the power plant, the motor is a four-cylinder cast in pairs, 5 ins. diameter, 5½ in. stroke and is so designed as to develop great horsepower, easy starting and quick acceleration up to approximately 1000 R. P. M. beyond which speed the power will rapidly diminish. This has been worked out on the theory that when running under full load speed will be limited, by this design, and that when running without load the tractor may be driven at higher rate of speed without damage. The motor is supported in front by a forged steel beam and the two rear legs are bolted to the frame, making a three point suspension. No sod pan is used under the motor but, in lieu of same, sheet steel webs are used between the crank case and the frame and a sheet housing covers the fly wheel and clutch. Ball bearing rocker arms operating the valves are used and are grease tight, eliminating grease cups in this connection.

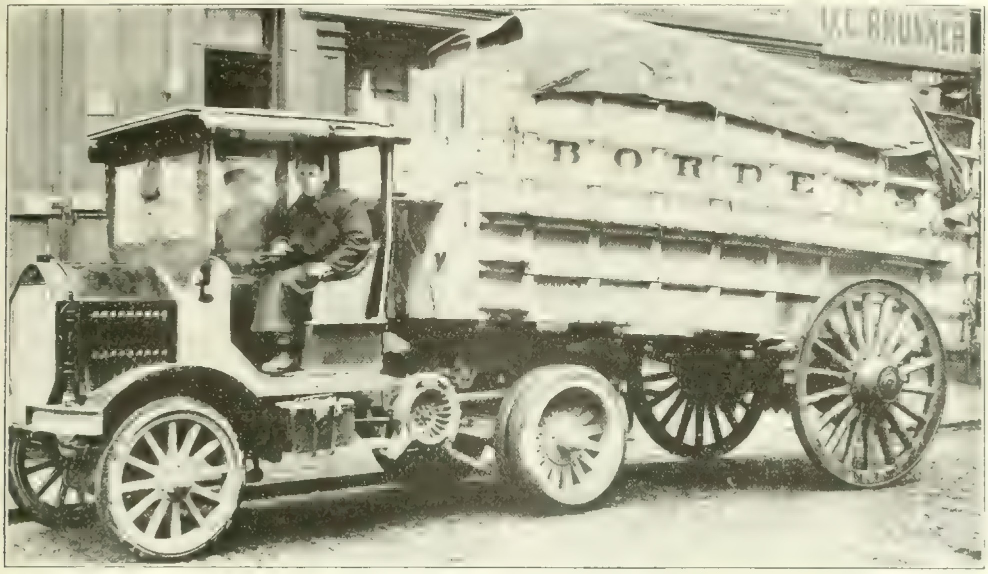


Fig. 1. Knox Ten-Ton Tractor.

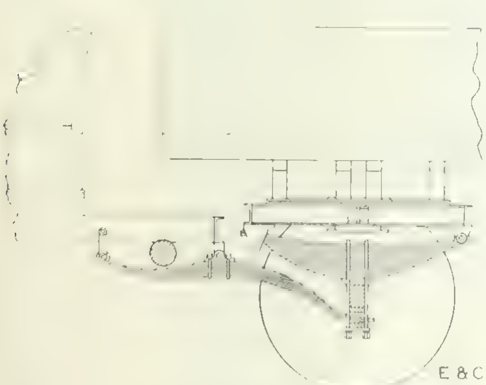


Fig. 2. Sketch Showing Chassis Support in Rear Axle of Knox Tractor.

The transmission is of the selective type, three speeds forward and reverse with center control and is of extremely heavy construction. The interlocking differential lock is incorporated in the transmission and is operated by a heel button in the floor at the driver's seat. Owing to the interlocking device the lock can not be used unless the transmission gears are in the neutral position. This eliminates the trouble encountered heretofore in breakage of differential locks which, although of tremendous advantage, have not been used due to this breakage. The trouble has been caused by using the lock when one wheel was spinning at a high rate of speed. With this new device the operator must bring the transmission gears to the neutral position, which immediately stops the spinning wheel, before he can engage the lock. After engagement any speed in the transmission may be used. Throughout, large double row ball bearings are used. All of the gears and shafts are of nickel steel, heat treated. The transmission case is of the barrel type with the holes for the bearings bored through the case. The top of the transmission case is nothing but a lid or plate. The transmission control lever is located between the two seats at the driver's right hand and the other controlling devices as well as the steering gear are located on the left hand side, making a left hand drive, center control layout.

The foot brake pedal is automatically locked, when desirable, and operates on the jackshaft through cast iron shoes against cast steel drums 14 ins. diameter, 4 in. face. These drums have a multitude of cooling ribs for the radiation of heat. The hand brake, which is located between the two seats alongside the transmission control lever, operates the hydraulic pump bolted to the top of the transmission gear shift housing and this lever, by an ingenious arrangement, operates in the same mannner as the ordinary hand brake, pulling back to apply the brake and easing forward to release it. The brakes are so designed that they will hold the tractor on a grade, when abandoned by the driver, and it should be noted that the jackshaft brakes can also be locked, if desired. Hydraulic cylinders are bolted to the strut rods and operate on the break levers at the rear axle. The rear axle brakes are internally applied and are 20 ins. diameter and 6½ ins. face steel spring bands lined with raybestos. The hydraulic brakes eliminate the necessity of brake rod adjustment when adjusting the driving chains. The wheelbase is 108½ ins., the tires in front 36x4 ins. single and the tire in the rear 38x6 ins. dual. The rear axle is a solid steel forging 2¾x4⅜ ins. of rectangular section and the entire vehicle is standard tread, so that in sand or on country roads it can roll along easily. The maximum load on the front tires is about 3400 lbs. regardless of the load on the trailer. At 1000 R. P. M. of the motor the gear will move the tractor as follows: High speed, 9.4 M. P. H.; second speed, 3.9 M. P. H. and low speed, 1.6 M. P. H. By changing the jack shaft sprockets and slight alterations the speed may be increased to 33 miles per hour.

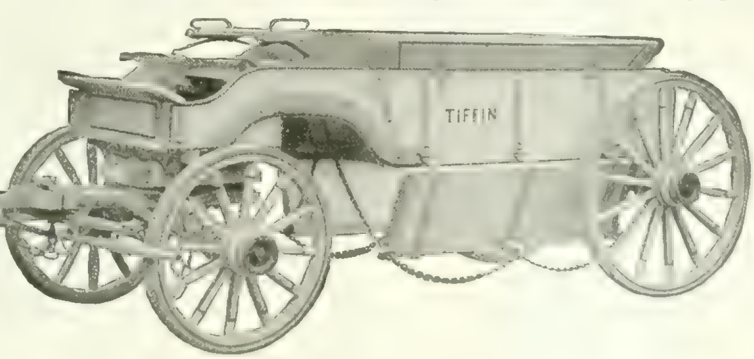
The weight of the complete tractor is about 8500 lbs., 3400 lbs. of which rest on the front tires under all conditions of load in the trailer. The price of the tractor, including standard equipment, is $4500 F. O. B. Springfield, Mass.

Small Mazda Lamps With Concentrated Filaments.—The distinctive features of the concentrated filament Mazda lamps of high wattages have proved so popular that the Edison Lamp Works of the General Electric Co. has developed vacuum Mazda lamps of similar appearance in the 25, 40 and 60 watt sizes. This concentrated filament construction gives greater vertical distribution of light than the regular Mazda lamps of corresponding wattages. The new lamps will, therefore, be employed where natural distribution of light downward is required. They can be used in existing sockets and fixtures. These lamps will be made in the same sized bulbs as the corresponding regular Mazda lamps, will have the same spherical watts per candlepower efficiency and will have a rated average life of 600 hours.

A New Dump Wagon With Patented Spring Tension Equalizer.

The illustration shows a new model of dump wagon in which a low selling price has, it is claimed, been secured with several operating and structural improvements. The patented equalizer, working by spring tension on the chains which run the full length of the body, provides for the raising of the doors, one slightly in advance of the other, so that there is no chance for sticking; and since there is an overlapping flange the bottom is absolutely tight. A patented king bolt in connection with a special fifth wheel construction allows the wagon to tip in any direction without strain. On account of the inequalities of the ground where most dumping wagons have to work, this is a particularly valuable feature.

The body is of very staunch design, oak heavily ironed, and with wrought steel hinges. A short wheel base allows turning in close quarters and the arched rear axle aids clearance over the dumped load. The winding device is said to be "fool proof." A safety catch prevents accidental dumping, while the releasing device is so certain in its action that it cannot fail to operate.



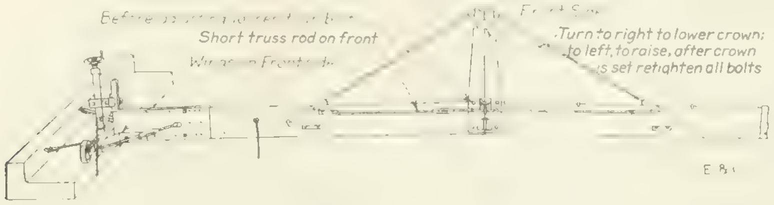
A New Model Dump Wagon.

Without changing any of its members, either drop or stiff pole can be fitted to the wagon. This wagon is made by the Tiffin Wagon Co., Tiffin, Ohio.

Plans for developing hydro-electric power on the river Spey, the swiftest running river in Scotland, at a point one-half mile from the coast, have been delayed by the war. The proposed plant would supply power to many towns and villages within a radius of 20 or 30 miles.

The Roughen Adjustable Paving Gage.

The gage illustrated is designed to eliminate the necessity of setting grade stakes on street paving work, to provide an accurate measure as to the trueness of the subgrade, to use as a strike board in the construction of concrete pavement and concrete base and as a template to strike the sand cushion for brick pavements. The gage of two steel shod template boards adjustable at the center to any desired crown of subgrade or pavement and is supported at the ends on rollers. The template boards are raised by a handwheel in passing over joints or obstructions. When used on a street having a curb the guide wheels shown in the illustration keep the template perpendicular to the curb. A hanger hooked over the gage is used to support the finishing bridge when used on concrete pavement construction. The machine is adjusted to slight variations in street widths by changing a few bolts and to great variations by changing the template boards. The gage is manufactured and sold by P. Roughen, 214 Amory St., Fond du Lac, Wis.


Short truss rod on front
Turn to right to lower crown; to left, to raise, after crown is set retighten all bolts
E & C

Adjustable Paving Gage.

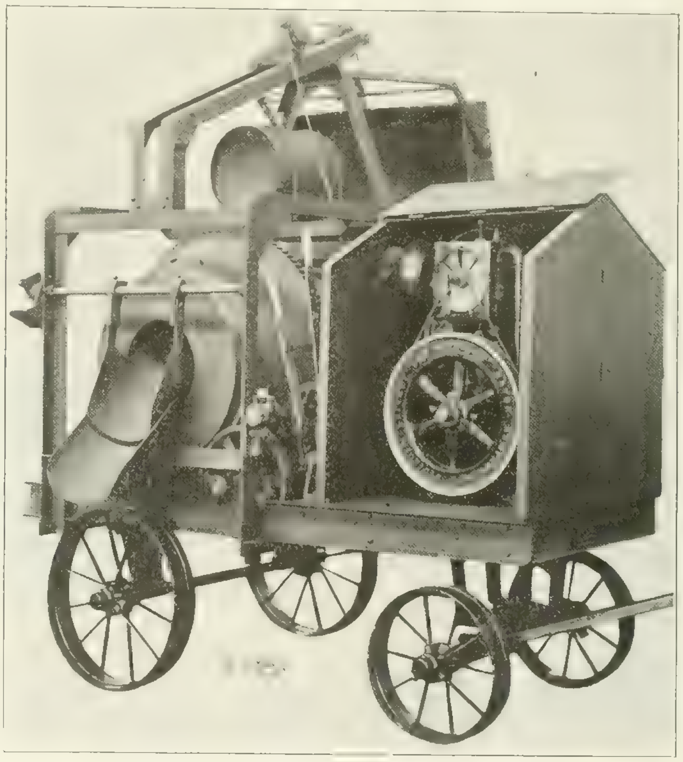
A Special Annealed and Tempered Shovel for Concrete Work.

The illustration shows a special shovel for concrete work. This shovel is known as the Ronberg Shovel and is made of special analysis steel high in carbon. In addition when the shovel is formed the blade is annealed from the end of the ferrule to within 3 ins. of the edge. This annealing makes the steel tough so that it will bend instead of breaking. To stiffen the blade against bending a much longer rib than is common is used. The 3 ins. of the edge not annealed is tempered by the Henry Mikkola process which gives a temper very hard at the edge and less hard inward toward the annealed portion. The tempered edge is finally hand pounded until it is true and so uniform in hardness that the edge wears straight across, and not in scallops. Finally, as shown by the cut, the point is dropped and so a ridge formed across the blade. This ridge helps to break the material as the blade is thrust into it and thus prevents wedging into the bowl of the shovel. The D-handle shovel shown has a 19-in. drop; the long handle, 4½ ft. shovel has a 30-in. drop. All handles are second growth ash seasoned at least 14 months, and are made unusually large at the ferrule. The shovels are made with several sizes of blades and are particularly designed for shoveling ore, concrete materials, concrete, etc. The makers are the Conneaut Shovel Co., Conneaut, Ohio, Department B.

Special Annealed and Tempered Shovel for Concrete Work.

A Compact Small Batch Concrete Mixer.

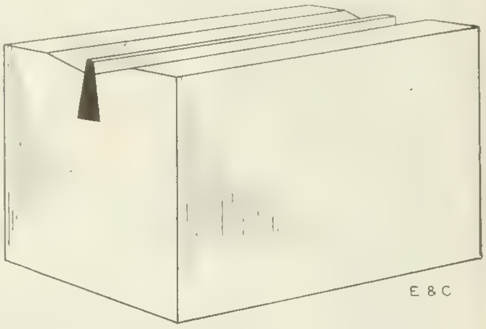
A small gasoline operated concrete mixer of notably compact design is illustrated here. This mixer has a capacity of 5 cu. ft. and is operated by a 3½ hp. gasoline engine completely housed as shown and all mounted on all-steel frame and trucks. It is optional with the buyer to have an electric motor in place of the gasoline engine. The specifications of the mixer are in general as follows: The drum consists of double cones of unequal tapers comprising only three parts; the large semi-steel conical head with gear, and a smaller slightly rounded head, joined together by a shell of heavy boiler plate steel; it is non-tilting and gear driven. A series of mixing blades and buckets insure uniform mixing and quick discharge. The side loader is of the pivoted type; clutch automatically released when bucket reaches discharge position. A batch hopper of this same capacity as drum is furnished instead of side loader when desired. The trunnion rollers are 15 ins. diameter, 1 11-16 in. face, pinned solid on 17-16 in. shaft in pairs; shaft revolves in babbitted bearings 4 ins. long. The trucks are all steel, three point suspension; rear wheels 24 ins. diameter, front wheels 18 ins. diameter, face 4 ins. The main frame is 83 ins. long, 36½ ins. wide; channels 5 ins. x 6½ lbs. The water tank is of the positive measuring type, 18 ins. long, 14 ins. diameter, capacity 12 gals., 100 lbs. working pressure. A complete set of necessary tools is furnished with each machine. The mixer is made by the Eureka Machine Co., Lansing, Mich.



A Truck-Mounted, Gasoline-Operated 5 cu. ft. Batch Mixer.

A Non-Slip Wood Paving Block.

Wood block paving as ordinarily laid possesses the disadvantage of slipperiness when laid on grades. To overcome this various expedients have been adopted and special types of blocks developed. The non-slip block illustrated has an iron insert fitted in a groove in the block. The upper edge of this insert is flush with the face of the block, a gripping edge being obtained by a sloping cut in the wood on each side of the iron. In laying the pavement a line of non-slip blocks is laid about every fourth course. This type of block has been subjected to a three year service test by the city of Boston and its use there is increasing. The block is manufactured by the Philadelphia Wood Block Co., Harrison Bldg., Philadelphia.



The Acme Non-Slip Paving Block.

Engineering and Contracting

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Honors for the Engineers of the Panama Canal 209

Editorial commenting approvingly on the recent recognition by Congress of the work done on the Panama Canal, by Col. Goethals and his assistants. E. & C., Mar. 10, 1915, ⅓ col.

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The Effect of Improved Methods of Manufacturing Paving Materials Upon the Construction of Various Pavements.... 209

Comments upon the change in the characteristics of various pavements due to improvements in methods of manufacturing. Recommends the endowment of scholarships for the study of paving materials. E. & C., Mar. 10, 1915; ⅔ col.

ENGINEERING: Water Power Problems.

Financial Safety Engineering............. 209

Editorial calling attention to article on the problems involved in water power development. Lays particular stress on the business features, and the necessity of studying the financial safety of such works. E. & C., Mar. 10, 1915; 1¼ cols.

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Underestimating the Cost of Motor Trucking 210

Protests against the publication of misleading cost data relative to motor truck hauling, and gives some samples of the method of estimating. Comments on a recent letter on this subject. E. & C., Mar. 10, 1915; 1⅔ cols.

BRIDGES: Main St. Viaduct, Fort Worth, Tex.

Design and Construction of the Main St. Reinforced Concrete Viaduct at Fort Worth, Tex.............................. 211

Describes in detail the design and gives construction features of a reinforced concrete viaduct at Fort Worth, Tex. The structural steel reinforcement used in the arch spans was designed to carry the forms, without the use of falsework. The bridge consists of a series of girder spans, arch spans and approaches between concrete retaining walls. The data on the methods used in the design are exceptionally complete. E. & C., Mar. 10, 1915; 20½ cols.

PILING: Steel Sheet; Pulling With Steam Hammer.

Pulling Steel Sheet Piling With a Steam Hammer 217

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Describes and illustrates methods of caulking joints with hot and cold lead, of testing caulked joints, and of laying the pipe line. E. & C., Mar. 10, 1914; 4½ cols.

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Gives several examples of this class of pollution. Gives opinions of various water works men as to remedial measures. Quotes pertinent legal opinions. Advocates physical separation of public and industrial water supply pipe lines. E. & C., Mar. 10, 1915; 8½ cols.

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Describes methods employed in trenching, distributing pipe and making up the joints with cost data for pipe laying. E. & C., Mar. 10, 1915; 1½ cols.

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Clear presentation of the business engineering problem of water power development. Describes the methods of procedure in the case of the Tennessee Eastern Electric Co. E. & C., Mar. 10, 1915; 11 cols.

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Methods and Some Costs of Mine Shaft Sinking in Very Tough, Hard Rock..... 226

Describes nature of rock and general and detailed methods of drilling, blasting and spoil renewal. Costs are given of 860 ft. of shaft completed. E. & C., Mar. 10, 1915; 2½ cols.

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Discusses the history of the old National Road, giving type of construction and appropriations for construction and maintenance. Gives data concerning reconstruction, methods used and progress of the work. E. & C., Mar. 10, 1915; 6 cols.

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STREETS: Gutter in Center.

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Discusses the possible advantages of using a single gutter in connection with modern paved streets. Advocates the more extensive use of that type of construction. E. & C., Mar. 10, 1915; 1¼ cols.

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The Educational Field for State Highway Departments 230

Discusses educational work as it relates to the employes of the department, county and township officials and the people of the state as a whole. E. & C., Mar. 10, 1915; 4½ cols.

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Discusses the true definition of a permanent road, fair distribution of the cost of road improvement and the construction of roads with funds derived from bond issues. E. & C., Mar. 10, 1915; 2½ cols.

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The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Iron and Steel Products.—Firm in North Africa desires immediate quotations on iron and steel products, nails, wire, etc. It is stated the firm is in the market for large quantities of these materials, and that if prices, etc., are satisfactory a very valuable business may result in the future. No. 15,809. [For address see first paragraph.]

House and Street Signs.—Supply Company in Central America wishes to secure prices and samples of house numbers. It is suggested that a nickel-plated steel or copper sheet 2½ to 3 ins. high might be used. It is stated that any material which would resist the humidity of the atmosphere will be considered. Prices should be made f. o. b. New York or New Orleans. The company also wishes to receive samples, prices, etc., on street signs. No. 15,837. [For address see first paragraph.]

Well Drilling Machinery and Wire Fencing. —Representative of Latin-American Government will arrive in New York soon for the purpose of purchasing well drilling machinery and 5,000,000 meters of wire fencing. No. 15,843. [For address see first paragraph.]

Searchlight.—Business man in one of the neutral European countries desires American manufacturers and exporters to quote, at once, prices f. o. b. New York, on searchlights for field service and fortifications, in all sizes. Correspondence may be in English. No. 15,826. [For address see first paragraph.]

Telephone and Telegraph Wire.—European agent desires immediate quotations, f. o. b. steamer, on telephone and telegraph wire. It is stated that the Government is preparing to expend $134,000 for this commodity. Correspondence may be in English. No. 15,824. [For address see first paragraph.]

Motors.—Business man in Russia desires to represent American manufacturers of motors for yachting purposes. No. 15,862. [For address see first paragraph.]

Iron and Brass Tubing.—Firm wishes to receive quotations and full information relative to iron tubing, not soldered, from ⅜ to 2 ins. in diameter; brass tubing and brass-plated tubing from ⅜ to 2 ins. in diameter; varnishes and metal polish paste; tinned wire for bed springs, etc.; angle iron, 1½ by 3/16 ins. and 1¼ by 1⅛ ins.; hoops, bands, or collars, 1⅛ by 1/32 ins.; and brass and enameled articles for the manufacture of beds. Correspondence should be in Spanish. No. 15,825. [For address see first paragraph.]

Magnetos.—A firm of pump specialists in Europe desires to get in communication with American manufacturers of high-tension magnetos for single-cylinder gasoline engines of 1 to 6 hp. A sample machine is desired for inspection. Full particulars, prices, conditions of payment, etc., should be sent at once. It is stated that cash will not be paid in advance. The firm states that if the terms, etc., are satisfactory an order for 50 magnetos will be made at once, with possible supplementary orders during the year totaling about 200. No. 15,865. [For address see first paragraph.]

Pitch Paper.—Business man in Greece wishes to be put in communication with American manufacturers of pitch paper to be used for wrapping, and also for roofing. The paper should be in rolls, 39.37 ins. wide, length not material. C. i. f. quotations and samples should be sent at once. It is stated that he wishes to purchase 100 tons of paper similar to the sample which may be examined at the Bureau of Foreign and Domestic Commerce or its branch offices. No. 15,854. [For address see first paragraph.]

INDUSTRIAL NOTES

Mr. Charles S. Fletcher has been appointed Manager, Sack Bureau, Universal Portland Cement Co., Chicago, and Mr. Oscar N. Lindahl has been appointed chief accountant. Mr. Gordon Wilson has resigned as assistant secretary to accept service with another company.

The Gate City Tent & Awning Co. and the Scott- Rawitzer Mfg. Co., both of Omaha, Nebr., have consolidated and incorporated as the Scott-Omaha Tent and Awning Co., with offices and factory at corner of 11th and Harvey Sts., Omaha, Nebr. Mr. N. C. Scott is president and treasurer. This company manufactures a complete line of contractors' camp and housing equipment.

NEW CATALOGUES

Saw Rigs.—Paper, 6x9 ins., 8 pp. C. H. & E. Mfg. Co., Inc., Milwaukee, Wis.

Shows C. H. & E. No. 6 portable saw rig and describes in detail its construction, operation and equipment.

Engineering and Drafting Specialties.—Paper, 3¼x5½ ins. Henry V. St. George, Inc., 10-12-14 Grand St., New York City.

Devoted to the subject of Heliography on tracing cloth. Describes the work, gives cost data, sample and testimonial letters.

Coal Drier.—Paper, 6x9 ins.; 4 pp. Link Belt Co., 39th and Stewart, Chicago.

Describes the Wendell centrifugal coal drier, a compact, self-contained machine for drying washed coal for coking purposes and the smaller sizes of steam and domestic coals. Illustrated with photographs and diagram showing operation.

Weights and Measures.—Paper, 6x9 ins.; 16 pp. Kansas City Testing Laboratory, 1013 Grand avenue, Kansas City, Mo.

Bulletin No. 7, consisting of definitions and tables of equivalents of weights and measures. The bulletin aims to aid in spreading a working conception of the metric system. Price 25 cts.

Concrete Road Forms.—Paper, 8x11 ins.; 16 pp. The Heltzel Steel Form & Iron Works, Warren, Ohio.

Describes the Heltzel hanging system of steel road forms and shows construction work in various parts of the country. Points out the advantages of the system and the economy of steel forms. Gives details of some large contracts and list of users of the forms.

Land Dredges.—Paper, 10x6¾ ins.; 32 pp. The Bay City Dredge Works, Bay City, Mich.

Shows Bay City land dredges in operation and the character of work performed. The views illustrate all manner of drainage, ditching and irrigation work, and are accompanied by testimonial letters which contain considerable data as to the practical operation of the dredges.

Forms for Building.—Paper, 6x9 ins.; 8 pp. Crist & Stukenberg, Kansas City, Mo.

Describes the Crist system of adjustable forms for concrete building construction. Shows the column mold and describes its use with mushroom or standard beam system of construction. The adjustable prop is also shown, and details of design, sizes, and application are given.

Coil Holder.—3½x6 ins.; 8 pp. Wm. A. Iden Co., 564 Washington Boulevard, Chicago.

Describes and illustrates the use of the Danker Improved Coil Holder for twine and rope, with data as to sizes and prices.

Business Training.—Paper, 6x9 ins.; 116 pp. Alexander Hamilton Institute, 69 Astor place, New York City.

"Forging Ahead in Business," is the title of this publication which comprises a very thorough and comprehensive exposition of the plan followed by the above institution and the value and practical application of the educational advantages to be obtained by its subscribers.

Wire Rope.—Paper, 3¾x6½ ins.; 72 pp. Broderick & Bascom Rope Company, 805 N. Main St., St. Louis, Mo.

Price List K and illustrated catalogue of B. & B. wire rope and equipment. Also gives a brief history of the firm, details of wire rope construction, describes "Yellow Strand" Powersteel, sheaves for rope transmissions, gives tables of transmission, directions for splicing, logging with wire rope, aerial tramways, etc.

Electric Hoists.—Paper, 6x9 ins.; 4 pp. Link Belt Company, 39th and Stewart, Chicago.

Describes and illustrates the Link Belt electric hoist, and outlines its advantages, such as the small head room required, accessibility of all parts, factor of safety, etc.

Steel Mine Ties.—Paper, 9x6 ins.; 42 pp. Cambria Steel Company, Johnstown, Pa.

Describes Slick steel mine ties and shows a number of photographs of installations. Gives tables of weights and dimensions, standard sections, standard rail drilling and splice bar punching, and other pertinent data.

CATALOGUE REVIEWS

Road Machinery. — Catalogue-memorandum, 3x5 ins.; 49 leaves. The Austin-Western Road Machinery Co., Karpen Bldg., Chicago.

The above company is sending out a neat and unique advertising memorandum book which is in brief a complete index to the line of road makers' machinery and contractors' equipment handled by the firm. In form it is a loose leaf memorandum book, with a handsome lithographed celluloid cover. The size, 3x5 ins., is convenient for pocket use, and the loose-leaf form enables the owner to keep any page on top as he wishes to consult it.

The advertising feature is also unique and should be of real service to an interested possessor. It consists of a summary and catalogue of the 10 large catalogues which describe the various classes of Austin-Western Machinery. On the back of each memorandum page appears a brief description and small cut of one of the distinctive types of the machines, with the number of the particular catalogue in which it is fully described and illustrated. A classified index to the entire line is given in the front.

This memorandum-catalogue will be sent by the company to anyone making application and using the name of Engineering and Contracting.

Machinery for Screened Products.—Paper, 6x9 ins.; 128 pp. Stephens-Adamson Mfg. Co., Aurora, Ill.

Section 5 of the "S-A" general catalogue No. 19, describing "S-A" machinery for screened products, consists largely of views of certain typical large and small gravel washing plants, with reproductions of the blue prints showing the layout of these plants. The introduction explains the "S.-A." system, the importance of clean gravel, the principle of the Gilbert screen, and the operation of a typical plant. The screen and automatic settling tank are then described and some data as to standard sizes of screened gravel are given. Then follow the photographs and diagrams, with brief descriptions of the installations, their distinctive features and specific work.

A number of portable screening plants used on large construction work are shown, also "S.-A." concrete mixing plants, "S.A." equipped ore washing plants and stone washing plants, "S.-A." equipped crushing and screening plants, "S.-A." shaker screens for coal tipples, storage conveying screens, revolving screens, steel housing, reciprocating grizzly feeders, "Newago" separators, steel bar screens, and other equipment.

The last pages of the book are occupied with data relative to perforated plates, gages for steel sheets and plates, weights, sizes, mesh, and prices of screens, price lists and dimensions of cars, tubs, hopper, steel rails, switches, car wheels, industrial turntables, hoists and other apparatus used in conveying and hoisting of bulk or package products.

CURRENT NEWS

The Doings of the Week.

No important developments from a commercial or industrial point of view occurred during the past week. Business, in general, continued to show improvement. Bank clearings for the week ending March 4 were more than $100,000,000 greater than the previous high record of this year, and only $56,000,000 under the corresponding period for 1914. Export figures for February show an excess of over $120,000,000 as compared with $23,800,000 for the same month of last year. Congress adjourned without having passed any particularly damaging legislation, and business interests are confronted no longer by talk of embargoes and shipping bills. The River and Harbor bill, carrying a flat appropriation of $25,000,000 and a provision for a further expenditure of $5,000,000 from unexpected balances was passed last week. This means the immediate taking of bids on a large amount of government projects. In the construction field the best showing so far this year was made during the past week. Many large undertakings, particularly in the way of highway improvements reached the call for bids stage. Numerous municipal projects, especially those of smaller cities, also are being advertised. In the road field alone four lettings representing an approximate expenditure of $2,000,000 are ready for bids. A number of big jobs were placed under contract and a great deal of new work made its appearance and will be ready for estimates in the next few weeks. In the iron and steel trade the improvement of previous weeks has continued. Steel buying during the past week was larger than the average during the last half of February. The Gary works of the American Bridge Co. secured a 40,000 ton order and as a result the plant which has been operating at 60 per cent capacity will go on full time April 1. Rail orders during the week aggregated 65,000 tons, export orders amounted to 40,000 to 50,000 tons and structural steel orders totaled 43,000 tons. Pig iron production in February amounted to 1,674,771 tons as compared with 1,601,421 tons in January.

The Iron Age prices for finished iron and steel and for sheets, nails and wire for the week ending March 3 were as follows:

Fininshed Iron and Steel, Per lb. to large buyers.	March 3. Cts	Feb. 24. Cts.
Bess. rails, heavy, at mill...	1.25	1.25
Iron bars, Philadelphia	1.15	1.20
Iron bars, Pittsburgh	1.10	1.10
Iron bars, Chicago	1.10	1.10
Steel bars, Pittsburgh	1.15	1.10
Steel bars, New York........	1.319	1.269
Tank plates, Pittsburgh	1.10	1.10
Tank plates, New York	1.269	1.269
Beams, etc., Pittsburgh	1.15	1.10
Beams, etc., New York	1.319	1.269
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh	1.25	1.25
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	1.80	1.80
Galv. sheets, No. 28, P'gh...	3.40	3.40
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, P'gh.....	1.40	1.40
Barb wire, galv., P'gh......	2.10	2.00

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 cts.

Railways.—No particular developments of importance in the railway construction field have taken place during the past week. No big jobs have made their appearance and no large contracts are reported. One or two minor undertakings have come up for bids. One of these calls for grading for the Charles City Western Ry.; the contract for this will be let March 10. Another improvement provides for the extension of the Ohio Valley Traction line of Portsmouth, O., from Sciotoville to Hanging Rock. The contract for steel for third tracking a portion of the Broadway elevated in Brooklyn, N. Y., has been awarded to Edwin F. Shoemaker at $37.20 per ton; a contract for seven stations on the Fulton St. elevated line in Brooklyn has been let at $258,664. T. A. Gillespie Co., 50 Church St., New York City, was awarded contract at $554,750 for Section H of Dorchester tunnel for Boston Transit Commission.

Roads and Streets.—A large volume of work in both the highway construction and municipal paving fields is now being advertised for bids. New York State Commission of Highways is asking proposals on 15 contracts covering 59 miles of road; the State Highway Commissioner of Ohio opens bids March 12 on 11 miles of improvements; Lake County, Florida, is asking proposals on road work calling for 1,147,610 sq. yds. of pavement; Duval County, Florida, opens bids March 25 for surfacing 40 miles of highway with brick, asphalt macadam, or other materials; Lowdes County, Mississippi, is asking bids on 22 miles of macadam. On the Pacific Coast many large county road jobs are now ready for bids. The municipal paving jobs are rather small in yardage, but large in number. The contracts let recently include a $97,000 job for East San Diego, Cal.; 40,000 sq. yds. for West Liberty, Ia.; large road lettings by Starke and Putnam counties, Ohio; a $100,000 paving contract for Baltimore, Md., and $125,000 worth of highway construction for Milwaukee County, Wisconsin.

Bridges.—A considerable amount of bridge construction came up for advertising during the past week. The greater number of the structures, however, are small, and no particularly large projects appear to have reached the call for bids stage. Calcasieu Parish, Louisiana is asking proposals on a highway swing bridge, and the bridge committee at Rogersville, Tenn., opens bids March 20 on a 1,600 ft. steel bridge. The contracts for the Columbia River Interstate bridge have been awarded, the total being about $1,305,000. The King Bridge Co., Cleveland, O., at $487,860, was low bidder for the superstructure of the Clark Ave. high level bridge at Cleveland. Central States Bridge Co., Indianapolis, Ind., was low bidder on a steel structure and O'Hagan & Lake, Chicago, Ill., were low bidders on a concrete structure at the letting March 1, at Winona, Minn. Edw. Fay & Sons, Philadelphia, Pa., at $74,812, were low bidders for repairs to the Mullica River bridge for Burlington County, New Jersey.

Waterworks.—The principal waterworks undertaking that came up for advertising during the past week appears to be the construction of the filtered water reservoir for Cleveland, O. This will call for 78,000 cu. yds. of excavation and 26,500 cu. yds. of concrete. Fredonia, Kan., is asking proposals for waterworks improvements to cost $40,000; Holton, Kan., opens bids March 12 on waterworks to cost $50,000. Several smaller cities, also, are calling for bids on new works or extension. E. W. Foley, 71 Wall St., New York City, at $99,000 was low bidder on the Ashley reservoir job at Fitchburg, Mass.

Sewerage.—No especially large sewerage jobs appear to have reached the call for bids stage during the past week. Most of the work advertised is for small systems, extensions, or disposal plants. Upper Darby, Pa., has awarded contracts for sewerage works to cost about $120,000. Philadelphia, Pa., let contracts for the Gunners Run relief sewer in Indiana St., requiring an expenditure of about $200,000; this city also awarded a $158,660 contract for sewer construction in Willow and other streets.

Competition Extraordinary.

Contractors are finding plenty of company at lettings these days. Almost every opening of bids brings together so many bidders that overflow meetings have to be held. On a recent $50,000 culvert letting in an Iowa county 33 bids were received; 20 contractors submitted proposals on an $86,000 bridge for a city in Minnesota; 30 bidders from half a dozen states presented bids for road work for a county in Ohio; on a $100,000 drainage ditch proposition in Wishington 15 firms submitted figures; 14 contractors offered to build a $550,000 tunnel section of the Transit system of Boston, Mass. The unusually keen competition at recent lettings has resulted in many cases in the work going at exceptionally low prices. A number of contracts have been awarded lately at figures that almost lead to the conclusion that the successful bidders expected some good angel to supply them with the necessary material free of cost. Just now many contractors in figuring on a job act as though that particular piece of work was the only one that would ever be let. Contracts have been taken at prices that allow for such a small margin for profit that should anything unforeseen happen some contractors will be wearing sackcloth and ashes for many moons. These conditions will not continue, but while they last municipalities would do well by taking advantage of them. By securing bids on their work at the present time cities can get much lower prices than will be obtainable later on when the real construction season opens up.

Labor Conditions.

Some contractors who can see trouble before it turns the corner are beginning to worry about the possibilities of a labor famine. They point out that the railways in commencing their spring maintenance and other work already have made serious inroads on the available supply of foreign labor in certain localities. They also believe that owing to the European war this supply for some months at least will receive no great number of recruits. A recently issued report of the U. S. Bureau of Immigration shows that there is some ground for this supposition. According to the report, only 30,335 immigrants came to this country during December; in the same month of the previous year 106,701 arrived. Nearly 20 per cent of the total for last December were from Italy, and of the entire number 18,266 were listed as laborers. It is probably true that the number of foreign laborers at present in the country is less than in previous years. This is due in a measure to the trouble in Europe and to a great extent to the dullness of last year in the construction field. Many foreign laborers, the Italians especially, when the first signs of slowing up in construction appear, return to their native countries. A great number of these men cannot now return. A probable active construction season and a possible scarcity of labor make an interesting problem for the contractor.

$2,000,000 of Road Contracts.

One branch of construction, at least, is beginning to make its appearance in accordance with expectations. State and county highway commissions are making a start on this year's program of road improvements. Since the first of March a number of important lettings have been advertised. New York called for bids on 59 miles of improvements, this work representing a probable expenditure of something like $1,000,000. Ohio is advertising about $190,000 worth of road improvements, covering 11 miles of highway. Duval County, Florida, is asking proposals for hard surfacing some 40 miles of road, while another county in that state will open bids in a few days on a contract calling for over 1,147,000 sq. yds. of highway paving. A couple of million dollars' worth of work represented in four lettings is not such a bad showing for this season of the year. It is a pretty good indication of what is to come, for all reports point to there being an exceptionally busy season in the road construction field.

THE $15,000,000 UNION TERMINAL AT ST. PAUL.

First Contract May Be Let Early in Spring.

Station to be Used by Nine Railroads Entering City.

Detailed plans are now being worked out for the new $15,000,000 union passenger terminal at St. Paul, Minn., and as noted in our Feb. 24 issue, it is likely that the first construction work in connection with this improvement will be started this spring. The new station will be located at the site of the old one and will have a 315-ft. frontage on Sibley St., and 220 ft. on Third St.

The present terminal property will be increased in area by moving the channel of the Mississippi River toward the south. This will add about 37 acres to the present property and will permit increasing the mileage of tracks from 9.2 to 24.9. The channel changes will be affected by dredging and will involve the construction of a riprap wall for retaining the fill. The river changes will be the first construction undertaken and it is expected that contracts for the work will be let early this spring.

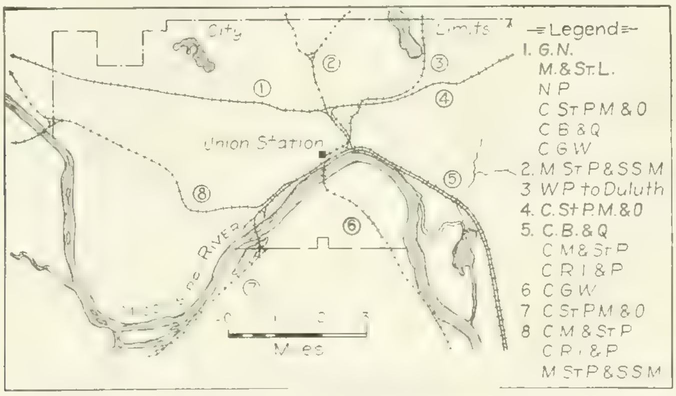
The general plans for the improvements, as submitted to the City Council of St. Paul, provide for a combination stub and through terminal with flexible track connections to the three main approaches, and a 218-car coach yard. It is planned to separate grades at street crossings, and between freight and passenger tracks to as great an extent as conditions will permit. The freight tracks, in general, under the plan will remain as at present on the lower level, while the passenger tracks in the terminal will be elevated and the through tracks carried on a viaduct past the station building.

There will be three main levels in the station. The main waiting room, ticket office, concourses, etc., will be located on the middle level and will give a main entrance from the street at grade. The train concourse will be 60 ft. wide by 350 ft. long, and will give direct access to the 16 stub tracks. The 10 through tracks will be reached by means of a subway concourse 40 ft. by 200 ft., leading from the main concourse. Several street changes are involved. Sibley St. will be carried under the through passenger and freight tracks in order to reach the freight house of the Chicago, Milwaukee & St. Paul Ry. and the public levee. Third St. will be lowered so that a wagon entrance can be provided on the basement level opposite Wacouta St. The top level of the building will be used for offices, meeting rooms, etc.

The baggage room will have an area of 20,000 sq. ft. A subway will extend to the ends of the train platforms and the baggage will be raised by 25 elevators. An area of 46,000 sq. ft. has been provided for mail and express matter, which will be handled in the same way as the baggage.

The station will have a base course of rough pointed Minnesota granite. The exposed portions of the walls will be Bedford or similar stone. The waiting rooms will be finished in red tile. The larger rooms of the station will be equipped with indirect heating and ventilating systems, and will be lighted indirectly by electricity. The power house for lighting, heating and ventilating will be located in the terminal yard.

The terminal will be used by all of the railroads entering St. Paul. An engineering committee representing these roads was in charge of the preparation of the plans. This committee consisted of Ralph Budd, assistant to the President of the Great Northern Ry., C. W. Johnson, Consulting Engineer, Chicago, St. Paul, Minneapolis & Omaha Ry., and C. F. Loweth, Chief Engineer, Chicago, Milwaukee & St. Paul Ry. The new terminal will cost about $15,000,000 and will be constructed by the St. Paul Union Depot Co., of which W. C. Armstrong, Hackney Bldg., St. Paul, Minn., is Chief Engineer.



Location of Union Station and Routes of Railways Entering It.

STATE HIGHWAY CONSTRUCTION IN WASHINGTON.

Bill Passed by House Appropriating $4,000,000.

Allotments of Funds to Various Counties.

A large amount of highway construction will be undertaken this season in the state of Washington. The House of Representatives of the State Legislature passed recently a bill appropriating $4,000,000 from the state road fund for the building of highways. This sum has been apportioned among the various counties and will be expended under the direction of the County Commissioners and the supervision of the County Engineers. The roads constructed under the permanent highway law of the state must have a graded width of at least 16 ft. and a surfaced width of not less than 12 ft. The following summary of completed contracts for permanent highway work from March 8, 1911, to Sept. 30, 1914, will give an idea of the types of construction in general use in this state and their costs:

Type of surface.	Miles.	Completed cost.
Gravel (spread loose)	71.9	$317,879
Gravel (rolled)	25.57	106,606
Waterbound macadam	63.46	320,367
Asphaltic macadam	30.83	249,413
Warrenite	13.39	212,467
Concrete pavement	38.41	447,363
Brick pavement	17.52	455,523

Of the above contracts 147.28 miles were on the line of roads designated by the 1913 Legislature as Primary State Highways. The total cost of this mileage was $1,288,830. The following table shows the permanent highway work under contract on Sept. 30, 1914:

Type of surface.	Miles.	Completed cost.
Gravel (spread loose)	48.08	$260,425
Gravel (rolled)	67.56	298,628
Waterbound macadam	62.09	386,808
Asphaltic macadam	19.30	220,309
Warrenite	2.00*	25,769
Standard asphalt pavement	3.97	59,124
Concrete pavement	16.59†	160,053
Brick pavement	5.24	163,312

*9 ft. width; balance of cost in macadam strip to make 16 ft. surface.

†Includes 4.2 miles of 7 ft. concrete with 14 ft. gravel strip.

The above mileage includes 102.31 miles on Primary State Highway roads, the total contract price for this being $723,331.

The distribution of the $4,000,000 fund among the various counties is as follows:

County.	County seat.	Amount.
Adams	Ritzville	$ 63,000
Asotin	Asotin	11,000
Benton	Prossed	40,000
Chehalis	Montesano	112,000
Chelan	Wenatchee	55,000
Clallam	Port Angeles	37,000
Clarke	Vancouver	56,000
Columbia	Dayton	28,000
Cowlitz	Kalama	41,000
Douglas	Waterville	33,000
Ferry	Republic	9,000
Franklin	Pasco	37,000
Garfield		16,000
Grant	Ephrata	48,000
Island	Coupeville	9,000
Jefferson	Port Townsend	22,000
King	Seattle	735,000
Kitsap	Port Orchard	19,000
Kittitas	Ellensburg	63,000
Klickitat	Goldendale	43,000
Lewis	Chehalis	72,000
Lincoln	Davenport	75,000
Mason	Shelton	19,000
Okanogan	Concully	24,000
Pacific	South Bend	47,000
Pend Oreille	Newport	20,000
Pierce	Tacoma	266,000
San Juan	Friday Harbor	8,000
Skagit	Mount Vernon	66,000
Skamania	Stevenson	14,000
Snohomish	Everett	122,000
Spokane	Spokane	375,000
Stevens	Colville	35,000
Thurston	Olympia	43,000
Wahkiahum	Cathlamet	6,000
Walla Walla	Walla Walla	94,000
Whatcom	Bellingham	89,000
Whitman	Colfax	140,000
Yakima	North Yakima	95,000

HIGHWAY CONSTRUCTION IN INDIANA.

Details of Work Contemplated by 28 Counties.

Gravel—Macadam—Brick—Concrete.

Highway work in Indiana is carried out with the county as a unit. The construction and maintenance of the roads are in charge of the County Commissioners. The principal type of improved roads are gravel and macadam. During the last two years, however, some of the counties have begun constructing bituminous macadam, concrete and brick paved highways. The improvements are carried out by contract. The contracts, as a rule, range from $5,000 to $20,000 in amount.

A summary of the road work to be undertaken this year by 28 Indiana counties is given in Table I. Further details regarding this construction follow:

TABLE I.—ROAD CONSTRUCTION PROGRAM FOR 1915 BY 28 INDIANA COUNTIES.

	Type of road			
County.	Gravel, miles.	Macadam, miles.	Brick, miles.	Concrete, miles.
Adams	..	25[1]	..	..
Clay	9	13	..	2
Dearborn	..	8½[2]	..	1.2
Decatur	.	16[3]	..	..
Delaware	16	17	..	..
Elkhart	12	5[4]	14[5]	3
Hamilton	12[6]	..	..	3[6]
Hancock	6	4½	..	..
Hendricks	10	7	..[7]	..
Kosciusko	31	2		..
Madison	19	..	..	13
Marion	4.5[8]	6.6[9]	..	4.5[8]
Marshall	60	..	.	..
Montgomery	3	6.5[10]	0.5	5.5
Ohio	.	2.3	.	..
Parke	14	..	..	3[6]
Porter	..	15	..	..
Posey	16	..		..
Pulaski	9	9		..
Randolph	9	6	..	..
Rush	..	15	..	..
St. Joseph	8	..	..	12.5
Sullivan	13	21	?	3
Vigo	14.75	5	..	..
Warrick	..	15	.	..
Washington	2	3.5	..	..
Wells	11.2[11]	1.5	..	..
Whiteley	63	12	..	..

[1] 20 to 25 miles. [2] Also 3 miles bituminous macadam. [3] Also 1 mile bituminous macadam. [4] Probable reconstruction. [5] Either brick or concrete. [6] Proposed. [7] 4,000 sq. yds. [8] Petitioned for. [9] Macadam or concrete; petitioned for. [10] Also 4 miles bituminous. [11] 10.7 miles of this is stone road. [12] Also .4 mile of asphalt macadam.

Adams County has $100,000 available for road construction purposes and proposes to build 20 to 25 miles of macadam during 1915. The work will be done by contract, 13 of these already having been let. Another letting was held on March 2. The remainder of the work will be placed under contract in April. Phil J. Macklin, Decatur, Ind., is County Surveyor.

Clay County during 1915 will undertake the construction of 9 miles of gravel road, 13 miles of macadam and 2 miles of concrete. The work will be done by contract, and the lettings will be held in the spring. Geo. A. Sheehan, Brazil, Ind., is County Surveyor.

Dearborn County already has awarded the following contracts for road construction this year: Seven miles macadam in Hogan Township to A. Miller for $15,000; 1½ miles macadam in Lawrenceburg Township to Thomas O'Neall for $13,000; 1.2 miles concrete in Lawrenceburg Township to Tripeer & Son, Peru, Ind., for $21,116; and 3 miles bituminous work in Lawrenceburg Township, to Nugent & Hines for $30,500. A. W. Karstetter, Lawrenceburg, Ind., is County Surveyor.

Decatur County proposes to construct 16 miles of macadam and 1 mile of bituminous macadam. The work will be done by contract. Some of the contracts were let last fall and winter. Bernard Blankman, Greensburg, Ind., is County Surveyor.

Delaware County has awarded contracts for 16 miles of gravel road and 17 miles of macadam for construction during 1915. S. H. Weber, Muncie, Ind., is County Surveyor.

Elkhart County's construction program for the present year includes 12 miles of gravel road, probable reconstruction of 5 miles of macadam, 14 miles of either brick or concrete and 3 miles of concrete. Contracts have been let for the gravel road and for the 3 miles of concrete road. All of the remaining work with the possible exception of the macadam reconstruction will be done by contract. Albert A. Rieth, Goshen, Ind., is County Surveyor.

Hamilton County proposes to construct during the present year 12 miles of gravel road and 2 miles of concrete road. The work will be done by contract. No date has been set as yet for calling for bids. E. A. Baker, Noblesville, Ind., is County Surveyor.

Hancock County will construct 6 miles of gravel roads and 4½ miles of macadam. Contracts for all of this work, with the exception of 3 miles of gravel construction, have been let. The 3 miles of gravel road will be let on April 5. The county has $55,000 available for construction purposes. G. C. Winslow, Greenfield, Ind., is County Surveyor.

Hendricks County has awarded contracts for road construction for 1915 as follows: Ten miles gravel road, 7 miles macadam and 4,000 sq. yds. brick pavement. T. W. Garrison, Danville, Ind., is County Surveyor.

Koscuisko County opened bids March 5 for about 6 miles of gravel road and about 2 miles of macadam. Contracts for other roads will be let later. There probably will be 20 or 25 miles of gravel road construction. Paul Suming, Warsaw, Ind., is County Surveyor.

Madison County will construct approximately 19 miles of gravel road and 13 miles of concrete road during 1915. Contracts have been let and the work will be started this spring. Wm. F. McVaugh, Anderson, Ind., is County Surveyor.

Marion County has not as yet decided upon its construction program for the present season. Petitions have been received for several road improvements, but no decision has been reached as to what will ve done. The types of improvement petitioned for and the total lengths are about as follows:

	Miles.
Gravel	4.5
Macadam or concrete	6.6
Concrete	4.5

If these roads are built the work will be done by contract. The County Commissioners will open bids on March 20 for furnishing 200,000 gals. road oil and 8,000 cu. yds. crushed rock, etc., for the use of the County Highway Superintendent in maintaining improved roads. Charles E. Cheney, Indianapolis, Ind., is County Surveyor.

Marshall County contemplates constructing 60 miles of gravel road during 1915. Contracts for 35 miles of these roads have been let. The remaining 25 miles are to be placed under contract if a township election carries. In addition to the above petitions are in for about 10 miles of other work. Arthur W. Thomson, Plymouth, Ind., is County Surveyor.

Montgomery County's construction program for this year includes the following:

Three miles gravel road, contract let March 2; 4 miles of macadam, contract let on Feb. 2; ½ mile of brick and 5½ miles of concrete, contract let on Feb. 2. In addition there are 4 miles of bituminous road work and 2½ miles of macadam now under construction. Milton L. Nees, Crawfordsville, Ind., is County Surveyor.

Ohio County will construct 2⅓ miles of macadam. The contracts have been let. About $8,000 is available for construction purposes. Geo. H. Keeney, Rising Sun, Ind., is County Surveyor.

Parke County will build about 14 miles of gravel road; contracts for this have been let. It also contemplates the construction of about 3 miles of concrete paving. If decision to built the latter is favorable, the contract will be let about April 1. H. L. Davies, Rockville, Ind., is County Surveyor.

Porter County will construct 15 miles of macadam during the present year. Contracts already have been awarded for 10 miles of the work; the remainder will be let April 5. Guy Stinchfield, Valparaiso, Ind., is County Surveyor.

Posey County has about $50,000 available for road construction purposes. It will build 15 miles of gravel road. Contracts for 8 miles have been let, and 7 additional miles are now being advertised. Thos. J. Johnson, Mt. Vernon, Ind., is County Surveyor.

Pulaski County has awarded contracts for 9 miles of gravel road and 9 miles of macadam. The sum of $45,000 is available for road construction purposes. C. E. Paul, Winamac, Ind., is County Surveyor.

Randolph County will construct 9 miles of gravel and 6 miles of macadam. Contracts will be let this month. A. B. Purdy, Winchester, Ind., is County Surveyor.

Rush County has $72,000 available for road purposes and will construct about 15 miles of macadam during 1915. Most of this work already has been placed under contract. A. Cameron, Rushville, Ind., is County Surveyor.

St. Joseph County will construct, during the present year, 8 miles of gravel road and 12½ miles of concrete road. Contracts have been let. Henderson McClellan, South Bend, Ind., is County Surveyor.

Sullivan County has $224,240 available for road purposes and will construct 13 miles of gravel road, 21 miles of macadam, and 3 miles of concrete. The work will be done by contract. About one-half of the improvements have been let, and the remainder will be advertised this spring. Wm. L. Sisson, Sullivan, Ind., is County Surveyor.

Vigo County proposes the construction this year of 14¾ miles of gravel road and 5 miles of macadam. The work will be done by contract; time for letting has not been set. Herbert C. Anderson is County Surveyor.

Warrick County will build about 15 miles of waterbound macadam. Contracts will be let some time in April and May. Louis Meyer, Boonville, Ind., is County Surveyor.

Washington County will construct 2 miles of gravel road and 3½ miles of macadam. The work will be done by contract, the letting to be held about May 1. John C. Prow, Salem Ind., is County Surveyor.

Wells County's construction program for the present year includes the following:

Location.	Type.	Length, ft.	Est. cost.
Jefferson Tsp.	Stone	[illegible]	[illegible]
Lancaster Tsp.	Stone	3,960	2,967
Jefferson Tsp.	Stone	5,195	3,244
Lancaster Tsp.	Stone	9,430	7,278
Lancaster Tsp.	Stone	[illegible]	[illegible]
Liberty Tsp.	Stone	15,400	10,229
Bluffton	Macadam	1,317	[illegible]
Bluffton	Asp. macadam	[illegible]	[illegible]
Bluffton	Macadam	[illegible]	[illegible]
Bluffton	Macadam	1,368	3,295
Harrison Tsp.	Gravel	2,648	1,932

Bids on the above work, the total estimated cost of which is about $63,000, will be received until March 19 by C. T. Kain, County Auditor, Bluffton, Ind. This is all of the new contract work that will be let this year. T. C. Guldin, Bluffton, Ind., is County Surveyor.

Whitley County during the present season will construct 63 miles of gravel road and 2 miles of macadam. Contracts for this work were let in 1914. J. E. Plummer, Columbia City, Ind., is County Surveyor.

Contracts for 59 Miles of State Highway in New York Advertised.

The first New York state highway letting of the year is now being advertised for bids. The work is divided into 15 contracts, the aggregate mileage amounting to about 59. Several of these contracts involve large amounts of work. The location of the improvements and the number of miles in each are as follows:

County.	Road No.	Name.	Miles.
Allegany	965A	Olri-Cuba	9.52
Cattaraugus	5543	Hinsdale-Franklinville, Part 1	6.98
Cattaraugus	5258A	Little Valley-Randolph, Part 3	5.35
Columbia	1230	Harlemville-Meilenville	4.97
Chemung-Schuyler	5208A	Horseherds-Montour Falls	1.81
Erie	5546	18-Mile Creek-Evans Center	4.48
Franklin	1222	Saranac Lake Village	.22
Jefferson	1225	Lorraine-Worth, Part 1	2.86
Jefferson	1226	Lorraine-Worth, Part 2	2.40
Jefferson	5269B	County Line-Adams Center	.51
Monroe	1237	Pittsford Village	.66
Niagara	758A	Olcott-Lockport, Part 1	8.33
Putnam	909A	Brewster-Carmel	.13
Rensselaer	5533	Rensselaer-De Freestville	2.11
Sullivan	5234	Liberty-County Line, Part 2	8.51

Bids for the above work will be received until 1 p. m., March 23, by Edwin Duffey, State Highway Commissioner, Albany, N. Y.

A $165,000 Bridge Project at Cincinnati, O.

A good-sized bridge undertaking for the city of Cincinnati, O., will be advertised soon. The work calls for the construction of a reinforced concrete bridge on Park Ave. over Kemper Lane at the entrance to Eden Park.

The improvement will include a reinforced concrete structure 360 ft. long and 65 ft. wide, with 40-ft. roadway and 12½-ft. sidewalks. At each end approach fills will be carried for about 50 ft. between reinforced concrete retaining walls of counterfort type. The portion of the bridge over Kemper Lane will be carried by three reinforced concrete arch ribs of 180 ft. clear span between abutments. The remainder of the structure will be of beam and girder construction, 25-ft. spans. The superstructure over the arch ribs also will be of beam and girder construction, 12½-ft. spans.

The roadway descends on a 1 per cent grade towards Eden Park. The improvement includes the relocation of Kemper Lane for a distance of about 500 ft., so that this street will pass under this arch at about the center of the span.

The estimated quantities of the principal items of work are as follows:

Grading, cu. yds.	27,000
Trench excavation, cu. yds.	9,000
Reinforced concrete, cu. yds.	7,000
Bituminous macadam pavement, sq. yds.	7,000
Granite curb, lin. ft.	[illegible]

The total estimated cost of the entire improvement is $165,000. Details, plans and specifications for the work are now being drawn up, but the contracts probably will not be let before May 1. The work is in charge of the Engineering Department of Cincinnati, O., of which F. S. Krug is the Chief Engineer.

Contracts Let for Columbia River Interstate Bridge.

Contracts were awarded a few days ago on the largest bridge undertaking that has come up for letting so far this year. The structure is to be known as the Interstate Bridge. It is to be constructed over the Columbia River to connect Portland, Ore., and Vancouver, Wash. The bridge and approaches are designed for highway and street car traffic and comprise about 5,000 lin. ft. of steel structure and 12,000 lin. ft. of embankment.

The improvement comprises a 12-span and one moveable span structure over the main channel of the Columbia River, 12 girder spans over the Oregon Slough, a girder span and trestle approaches over Columbia Slough and an embankment across Hayden Island. The bridge will have a 38-ft. roadway and one 6-ft. sidewalk. The principal quantities include 9,500 tons of steel, 1,000,000 cu. yds. of embankment and about 29,000 cu. yds. of concrete.

Bids for the construction of the bridge were received by the Interstate Bridge Commission at the County Courthouse, Portland, Ore., on Feb. 23. The contracts were awarded to the following: U. S. Steel Products Co., Portland, Ore., furnishing superstructure for Columbia River spans at $417,300; erecting superstructure, Columbia River spans, Porter Bros., Portland, $99,800; furnishing superstructure for spans over Columbia and Oregon Sloughs, Northwest Steel Co., Portland, $89,140; erection superstructure, Columbia and Oregon Sloughs, Porter Bros., $18,600; Pacific Bridge Co., Portland, Ore., substructure, Columbia River spans, at $319,400, substructure Columbia and Oregon Slough spans, $119,700; embankment over Hayden Island, Tacoma Dredging Co., Tacoma, Wash., $158,200; floor on steel structure, Warren Construction Co., Portland, Ore., $82,800.

The bridge is to be paid for by Multnomah County and Clark County, the former providing five-sevenths of the cost and the latter two-sevenths. The plans were prepared by Waddell & Harrington, Consulting Engineers, Kansas City, Mo.

State Highway Contracts in Ohio to Cost $174,000.

Four state highway contracts are now being advertised for bids by the State Highway Commissioner of Ohio. In all about 11 miles of road are to be improved at an estimated cost of $174,883. The largest piece of work (I C H No. 3) is located in Erie County. It calls for the construction of Section K of the Cleveland-Sandusky Roads in Vermillion Township. In Knox County, Section G of the Mt. Vernon-Coshocton Road in Monroe Township is to be paved with waterbound macadam and brick. This work is known as I C H No 339. The other two contracts are in Mercer County and Tuscarawas County. The work on the first mentioned is I C H No. 73, and is Section F of the St. Marys-Fort Wayne Road in Dublin Township. The improvement in Tuscarawas County is on Section J of the New Philadelphia-West Lafayette Road (I C H No. 408) in York Township. The following table gives some details of the work:

Highway.	I C H No. 3.	I C H No. 339.	I C H No. 173.	I C H No. 408.
Length, miles...	4.32	3.08	1.60	2
Width pavement, ft	16	14	16	14
Width roadway, ft ..	26	26	26	29
Pavement	Conc	*Brick.	Conc	Brick
Estimated cost..	$74,155	$44,892	$23,003	$32,823
Date for completion	Sept. 1.	Sept. 15.	Sept. 1.	Sept. 1.

*Waterbound macadam and brick.

Bids for constructing the bridges and culverts, grading roadway and paving will be received by James R. Marker, State Highway Commissioner, Columbus, O., until 2 p. m., March 12.

As showing the possibilities for tree growth in regions where irrigation has to be depended upon, it is pointed out by the Forest Service that Boise, Idaho, has as many as 94 different kinds of ornamental and shade trees.

PERSONALS

Dr. J. N. Hurty of Indianapolis was elected president of the Indiana Sanitary and Water Supply Association at its latest annual meeting. Dr. Hurty is well known throughout the country for his very effective service as secretary of the Indiana State Board of Health, in which position he has formulated constructive measures for the safeguarding of the public health. For 19 years he has been State Health Commissioner. During that time 14 health statutes have been recommended by the Indiana State Board of Health. All these have been passed and are in operation. These statutes cover almost every phase of administrative hygiene. Two of these laws, namely, The Antitoxin Law and the Rabies Law relate more to cure than they do to prevention and consequently are the most popular.

Dr. Hurty has told many plain truths to the people of Indiana about unsanitary living conditions. Naturally some resentment of this has been shown, particularly in the rural districts. The resentment is giving way to appreciation and gratitude as rapidly as the uninformed become informed. Few men in Indiana are as widely and as favorably known as Dr. Hurty. While best known for his work as State Health Commissioner he has held other important positions. For 15 years he was professor of hygiene and preventive medicine in Indiana University. He was, also, at one time a member of the faculty of Purdue University. Just before his engagement as State Health Commissioner he was City Sanitarian of Indianapolis (1893-1896).

J. N. Hurty

In addition to his active work as member, adviser and officer of The Indiana Sanitary and Water Supply Association, throughout the life of that useful organization, he was president of the American Public Health Association for 1912.

Dr. Hurty is widely known for his scholarly and philosophical public health writings which also possess much literary merit. Nothing in public health literature has been more widely quoted than his fable of the young, overworked mother, who died of tuberculosis in the absence of financial aid from the state, and of the hog who waxed fat and thrived under the protection of the appropriations by the State Legislature. The moral of the fable is: "Be a hog and be worth saving." In discussing some of the aspects of public health work he says:

> It is plain that the most important and the most difficult thing to accomplish is to extract from the minds of the people their confidence and dependencies upon cure. Cure does not get society anywhere. Of course, it is valuable to individuals. The race is not benefited by cure; at least very little. We must depend upon prevention if the race and the nation are to be made stronger.
>
> The Ophthalmia Neonatorum law for the prevention of blindness meets with very little approval and in some localities with opposition. This is strange indeed, when every person fully accepts and advocates the old saying, "An ounce of prevention is worth a pound of cure." Yet for one to stand strictly for the practice of prevention is but to secure the epithet of a crank, while to stand for cure one will be called practical and be paid well.
>
> Of course public health work everywhere is uphill work. The road is indeed a rough one, but in time will become smooth and easily traveled. What the nation needs is more health. With health will come strength, wealth and more happiness. The degenerative forces which tear down the nation and society may be all included under one head, and that is disease.

Mr. Robert M. Feustel has resigned as chief engineer for the Illinois Public Utilities Commission, and will resume his consulting engineering practice with the firm of Sloan, Huddle, Feustel & Freeman of Madison, Wis. Mr. Feustel was formerly assistant chief engineer for the Wisconsin Railroad Commission, and the firm of which he is a member specializes in valuation and rate making studies. Mr. Fuestel is a graduate of Purdue University and has had considerable experience in the construction and operation of electric railways and electric lighting plants in Indiana and Ohio.

Mr. H. E. Smith has been appointed chemist and engineer of tests for the New York Central Railway, and is in charge of chemical and physical testing of materials, mill inspection of materials for locomotives and cars, service trials and various investigations in relation to materials and methods of operation. Mr. Smith graduated from the Massachusetts Institute of Technology, in 1887, and for several years following was assistant chemist for the Chicago, Milwaukee & St. Paul Railway. In 1890 he was made chief chemist for that company, and in 1902 was appointed chemist and engineer of tests for the Lake Shore & Michigan Southern Railway at Collinwood, Ohio.

Mr. Henry V. Macksey, civil engineer of Boston, Mass., and a member of the American Society of Civil Engineers, has been appointed superintendent of public works at Woburn, Mass. Mr. Macksey is an engineer of much experience, having held such positions as engineer in the water department of Boston; superintendent of streets, Boston; construction manager, Buffalo; Lockport & Rochester Railroad; locating engineer, Northern Contracting Co., Atlanta, Ga.; locating engineer, Amazon-Pacific Railway, Lima, Peru; location and construction engineer, Jamaica Railways, Jamaica, W. I.; construction engineer, Western Dominion Railway Co., Alberta; consulting engineer; director of the port of Boston, and principal assistant engineer of construction for the Virginia Air Line Railway. Mr. Macksey is also a member of the New England Water Works Association, the Boston Society of Civil Engineers, and the Massachusetts Highway Association.

Mr. James B. True has been appointed state engineer of Wyoming for a six-year term beginning Feb. 20, 1915. Mr. True received his engineering education partly at the University of Denver and partly at the University of Wisconsin. During his summers, before leaving college, he had gained considerable practical experience by working as a draftsman for a consulting engineer in Denver, and as assistant on construction of a hydro-electric pipe line for the Colorado Fuel & Iron Co. After leaving Wisconsin University in 1907 Mr. True was employed by the Central Colorado Power Co. as office engineer on a hydro-electric tunnel at Shoshone, and field engineer on location and inspection of towers, cables, etc. Most of his succeeding experience has been in the field of drainage and irrigation work. In the summer and fall of 1908 he was resident engineer with the United States Sugar & Land Co., Garden City, Kans., on topographical surveys, reservoir, ditch and canal location, estimates, etc. In 1909 he was engineer with the Antlers Orchard Development Co., and in 1910, draftsman and office engineer for Field, Fellows & Hinderleider, consulting engineers of Denver, engaged in similar work. For about two and one-half years he was division engineer with the Southern Alberta Land Co., Medicine Hat, Alta., engaged in reclamation of 400,000 acres of land. Mr. True had complete charge of location and construction of 70 miles of the main canal, topography, location and construction of canals, reservoirs and distribution system for the 160,000 acres of his division. Since March, 1913, Mr. True has been assistant state engineer for Wyoming, where his special experience has been of much value.

Mr. H. E. Breed has been appointed first deputy highway commissioner for the State Commission of Highways of New York, and has general charge of all construction plans, etc. The appropriation for this year is $10,000,000, and many of the roads begun under last year's appropriation are to be finished this year. Mr. Breed was in the Department of the State Engineer of New York from 1901 to 1908, holding various positions up to that of assistant engineer. He was auditor for that department from 1909 to 1910, and the following year was assistant chief engineer for the Coleman du Pont Road, Inc. Since that time he has been in practice as consulting engineer, on highway improvement and development work.

OBITUARIES

George E. Dwyer, formerly city engineer of Marion, Ohio, and later engineer at Dayton on the Miami & Erie Canal, died at Cincinnati Feb. 28. Mr. Dwyer graduated in civil engineering from the Ohio Northern University at Ada, and practiced in Ohio for about eight years prior to accepting the position at Marion. He was for several years county surveyor of Marion County.

Col. James B. Quinn, Corps of Engineers, U. S. A., retired, died at his home in Woodstock, Md., Feb. 23. Col. Quinn graduated from West Point in 1866, and was assigned to the engineer corps as second lieutenant. He was assigned to the improvement work on Michigan harbors, and later was engaged in the survey of the Union and Central Pacific railways. He was retired from active service in 1907.

William F. Gurley, president of the firm of W. & L. E. Gurley, makers of mathematical and surveyors' instruments, Troy, N. Y., died on Feb. 17 at Atlantic City. Mr. Gurley was born in Troy in 1860, and was the son of Lewis E. Gurley, one of the founders of the well-known firm. He graduated from Williams College, entering the Gurley works at once and making himself thoroughly acquainted with the practical details of the business. Upon the death of his uncle, William Gurley, he entered into partnership with his father.

CIVIL SERVICE NEWS

The United States Civil Service Commission announces examinations as follows:

Landscape Architectural Designer, Engineer Department at Large; $90 per month. April 7.

Expert Landscape Architectural Designer, Office of Public Buildings and Grounds; $200 per month. April 6.

Assistant Inspector of Engineering Material; $4.48 per diem. April 7.

Electrical Draftsman, Radio; $4 per diem. April 7-8.

Subinspector, U. S. Navy Yards; $4.48 per diem. April 7.

New President of American Concrete Institute.

Leonard Chase Wason, president, treasurer and general manager of the Aberthaw Construction Co. of Boston was elected president of the American Concrete Institute at the annual meeting in Chicago, Feb. 10. Mr. Richard Humphrey, the retiring president, held that office for 10 years, or since the organization of the Institute, and had refused to stand for reelection. Mr. Wason has been a devoted and able participant in the work of the Institute. For seven years he has been on the board of direction and for three years past has been vice-president. He is recognized as one of the foremost exponents of efficiency in reinforced concrete construction in this country.

Mr. Wason graduated from the Massachusetts Institute of Technology in 1891 and has been engaged in engineering work directly or indirectly ever since. For the past 21 years he has specialized in reinforced concrete work. He has been responsible for the design and execution of over $10,000,000 of concrete work, including many of the most important structures in the United States, and especially the earlier ones.

Leonard C. Wason.

Mr. Wason organized the Aberthaw Construction Co. of which he has been president since 1895. The company has executed many million dollars worth of work of every variety in which cement is used. during the past 21 years. Among these structures are numerous bridges, mills, residences, etc., in the New England states, the Harvard Stadium, and the largest concrete standpipe in the world. For seven years the company has specialized on reinforced concrete in industrial work, chiefly mills and hydro-electric development. We learn that the company has under contract at present one very large dam, many mill buildings and several school houses.

Mr. Wason is a director of the Contractors' Mutual Liability Insurance Co. and a member of the Boston Society of Civil Engineers. He is also author of the Engineers' Handbook of Reinforced Concrete, published in 1905.

Professor William K. Hatt of the civil engineering department of Purdue University and Mr. Henry C. Turner, president of the Turner Construction Co., were elected as vice-presidents of the American Concrete Institute. Mr. Robert W. Lesley of Philadelphia is treasurer and Mr. Charles L. Fish is secretary. Mr. Fish is a graduate of Worcester Polytechnic Institute and has been employed both as engineer and in the sales department by Milliken Brothers. Recently he has been with Emerson & Norris, artificial stone manufacturers.

Construction About to Start on $1,750,000 Highway System of San Bernardino County, California.

San Bernardino County, California, is about to commence construction work on the extensive system of highways to be built with the proceeds of the $1,750,000 bond issue. The first $500,000 installment of these bonds was sold Feb. 15 to the Anglo & London-Paris Bank of San Francisco and brought a premium of $17,338. The County Highway Commission has selected 31 miles of roads for improvement first, and work on these will be started in the immediate future. The first highways to be improved are as follows:

	Miles.
Base line, San Bernardino east to Palm Ave., Highland	4
Colton Ave., San Bernardino, to Redlands	4.5
Colton Ave., San Bernardino, southwest to Colton City	1.7
Colton Ave., Colton, to Riverside County line	2.7
Colton Ave., Colton, to Cedar Ave., Bloomington	3.5
San Bernardino Ave. through Rialto	1.5
Archibald Ave., Cucamonga, to Colton Ave.	3.5
10th St., Upland, to Los Angeles County line	3
Euclid Ave., Ontario, south	3
Central Ave., to Chino	2.3
Silo Ave., Chino, to Euclid Ave.	1.25

The above highways are to have a 20-ft. roadway, of which 16 ft. will be concrete. In order to furnish a comparison of the cost of doing the work by day labor and by contract, one-half of the first roads will be constructed by the first method and the remainder by contract. The Highway Commission will furnish the cement to the contractors and on March 8 opened bids for supply of 100,000 to 200,000 bbls. of this material. The Commission also opened bids for furnishing road rollers and concrete mixers for equipping the county crews that will do the day labor work. Other materials on which bids were opened March 8 included the furnishing of corrugated iron pipe, 50,000 cu. yds. No. 1 Class B rock, 50,000 cu. yds. No. 1 Class A rock, 20,000 cu. yds. No. 2 Class A rock, 5,000 cu. yds. No. 3 Class A rock, 40,000 cu. yds. gravel and 40,000 cu. yds. sand. R. H. Mack, San Bernardino, Cal., is Secretary County Highway Commission.

Steel Drums Preferred for Shipping Cement.—American cement imported into Costa Rica is used chiefly by the railroads and the United Fruit Co., immediately on receipt. German cement is imported by the dealers who carry large amounts for several months at a time. On the part of the dealers, according to a consular report, there is a strong prejudice against the wooden barrel, and they are willing to pay the additional cost of 32 cts. per barrel to obtain the steel drums. American cement manufacturers have thus far refused to meet local demands by shipping in steel drums, and the trade has suffered as a result. The American manufacturers insist that they have an excellent tongue-and-groove barrel which is in every way equal to the steel drum, but actual experience does not prove this to be a fact. The loss in shipment with steel drums is practically nil, and there is no subsequent deterioration caused by the dampness of the long rainy season, while with shipment in wooden barrels there is said to be a loss of at least 10 per cent in transportation, which is materially increased by the subsequent hardening of the cement in the barrel during the seven or eight wet months of the tropical year.

The steel barrels are made of rather thin material, and on being dropped heavily crush a little, but do not break or open and admit moisture. Wooden barrels, with equal treatment, no matter how well made, become loose, if not entirely broken, and expose the contents to subsequent deterioration. A careful review of the market indicates that the matter of the steel barrel is the only obstacle that prevents American manufacturers from securing all of the cement trade of this and other Central American countries. English, Belgian, and German exporters will supply the steel barrel whenever it is asked for.

RAILWAYS

BIDS ASKED.

Ontario

Toronto, Ont.—Until noon, March 16, by Mayor T. L. Church, Chairman Board of Control, for furnishing track material, overhead line material and oak ties for construction Lanstowns Ave. car line. Advertisement in this issue.

PROSPECTIVE WORK.

Arkansas:

Trumann, Ark.—Poinsett Lumber & Manufacturing Co. is having surveys made for 8-mile extension of its logging road to Harrisburg.

California:

Mill Valley, Cal.—Marin County Electric Ry. Co. is reported to have secured enough stock subscriptions to warrant beginning work on its proposed line between this city and Sausalito. W. Wesley Hicks is interested.

Connecticut:

New Britain, Conn.—Application has been made for charter for New Britain Street Ry. Co., proposing line in Northwestern section of city. William J. Farley, New Britain, is interested.

Georgia:

Byronville, Ga.—Georgia Lumber Co. contemplates extending its logging road to timber tract in Sumter County.

Iowa:

Charles City, Ia.—Charles City Western R. R. has taken bids for grading and bridge work for extension from Charles City to Miles Township, 8 miles, and will let contract March 10. Work is now underway on electrification of present line, this improvement being in charge of R. A. Anderson, Waterloo, Ia. E. R. Erusberger, Charles City, Ia., is General Manager of railway.

Kentucky:

Lexington, Ky.—A $7,500,000 bond issue of Lexington & Eastern R. R. is reported to have been sold. It is stated that part of proceeds will be used for extensions into Letcher and Knott County coal territory, near Rockhouse Creek.

Maryland:

Cumberland, Md.—Western Maryland Ry. is reported to contemplate construction of spur from its Connellsville Division into Jenner-Quemahoning coal field in Somerset County, Pennsylvania.

Michigan:

Owosso, Mich.—Michigan United Traction Co., Jackson, Mich., is reported contemplating beginning work this spring on extension from Owosso to Saginaw, via Henderson, Oakley and St. Charles.

Minnesota:

Minneapolis, Minn.—Red River Valley R. R. has been incorporated and proposes a line from Fargo, N. Dak. to Winnipeg. W. H. Graves, C. M. Drew, Minneapolis, and Robert Hamilton, Milwaukee, Wis., are incorporators.

North Carolina:

Edgemont, N. C.—Application has been made for charter for railway to extend from this place to Newland, 21 miles. W. H. Ragland and J. Robert Campbell, Newland, and W. W. Barber, Edgemont, are interested.

North Dakota:

Beach, N. Dak.—It is reported that if subscribers to right of way fund will pay 80 per cent of their subscriptions by June 1 the Northern Pacific will build its extension south of Burkey and Ollie and will have it in operation by Nov. 15.

Ohio:

Portsmouth, O.—Ohio Valley Traction Co., R. D. York, General Manager, is reported to have taken bids for its extension from Sciotoville to Hanging Rock.

New Athens, O.—Arrangements are underway for financing Adena, Cadiz and New Athens Ry., proposing a line from Adena to coal fields in Harrison and Belmont Counties. Short Creek Coal Co., has filed mortgage providing for $600,000 bond issue for the line, which will be a feeder for Wheeling & Lake Erie R. R.

South Dakota:

Mitchell, S. Dak.—Fairmont & Veblen Ry. is reported to contemplate building line from Mitchell to Wheeler, grading to be started this spring. J. Rosholt, Fairmont, N. Dak., is president.

Texas:

Palestine, Tex.—Bill is before legislature to appropriate $600,000 for extension of Texas State R. R. from Palestine to Dallas, 100 miles. Chas. Hurdleston, Rush, Tex., is manager.

BIDS OPENED; CONTRACTS LET

Massachusetts:

Boston, Mass.—T. A. Gillespie Co., 50 Church St., New York City, for $554,750, awarded the contract by the Boston Transit Commission for Section H of the Dorchester tunnel.

New York:

New York, N. Y.—John Thatcher & Son, New York City, have been awarded contract at $258,664, for 7 stations on Fulton St. elevated railroad in Brooklyn.

New York, N. Y.—Lewis F. Shoemaker & Co. have been awarded contract at $37.20 per ton for supplying steel for third tracking Broadway elevated railroad from Myrtle Ave. to Aberdeen St., Brooklyn.

ROADS STREETS

BIDS ASKED.

Connecticut:

Meriden, Conn.—Until 6 p. m., March 23, by W. S. Clark, Supt. Public Works, for paving State St. with wood block and vitrified brick.

District of Columbia:

Washington, D. C., Until 2 p. m., March 15, by District Commissioners, for grading streets requiring 30,000 cu. yds. excavation.

Florida:

Jacksonville, Fla.—Until March 25, by County Commissioners, E. A. Ricker, chairman, for surfacing with vitrified brick, asphalt macadam or other material, about 40 miles of road.

Tavares, Fla.—Until April 15 (readvertisement) by County Commissioner, H. H. Duncan, Clerk, for system of roadways, the work including 1,091,046 lin. ft. of roadway, 329,630 cu. yds. excavation, and 1,147,610 sq. yds. pavement. Bids are asked on sand-clay shell, modified asphalt, waterbound macadam, macadam with Rocmac binder, and oiled macadam. The type of surfacing will be determined after the bids are in. It is desired to let the contracts in as large sections as possible. J. B. McCrary Co., Engineer, Third National Bank Bldg., Atlanta, Ga.

Georgia:

Waycross, Ga.—Until 7:30 p. m., March 16, by A. C. Lowther, City Clerk, for 11,000 sq. yds. of brick pavement.

Illinois:

Highland, Ill.—Until 2 p. m., March 27, by Louis Lory, Jr., Town Clerk, for 5,800 ft. of 9-ft. cement road, with 3-ft. macadam shoulders. W. E. Howden, County Superintendent of Highways, Edwardsville, Ill. Advertisement in this issue.

Moline, Ill.—Until 10 a. m., March 17, by Board of Local Improvements, Lyle Payton, secretary, for 936 sq. yds. reinforced concrete pavement, and 37,600 sq. yds. brick pavement.

Aurora, Ill.—Until 10 a. m., March 13, by Wm. C. Flannigan, Town Clerk, for furnishing 3,600 bbls. cement for concrete road construction in Aurora Township. Further information may be obtained from Geo. N. Lamb, County Superintendent of Highways, Geneva, Ill.

Rockford, Ill.—Until 11 a. m., March 15, by W. W. Bennet, president Board of Local Improvements, for 6,500 sq. yds. brick pavement on Melrose St., 5,900 sq. yds. brick pavement on Clinton St. and 9,600 sq. yds. macadam on Prospect St.

Indiana:

Ft. Wayne, Ind.—Until 10 a. m., March 31, by Will Johnson, County Auditor, for furnishing crushed stone for road construction.

Richmond, Ind.—Until 10 a. m., March 18, by Alfred Bavis, president Board Public Works, for paving several streets.

Salem, Ind.—Until April 5, by I. H. Rutherford, County Auditor, for two roads in Washington Township.

Terre Haute, Ind.—Until 11 a. m., March 27, by N. G. Wallace, County Auditor, for two gravel roads.

Newport, Ind.—Until 10 a. m., April 5, by Roy Slater, County Auditor, for gravel road in Highland Township.

Iowa:

Burlington, Ia.—Until 9 a. m., March 18, by H. G. Vollmer, City Engineer, for 16,000 sq. yds. concrete pavement. Advertisement in this issue.

Perry, Ia.—Until 8 p. m., March 11, by City, for 12,800 sq. yds. pavement; bitulithic, concrete, vitrified block, bituminous concrete, sheet asphalt, vertical fibre block, wood block or Dollaway. Chas. E. Wilson, engineer.

Kansas:

Topeka, Kan.—Until 2:30 p. m., March 11, by C. B. Burge, City Clerk, for paving certain streets with asphalt concrete; also for paving with brick.

Topeka, Kan.—Until 2:30 p. m., March 11, by C. B. Burge, City Clerk, for paving on 11th St. with asphaltic concrete.

Louisiana:

Lake Charles, La.—Until 10 a. m., April 6, by Calcasieu Parish, Police Jury, E. C. House, Clerk, for the construction of highways Nos. 5 and 7. Approximate estimate of quantities: No. 5—Clearing 80 acres; grubbing 600 stations; excavating 90,000 cu. yds.; 900 lin. ft. 18-in. vitrified pipe. No. 7—clearing 25 acres; grubbing 400 stations; 48,000 cu. yds. excavation; 700 lin. ft. 18-in. vitrified pipe, and 5,000 cu. yds. embankment.

Massachusetts:

Boston, Mass.—Until noon, March 12, by D. Frank Doherty, Supt. of Supplies, for furnishing 200,000 gals. of emulsified road oil.

Minnesota:

St. Paul, Minn.—Until 10 a. m., March 15, by Aug. Hohenstein, City Purchasing Agent, for furnishing 1,000 tons limestone dust, 1,000 tons ⅜-in. binder stone, 950 cu. yds. crushed limestone, 41 cars crushed granite, 13,000 cu. yds. 1½-in. crushed rock, 3,000 cu. yds. asphalt sand and 4,500 cu. yds. screened sand.

St. Paul, Minn.—Until 10 a. m., March 15, by Aug. Hohenstein, City Purchasing Agent, for grading and improvement of Arcade St. and Lewis and Mabons addition alley.

Minneapolis, Minn.—Until March 15, by A. P. Erickson, County Auditor, for grading and macadamizing Road No. 296.

Mississippi:

Columbus, Miss.—Until March 24, by Good Road Commission of Second District, Lowndes County, for 22 miles of macadam roads. Gus E. Hauser, Jr., Engineer, Columbus, Miss.

Missouri:

Kansas City, Mo.—Until 2 p. m., March 16, by Park Commissioners Thomas C. Harrington, Secy., for concrete sidewalk on west side of a boulevard along Belmont Ave.

New Mexico:

Silver City, N. Mex.—Until March 15, by City Clerk, for paving about 12 blocks of

New Jersey:

Millburn, N. J.—Until 8 p. m., March 22, by Millburn Township Committee, Milton R. Silance, Clerk, for the laying of a Portland cement curb on both sides of Millburn Ave., between Holmes and Spring Sts., and for cement sidewalk on north side of same thoroughfare, Main St. westerly to Essex St.

New York:

Albany, N. Y.—Until 1 p. m., March 23, by State Commission of Highways, L. J. Morris, secretary, for 15 contracts, aggregating 59 miles, for highway improvement.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Cost of Construction

Volume XLIII. CHICAGO, ILL. MARCH 17, 1915. Number 11.

"Colonel Goethals's Own Story."

In the March number of *Scribner's Magazine* we have the first of a series of articles by Colonel Goethals on the Panama Canal. Beginning with a brief review of the steps that led to his appointment as chief of the canal work, he passes on to a rather extended defense of the plan of building the canal by day labor forces rather than by contract. He says:

> I had never held the opinion that it is, generally speaking, more economical or advantageous to the government to do its work by contract, basing my conclusions not only on experience gained by doing work in both ways, but from handling all matters relating to contracts for work connected with fortifications and rivers and harbors under the Engineering Department at Large, during upward of three years, while on duty as assistant to the Chief of Engineers, United States army.

This statement clears up at once the reason for the abandonment of plans to build the canal by contract. His predecessors, Wallace and Stevens, both railway engineers of great experience, had favored construction by contract, and Colonel Goethals adds:

> Not only were the President (Roosevelt) and Secretary of War (Taft) prejudiced in favor of the contract system, but the former had assured me that the general opinion was on the same side.

Now that the work is done he remains of the same opinion as to the wisdom of building by day labor. He says:

> Considering the work as a whole, were it to be done over in the light of the experience gained by its construction, I would advocate employing again the method that has been followed.

Following this statement one naturally expects to find some comparisons of unit costs to prove the alleged economy of the day labor system on the canal. But no comparisons are given, because, he says, none are possible.

> From the very nature of the case it is impossible to say whether the work has been done more cheaply or more quickly than it could have been done by contract if the plan favored by Mr. Stevens had been adopted, for comparison is impossible.

This last statement should not be forgotten, for in the future the construction of the Panama Canal by day labor will often be cited as *proof* of the economy of that method. Colonel Goethals asserts that no such proof can be secured, "for comparison is impossible."

The theoretical reasons that Colonel Goethals advances in favor of the day labor system can all be, and indeed all have been, met by equally convincing arguments to the contrary.

His added statement that, save for some changes, the canal was built within the estimated cost is not a new statement. It is apt, however, to be very misleading to those who do not know that he does not refer to the original estimate of 1906, under which the canal project was undertaken by the government. In 1908 a revised estimate of cost was made, based on the high unit costs that had been incurred under the day labor system. Evidently it is this revised estimate to which Colonel Goethals refers, although he does not specifically say so.

The total cost of the canal has been approximately $375,000,000, not including interest during construction. At 3 per cent per annum on the funds tied up in the canal work we estimate that interest during construction would amount to $50,000,000, making a grand total construction cost of $425,000,000.

For a good many years to come the tolls will probably not pay 3 per cent interest on this investment. Therefore this "development cost" may itself become a very large sum. Great as it is, the investment will undoubtedly prove profitable to the country before many years. But the unprofitable development period will be a national object lesson in teaching the general public what railway officials mean when they say their "development costs" have been enormous.

The Immediate Problem in Irrigation Water Measurement.

Studies of irrigation water measurement are attaining volume. There is need now of the direction of invention toward perfecting measuring devices. At present there is no device for measuring irrigation water which combines the essentials of accuracy, low cost, automatic registry and applicability to all conditions. This is the main general fact determined by the tests which are outlined in another section of this issue. In passing it may be noted that these tests are the first recorded work of a testing station which is destined to produce, as time goes on, exact information concerning a class of devices which the irrigation engineer has, in the past, had to take largely on speculation.

There is coming a time not so far ahead when no irrigation works will be planned without full consideration of necessary means for measuring the water supplied. As an example of what is bound sooner or later to occur in every extensively irrigated state one may cite the state of California. In California for a longer time than in any other state water for irrigation has in many places been demanded in volumes close to or in excess of the supply. This has raised the price of water to very high figures and this in turn has brought a demand from both seller and buyer for careful measurement of water. Finally the step has been taken by law of placing in charge of a central public authority the power to fix rates charged for irrigation water. With a law fixing rates for supplying a public service there must be means for exact measurement of the service supplied.

As the town dweller now pays for metered water, metered gas and metered electric current, so the time is coming when the irrigated land owner will pay for metered irrigation water. But the problem of metering irrigation water is by no means the simple problem that the metering of domestic water supply is. Some of its complexities are so well indicated in the report to which we refer above that we quote briefly as follows:

> While extreme accuracy is not expected and thus far is almost never reached, measurements within, say, from 2 to 5 per cent of correct are reasonable to expect, and no device can be considered very satisfactory that does not accomplish such a result. Sometimes, and especially in the flatter valleys, irrigation ditches are but very little higher than the land to be watered, making measurement over a weir or other device requiring a free over-fall of the water impossible. In such cases some form of the submerged orifice or some kind of mechanical registering meter must be used. With almost any one of these, silt or debris carried in the water, as well as temporary changes in the canal or ditch above or below the measuring point (as from checking up the water to get it on to the higher land) sufficiently change conditions to alter results and to impair the accuracy of measurements if they are not taken account of. An additional element of difficulty is found in the fluctuations in flow that almost invariably occur on every system, the same device sometimes being required to measure less and sometimes more than the quantity it is best suited to take account of. Besides measuring water with reasonable accuracy, under sometimes widely varying conditions, a satisfactory device for taking account of farm water deliveries must be extremely simple in design, and be made of materials that are available and inexpensive. It should at least in part be susceptible of construction by the farmer to be served, and to be widely used, should not cost above, say, from $25 to $50.

The need of the irrigation engineer is now not argument to prove the desirability of measuring irrigation water but a measuring device which will meet the complex requirements to be satisfied. Invention has in this task a wide opportunity.

Wear of Pipe and Trough Conveyors for Concrete and Concrete Materials.

The successful conveying of concrete materials and particularly mixed concrete in pipe lines and inclined troughs or chutes has been a notable development in the last few years in concrete engineering. The various problems of size and support of pipes and troughs, shape of troughs, consistency of mixture and general procedure have been very completely solved, but how to reduce wearing of pipes and troughs is still demanding serious study. Old dredge men who have pumped mixed clay and gravel through steel pipe know well its astonishing capacity at times for cutting the best of steel into ribbons. Concrete physically is not greatly different from gravelly clay and its abrasive powers should be much the same. At any rate concrete when run or driven through chutes and pipe lines does wear them out and oftentimes does it in a very short time. The citation of a few examples will perhaps best present the condition encounterd.

In lining pressure tunnels on the Catskill Aqueduct concrete materials were in several places fed down shaft through steel pipe to mixers at the bottom. In one case recalled, an 8-in. pipe was used and in another case a 15-in. spirally rivited steel pipe. In both cases excessive wear put pipe delivery out of competition as an economic means of conveying concrete aggregates great vertical distances. Incidentally clogging occurred so frequently that, putting excessive wear aside, pipe chutes were a failure.

On recent tunnel work in San Francisco, placing concrete lining by pneumatic mixer and conveyor, very interesting studies of pipe wear are reported. An 8-in. steel pipe was used for conveying and 16-cu. ft. charges were forced through the pipe under 120 lbs. air pressure with velocities of 75 to 100 ft. per second. On level straight lines ordinary 8-in. flanged connection steel pipe not quite new had a life of about 6,000 cu. yds. of concrete conveyed. The same pipe on an upgrade of 7 per cent wore through first on the top. Threaded connections proved least durable; the thinning of the section by threading resulted in rapid cutting through at the joints. At bends, 4-ft. radius, ½-in. steel pipe cut through in instances in 12 hours continuous conveying and averaged only 60 hours life.

Records of gravity conveying of concrete in open trough inclined chutes may be summarized about as follows: No. 14 gage blue annealed steel open trough chutes have in instances cut through small holes with 1,500 cu. yds. of concrete conveyed, and there are recorded instances of such chutes having carried 20,000 cu. yds. without wearing holes.

The examples selected, it must be remembered, are purposely examples of failures. They are chosen to show the worst results likely to be experienced in wear of pipe and trough conveyors. Ordinarily the contractor will not experience anything like such adverse conditions. Were this not true these conveying methods would never have attained the extensive use that they have. When excessive wear occurs the records, though they are unfortunately very meager, indicate that it occurs because of exceptional circumstances.

As indicated by the example cited, pipe line wear is greatest at bends, at thin spots like threaded joints and on up-grades. Trough chutes cut through first at dents or bumps or where there are "soft spots" in the rolled plate. Again the character of the aggregates affects greatly the rate of wear. For example pit run gravel will cause least wear, broken stone causes more rapid wear, and slag causes extremely rapid wear. Velocity of travel of the concrete is another factor of importance. Driving a batch of concrete through a closed pipe under crowding pressure at a speed of over a mile a minute is a severe abrasive action for any steel to resist. The wonder is that the destruction is so small as it is. Speed and pressure of flow increase materially the rate of wear of pipes and chutes.

The causes named for excessive wear indicate the possible remedies. At bends in pipe lines, for example, elbow sections of special pipe may be used. Cast manganese steel bends were finally adopted on the San Francisco tunnel work previously named and despite their greater expense proved more economical than ordinary steel elbows. It might even be economical when long use is expected to adopt alloy steel or special steel pipe for the line as a whole. Another remedy is a special joint construction, one which will not produce a thin spot or an irregularity which will intensify the wear locally.

Open trough chutes, inclined so that flow is by gravity, present a different problem. Good uniform quality steel plate shaped smooth and kept undistorted by denting or buckling is the first requisite. Where this will not serve, resort to interlining or to alloy steels is probably the only solution unless change is possible to a smoother aggregate or to reduced chuting speeds. Inquiry of one of the leading makers of concrete chutes, the Insley Mfg. Co., brings out data on relining chutes which contractors will be interested in noting.

For the ordinary job the relined chute is not advisable because of the increased weight. The standard untrussed unlined chute of No. 14 steel weighs from 20 to 30 lbs. per lineal foot so that the ordinary 30-ft. section weighs about 450 lbs. A 50-ft. trussed section without lining weighs 905 lbs. These weights are about as great as the contractor can handle well. No. 14 bottom liner plates 12 ins. wide add about 3½ lbs. per lineal foot or 165 lbs. to a 50-ft. section. Taking into account all the factors causing wear it is probable that a lined chute will wear three times as long as one without lining. Also relined chutes are less liable to become dented and if the plates contain soft spots they are not likely to coincide in locations. For work of considerable volume lined chutes are practically always advantageous.

Broadly speaking the statements made indicate an increased life due to relining which well repays the greater cost and weight wherever increased life will save renewal. The notion occurs that perhaps the same result could be obtained without the burden of increased weight by using manganese steel. Manganese steel plate is now being rolled with high success and concrete workers are already familiarized with its use in shovel blades and for the stirring plates of mixers. For chutes and pipe lines for carrying concrete nothing presents greater claims for investigation than manganese steel.

A New York Newspaper Nominates an Engineer for a Public Service Commissionership.

It is a matter worthy of note that one of the great dailies of New York City advocates the appointment of an engineer as chairman of a state Public Service Commission. It seems likely that at least four of the five State Commissioners of the First District will be forced out of office by the new governor of the state. Commenting on this contingency the *New York Evening Post* says:

> As to the question of appointments, we sincerely trust that the Governor will not appoint Mr. Hayward to a Commissionership. It would be a bad precedent to establish, this putting an investigator into the office he has investigated; besides, there are plenty of other men who, with no disrespect to Mr. Hayward, would bulk larger and carry far more weight in the public eye. Is there no engineer of high standing available as chairman, of the type of President Humphreys of Stevens Institute?

Mr. Seth Low, former mayor of New York and ex-president of Columbia University, testified recently before an investigating committee of the state legislature to the effect that the members of the Public Service Commission of the First District had lacked the necessary training and experience. He voiced the judgment of thinking men when he strongly advocated the selection of the most competent men available for such positions. Certainly the fact that a man has practiced law is not a sufficient qualification in itself, as many governors seem to have thought when selecting public service commissioners.

It may be said that to have practiced engineering is not a sufficient qualification either. And that is true. But an engineer who is judicial in temperament, who has been a student of public utility regulation, and who has a strong, upright character, would make excellent material for a commissionership. The governor of Connecticut has recently selected such an engineer as a public service commissioner, and it is to be hoped that the governor of New York will do likewise.

Doubtless engineers in New York state will urge upon the governor such an appointment. Would it not be well for them to secure the assistance of the daily press in furthering this object? The *Evening Post* has already led the way, and other papers might be induced to comment favorably upon the creation of a public service commission composed largely of engineers of high standing. New York is rich in engineers competent to fill such commissionerships with great effectiveness. Publicity of the right sort can make this fact generally known.

Comprehensive Charts for Designing Reinforced Concrete Beams.

For the solution and explanation of many problems a graphical analysis is greatly superior to any other process. The real danger of a graphical solution, however, lies in the inability of many men to recognize in it anything more than a routine procedure of drawing straight lines and curves—they do not at all times realize that a problem is being completely analyzed. In our issue of Aug. 5, 1914, we published a comprehensive chart for designing reinforced concrete beams, which, together with the chart given in the "Buildings" section of this issue, deserve the careful study of all structural engineers. Both charts are original and involve features more comprehensive in scope than any diagrams heretofore published. They show, in a graphical way, the mathematical skeleton about which all our rational processes of reinforced concrete designing are built. In the form in which the charts are shown, they constitute an efficient and labor-saving means of solving problems relative to the design of all types of reinforced concrete beams. By following up the suggestions contained in the explanation of the two charts mentioned, as regard extensions of their scopes, they also furnish efficient means of investigating non-homogeneous beams of all kinds. The charts have been reproduced to a scale sufficiently large to permit their direct application to problems of reinforced concrete design. The author of these charts deserves credit for the original and efficient manner in which he has handled his subject.

WATER WORKS

Economy Effected in the Use of River Sand as a Filter Medium at Moline, Ill.

In the selection of sands for use in filters the common practice has been to choose the uniform kinds usually obtained from banks or at the sea coast. Bank sands are found in various parts of the country, yielding a product which has proved very efficient as a filter medium. Bank and coast sands are generally very expensive. To avoid this cost other sands are gradually coming into use, notably river sand. If a river sand can be found free from mud and other objectionable matter and of a uniform size it is satisfactory for filter use. The cost of removal of the clay, mud and other foreign matter present may offset the lower first cost of river sand and make the bank sand cheaper in the end. The present article, based on a paper by L. A. Fritze, City Chemist of Moline, Ill., before the recent annual meeting of the Illinois Section of the American Water Works Association, gives some cost data on the use of river sand for water filters at Moline and Rock Island, Ill.

River sands have been in use in a few slow and rapid sand filters from seven to twelve years, and the results prove that a satisfactory effluent can be obtained through this medium. Moreover, since the introduction of chlorine sterilization as an adjunct to filtration the necessity for a sand of such high merit as formerly is not now of such exacting importance. However, the size of the sand must be considered, for one too fine will clog quickly, and one too coarse will not yield a satisfactory effluent.

In rapid sand filtration, the use of river sand has become quite common. Inquiries sent to a number of these plants show that a very satisfactory water has been obtained with a sand costing only one-fourth as much as the sand formerly used.

EXPERIENCE AT MOLINE AND ROCK ISLAND, ILL.

In Moline and Rock Island, the experience has been the same. River sand has been in service for two years with results which indicate its permanent use. This sand is obtained from the Mississippi River, above the city of Moline. A local sand company supplies the material, collecting it in the following manner. By means of a centrifugal sand pump on a boat, a barge is loaded. This barge is then unloaded, at the docks of the company by a stream of water from the sand pump, into the river again. After emptying the barge, the sand is then taken from the river and pumped into the sand bins. By this means of unloading, the sand is thoroughly washed and freed from objectionable matter.

This raw, unscreened product has an effective size of 0.28 mm. and a uniformity coefficient of 2.11. When placed in a filter, the fine powder will find its way to the surface during washing. Unless this powder is removed, the filter will clog very quickly and necessitate an increase in wash water. By scraping the bed and freeing the sand of this material, a medium will be obtained with an effective size of .51 mm. and a uniformity coefficient of 1.34. For filtration purposes this sand is very efficient.

The loss due to the discarding of the fine powder will vary with the different sands, ranging from 5 to 40 per cent. The Mississippi sand contains about 5 per cent fine powder, which is very easily removed by washing.

It has been found that the size of gravel used will affect the results obtained with river sand. Small gravel ¾ in. to ¼ in. in size was in use for a year, but the results show that larger gravel is needed. To meet this requirement gravel 2 ins. and over was placed next to the strainers to a depth of 9 ins. With the smaller gravel on this bed and the sand on top, conditions are very satisfactory. This filter has been in service six months and to date we have been unable to find packing and strainer trouble. Likewise in Rock Island, it was found necessary to supplant the fine gravel with the larger material, when the river sand was employed. Using the larger size gravel has eliminated considerable of their trouble.

The financial saving of the river sand over the more expensive bank sands is considerable. The cost of the Mississippi River sand per cubic yard delivered to the filter plant is 70 cts. The loss in this sand due to the fine powder is 5 per cent, making the actual cost per cubic yard 72.9 cts.

Large gravel to the depth of 9 ins. is needed to obtain satisfactory results. This quantity represents about 9 cu. yds. and costs $2.35 per cu. yd., totals $21.15. This cost must be added to that of the sand. The wash water required to free the sand of the fine powder amounts to 125,000 gals. and costs 1 ct. per 1,000 gals. This totals $1.25. Considering these additional factors, the cost of the river sand ready for service in the filters is $1.47 per cu. yd.

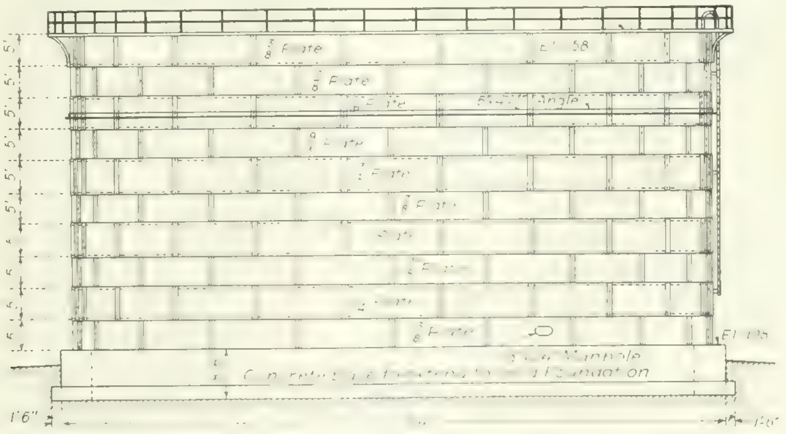


Fig. 1. Elevation of New Steel Standpipe at Youngstown, O.

For comparison, we will select a well known bank sand, commonly in use in this section of the country, that from Red Wing, Minn. The best grade of filter sand obtained at this place costs $3 per ton or $4.05 per cu. yd. The freight from Red Wing to Moline is $1.80 per ton or $2.43 per cubic yard, making a total cost per cubic yard, delivered to the filter plant, of $6.48. An additional charge of 25 cts. per yard must be made for unloading, bringing the total cost per cubic yard to $6.73.

Using the two figures for sand costs as found at Moline, the river sand shows a net saving of $5.26 per cubic yard over the Red Wing bank sand. Thirty cubic yards of sand are needed per filter to make the medium the proper depth, and with the above figures the saving per unit is $158 or $789 for the five 1,000,000-gal. units in the plant.

It has been found that the yearly loss of sand due to various causes is about 1 cu. yd. per filter. With river sand this means an annual loss of $3.65, with bank sand $33.65, or a net saving of $30 per year by using river sand.

Cost records on the cleaning of filters, that is, the removal of the sand and gravel, and the cleaning of the collecting system, show that 120 hours time is necessary for the work, costing $30. In other words, we can clean one unit and replace the lost sand in the other units for the same amount of money as needed for only replacing the lost bank sand.

In conclusion, river sand is being used with satisfactory results in a number of filter plants, the cost is much less than the average bank sand, and water works proposing to buy new sand can well afford to investigate the quality and quantity available in their own locality, before purchasing from a remote point.

Design and Construction of the New Standpipe of the Youngstown, Ohio, Water Works.

Contributed by N. E. Hawkins, Water Works Engineer, Youngstown, O.

The erection of the new south side standpipe for the municipal water works department at Youngstown, Ohio, was recently completed by the Chicago Bridge & Iron Works of Chicago. The structure is 100 ft. in diameter by 50 ft. high and will normally provide a storage of about 2,885,000 gals. The sides of the standpipe are constructed of ten rings of plates of the thickness shown in Fig. 1. The bottom is made up of ½-in. steel plates and is connected to the sides by a 6x6x1-in. angle A stiffening angle, 6x4x½-in., is riveted to the middle of the eighth ring to take care of the wind stresses with the tank empty. A continuous filler between butt straps and of the same thickness was used between this angle and the shell. The top of the standpipe is reinforced by a horizontal circular girder 3 ft. 6 ins. wide. This girder is figured to have a section modulus not less than the square of the diameter of the standpipe in feet divided by 250; this is also figured to support a uniformly distributed load of 50 lbs. per square foot, or a concentrated load of 500 lbs. at any point.

The shell was figured to keep within the following unit stresses:

Axial compression—$17{,}500-57\frac{l}{r}$ max. 12,000 lbs.

Tension in plates—12,000 lbs. per sq. in. net section.

Bearing on rivets—9,000 lbs. per sq. in. net section.

Shear on rivets—19,000 lbs. per sq. in.

Steel plates were required to show an ultimate strength of from 55,000 to 65,000 lbs. per square inch, with the elastic limit not less than one-half the ultimate strength. The ultimate strength of rivet steel was required to be 48,000 to 58,000 lbs.

All vertical joints are double butt strapped and all horizontal joints are lap joints. For the bottom plates 1⅛-in. rivets were used, for the intermediate joints 1-in. and ⅞-in. rivets, and for the top plates and the bottom of tank ¾-in. rivets were used. The rivets used in the horizontal lap joints were required to be the same size as the adjacent vertical joint. All rivets in the shell were driven with a compression yoke riveter, shown in Fig. 2, and the bottom rivets were driven with an air hammer. The pitch of the rivets in the horizontal joints vary from 5.6 ins. at the bottom to 3¾ ins. at the top. The specifications required in this regard, a pitch not to exceed 6 ins. or ten times the thickness of the thinnest outside plate, where caulking was required, and elsewhere not to exceed 6 ins. or 16 times the thickness of the thinnest outside plate. A view of the interior of the standpipe and the erection derrick used is shown in Fig. 3.

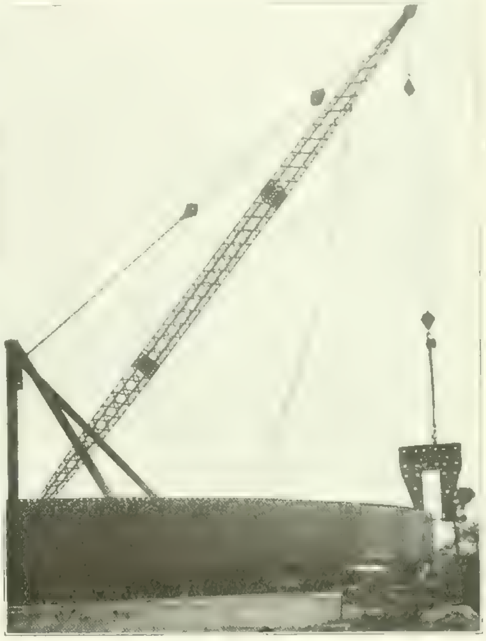


Fig. 2. View Showing Compression Yoke Riveter and Method of Blocking Bottom Employed in Standpipe Construction at Youngstown, O.

The inside of the standpipe after erection was painted with two coats of Heath and Milligan Mindura Brine Proof metal preservative, and the bottom was covered with a 2-in. slab of concrete mixed one part cement to two parts sand to four parts small pea gravel, reinforced with expanded metal.

The foundation was carried down to hard yellow clay. The footing ring is 8 ft. 6 ins. deep by 4 ft. 6 ins. wide with an 18x24-in. offset on the outside at the bottom, as shown in Fig. 4. This was poured with 1:2½:5 concrete. The top 5 ft. inside of the footing was removed and refilled with granulated slag, spread in 9-in. layers and thoroughly soaked with a fire hose. A 12-in. floor composed of 1:2:4 concrete, reinforced with 1.2-lb. expanded metal, was poured and carried into the footings. There has been no indication of any settlement and none is expected.

A small valve house 10 ft. x 12 ft. in plan with brick walls, concrete basement, and slate roof was built by the masonry contractor.

The cost was as follows:

2,400 cu. yds. earth excavation, at 40 cts.	$ 960.00
1,700 cu. yds. granulated slag fill, at 90 cts.	1,530.00
830 cu. yds. concrete, at $6.50	5,395.00
4-in. drain pipe	1.40

Valve house complete	516.32
Total masonry contract	$ 8,402.72
Standpipe proper	35,960.00
Total	$44,362.72

The Chicago Bridge and Iron Works erected the standpipe. Mr. J. H. DeCarpenter of Youngstown was masonry contractor. Mr. J. S. Lewis is superintendent of water works and Mr. N. E. Hawkins is water works engineer.

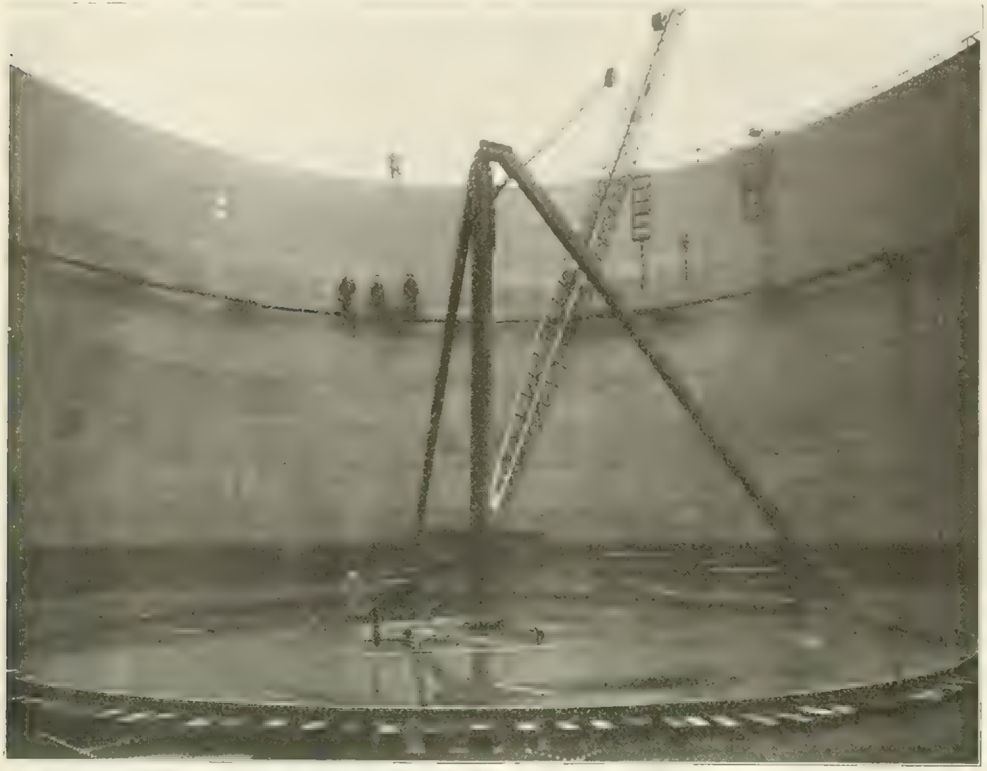


Fig. 3. View of Interior of Youngstown Standpipe and Erection Derrick Used.

The Proper Installation of Air Lift Pumps.

The increasing use of deep wells as sources of water supply for cities in different parts of the country has greatly stimulated the adoption of the air lift. Briefly the advantages and disadvantages of air lifts may be reviewed as follows. They are superior to pumps of other kinds because of the entire lack of moving parts in the well and the large rate of flow which can be obtained by their use. These are especially desirable qualities when one or two wells are depended on to furnish the entire water supply of a town. Opposed to these desirable qualities is the low efficiency of the device. Its use should therefore be limited to those cases where efficiency can be sacrificed for the sake of reduction in maintenance expense, increase in well output or increase in reliability. The use of the air lift should therefore, as a rule, be limited to crooked wells or those in which water must be pumped from a greater depth than 200 ft.

Though air lifts have been used for pumping water from deep wells for the past 50 years, the theory of their operation is still so imperfectly understood that their design is almost wholly dependent on empirical formulae. The present article discusses the proper installation of air lifts and is based on a paper by A. H. Ford of Iowa City before the annual meeting of the Iowa Engineering Society.

In general an air lift consists of an air pipe extending a considerable distance below the level of the water in the well and so arranged that the air supplied to it by an air compressor, located at the surface of the ground, is delivered near the bottom of the eduction pipe which carries the mixture of air and water to the point of discharge.

The maximum air pressure required to start a lift to operating is equal to 2.31 times the submergence of the air pipe, in feet. As soon as the lift begins to operate, the pressure is reduced; because of the drawing down of the water in the well, thus reducing the submergence, and increasing the lift. This lowering of the water level may be considerable and is the determining factor in fixing the economical output of a well.

A number of the factors which enter into the efficiency of an air lift must of necessity be determined by experiment on the particular well in question; but some of them admit of generally applicable determinations being made. Among these is the best form of foot piece, as the connection between the air pipe and the eduction pipe is called. There are a number of forms of foot piece on the market, for some of which extravagant claims of efficiency are made; but as wide variations in the efficiency are due to slight changes in proportion of other parts of the system or the method of operation, such claims are to be looked on askance, unless they are backed up by adequate guarantees. Tests have shown that the effect of a change in foot piece may be to increase the efficiency as much as 50 per cent when the head is high, with a much smaller increase when the head is low.

TABLE I.—EFFECT OF SUBMERGENCE ON EFFICIENCY OF AIR LIFT AT HATTIESBURG, MISS.

Submergence lift.	Efficiency. Per cent.
8.70	26.5
5.46	31.0
3.86	35.0
2.91	36.6
2.25	37.7
1.86	36.8
1.45	34.5
1.19	31.0
.96	26.5

Flow about 1,100 gals. per min.
Lift about 37 ft.

The efficiency of even a well designed air lift is low; varying from 20 per cent for a lift of 600 feet, to 45 per cent for a lift of 50 ft.; and is greatly influenced by the ratio of the submergence of the air pipe to the lift; the best ratio being about 2. This is clearly shown in Table I giving data on a test of a well at Hattiesburg, Miss., as reported in "Pumping by Compressed Air," by E. M. Ivans. In this test, the speed of the air compressor was adjusted so as to keep the rate of flow of water constant, while the length of the air pipe was varied. The dimensions of the well and air lift were as follows:

Total depth of well, ft.	453.5
Inside diameter of casing, ins.	9⅝
Inside diameter of air pipe, ins.	2½
Inside diameter eduction pipe, ins.	9⅝
Static lift, feet	4.0

The results in Table I show that the maximum efficiency is secured when the submergence is 2.5 times the lift and that the efficiency falls off more rapidly for a reduction in the submergence than for an increase. It is a good plan therefore to have the submergence more than that calculated for the best efficiency, rather than less. This allows for the usual occurrence, viz., that the pumping lift increases as more wells are sunk and as the well is pumped more.

TABLE II.—RESULTS OF TESTS TO DETERMINE BEST FLOW FROM DEEP WELLS AT HATTIESBURG, MISS., WITH AIR LIFT.

Length of air pipe (feet).	Flow (gal. per min.).	Efficiency. Lift (feet).	Per cent.	Duty (gals. per hp.-hr.).
224	1,495	47.5	32.6	1,630
208	1,459	45.8	31.5	1,640
184	1,419	44.3	31.1	1,670
162	1,359	39.4	30.0	1,790
142	1,299	37.7	30.6	1,920
124	1,219	37.5	32.8	2,070
105	1,106	37.1	36.7	2,340
86	1,008	32.5	33.4	2,450
79	904	29.3	31.3	2,530
67	802	26.0	30.5	2,750
43	690	21.2	29.8	3,240

Previous to this test the length of the air pipe in this well had been varied with a view to finding out the best flow at which to operate the well. The important data are given in Table II.

The air supply was apparently adjusted so as to get the best efficiency for each submergence.

This test shows an anomalous variation of the relation of lift to rate of flow; which is probably due to the coming into action of a second water bearing stratum, there being two cut by the well, when the level of the water had dropped 35 ft. on account of the operation of the lift.

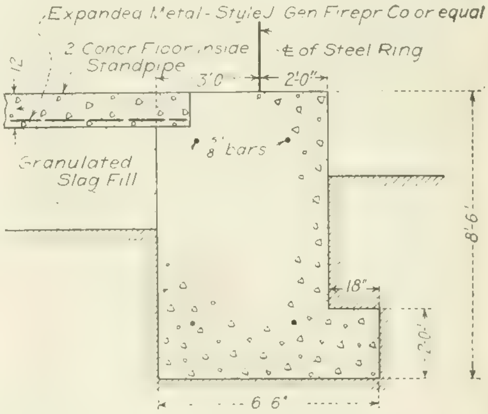

Expanded Metal - Style J Gen Firepr Co or equal
2 Concr Floor inside Standpipe
℄ of Steel Ring
12
3'0"
2'0"
5/8 bars
Granulated Slag Fill
8'-6"
18"
2'-0"
6'6"

Fig. 4. Partial Cross Section of Foundation of Youngstown Standpipe.

The writer believes that pump duty, water pumped per unit of energy supply, should be made the criterion of operation rather than mechanical efficiency. He has therefore calculated the last column. This shows that the test was not carried to low enough submergence to reach maximum duty. The duty of this lift would have been increased 42 per cent, and the cost of pumping reduced that amount, had the well been operated at a flow of 700 gals. per minute instead of 1,100 gals. per minute. The demand for water might not have allowed operation at this rate in this case, but in general the rate of pumping should not be so high as to lower the water level in the well to such an extent as to seriously decrease the duty, as defined above.

The present status of the air lift is such that it can be considered as a thoroughly reliable piece of apparatus, but one should not be installed without the advice of an engineer who has made a special study of the subject and he should be given opportunity to make trials with various lengths of air pipe and various speeds of compressor operation, after the lift has been installed; so as to find the conditions for best operation.

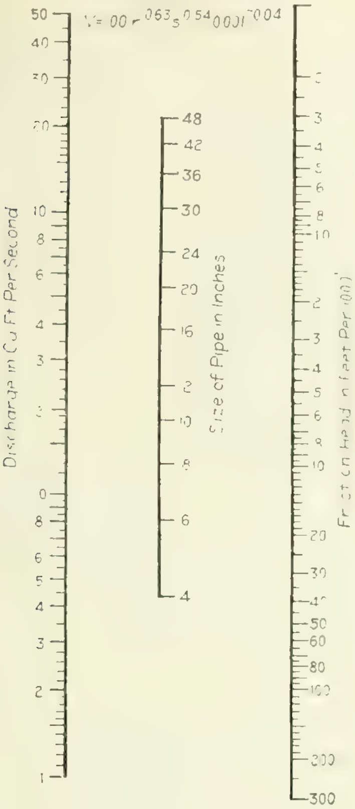


Fig. 1. Plot of the Williams and Hazen Formula for the Flow of Water in Cast Iron Pipe—Shown to Illustrate Method of Logarithmic Diagram Plotting.

Water-Supply Paper 323, covering the Ohio River basin, 1912, compiled by A. H. Horton, W. E. Hall, and H. J. Jackson, has recently been published by the Survey, and is for sale by the Superintendent of Documents, Washington, D. C.

Procedure in Logarithmic Diagram Plotting of Hydraulic Formulas.

Contributed by Warren A. Lyon, Syracuse, New York.

A logarithmic diagram of the type shown in Fig. 1 offers a very convenient means of expressing graphically a formula of the kind $V = K\ D^a\ S^b$. Many of the best hydraulic formulas are in this form and their algebraic solution is often difficult and tedious on account of the fractional exponents.

The only method which the writer has ever seen published of plotting these diagrams was given in a series of articles in "Power" during April, 1911. The method there given was very complicated and long drawn out. The writer has devised the following solution for graphical plotting, the only computations necessary being four solutions of the original equation.

Fig. 1 is plotted from the Williams and Hazen formula, $V = 100\ r^{0.63}\ s^{0.54}\ 0.001^{-0.04}$, for the flow of water in cast-iron pipe. In this equation, V is the velocity in feet per second, s the slope or friction head, and r the hydraulic radius in feet. The discharge and friction head lines are drawn parallel any convenient distance apart. After the desired limits of discharge and friction head have been chosen (in this case, 0.1 to 50 cu. ft. per second and 0.1 to 300 ft. per 1,000 ft.), their values are plotted logarithmically to any suitable scales.

Note that the graduations from 0.1 to 1, 1 to 10, 10 to 100, etc., are the same. It is hence necessary only to plot the logarithms of the numbers from 1 to 10 on a separate slip of paper and then use this slip as a scale in marking off the lines in the diagram.

After the discharge and friction head lines have been graduated, the desired limits of pipe sizes are chosen, in this case 4 ins. to 48 ins. Now solve the equation for a friction head of 1 ft. in 1,000 ft. and diameter of 48 ins.; the discharge is found to be about 40.2 sec. ft. Draw a line connecting the 1.0 ft. point with the 40.2 sec. ft. point. Solve again with friction head of 0.1 ft. in 1,000 ft. and get discharge equal to about 11.4 sec. ft. Draw a line connecting the 0.1 ft. point and 11.4 point and mark where it intersects the first line.

Repeat this operation using diameter equal to 4 ins. and friction heads of say 300 ft. in 1,000 ft. and 10 ft. in 1,000 ft., thus obtaining a second intersection. A line drawn through these two intersections will be parallel to the other two lines if the work has been correctly done.

This third line, on which are marked the sizes of pipe, must be graduated logarithmically. Since in all probability, no even scale would exactly fit this line, it is necessary to construct a special scale. To do this, use the simple geometric problem of dividing one line proportional to another line. The construction is shown in Fig. 2.

In Fig. 2, line AB is divided logarithmically to some even scale. Line AC makes any convenient angle with AB and distance AC equals the distance between the 4-in. and 48-in. points in Fig. 1. Connect B and C and draw lines parallel to BC through the points on AB, thus graduating AC in desired manner. These graduations may now be transferred to the size-of-pipe line in the diagram.

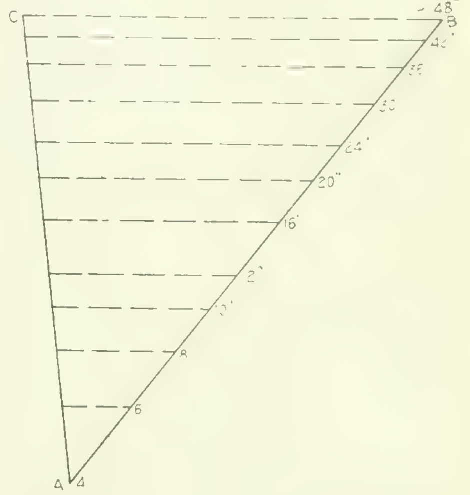


Fig 2. Construction for Dividing Line—AC Proportional to the Dividing of AB.

(The length A C equals the length of the middle or size-of-pipe line in Fig. 1. The length of the latter line is determined by intersections of two pairs of lines drawn following four algebraic solutions of the formula.)

In a similar manner, a fourth line may be constructed giving the velocity for any discharge. In this case, substitute the area of the pipe in square feet and velocity in feet per second, in the formula, $Q = aV$ and get resultant discharge in cubic feet per second. The diagram in Fig. 1 was plotted for discharge only and the corresponding velocity line would lie an inconvenient distance to the right. Since the friction-head line falls between the size-of-pipe line and the velocity line, it might be better in most cases to start plotting with velocity-discharge relation and then determine the position and graduations of the friction head line. In all cases of substituting in an equation the size of pipe should be made one of the substituted quantities.

BUILDINGS

A Graphical Method for Designing Simple Reinforced Concrete Beams and Data for Designing Simple, Double-Reinforced and T-Beams.*

Contributed by Ralph R. Leffler, Chicago, Ill

The object of this article is to set forth a graphical method for designing simple rectangular reinforced concrete beams for moment and shearing area. The author believes this method to be new, that it both eases and expedites the work, and, at the same time, owing to its comprehensive and graphical nature, insures greater accuracy of results. The formulas underlying the method are the commonly used ones derived on the basis of rectilinear variation of stress. These formulas are: $M_s = Kf_sbd^2$, $M_c = Lf_cbd^2$, and $Kf_s = Lf_c$, in which, for convenience, K and L have been substituted for pj and $\frac{kj}{2}$, respectively. This substitution, although very simple, makes possible the construction of the chart.

After M and V have been found, and n assumed equal to 15, the use of a shearing area diagram, the bd^2 table, and the chart make possible the finding of the required values of b, d and p in connection with any of the usual values of f_s, f_c and v without the use of pencil or slide rule. A shearing area diagram for solving the equation $\frac{V}{v} = bd$ can easily be constructed, but such a diagram will not be shown here.

The bd^2 table (see Table I) is merely a tabulation of values arranged so that if any one of the commonly used ratios of b and d is used, the numerical value of bd^2 can be found by reading in the outer left-hand column. It can easily be made more comprehensive, but its present scope is sufficient for the purpose of this article.

CONSTRUCTION OF THE CHART.

To understand the chart it is convenient to refer to the writer's comprehensive chart for designing both simple and double-reinforced concrete beams, which was published in the Aug. 5, 1914, issue of ENGINEERING AND CONTRACTING. On that comprehensive chart, directly under the $p' = o$ curve, will be found the numbers, 43.2, 36.4, 31.6, 26.1, 18.6, etc., which are ratios representing $\frac{L}{K}$ at the points where p curves intersect the $p' = o$ curve. Note that if on the comprehensive chart the point (see text explaining comprehensive chart) falls on the $p' = o$ curve, then $\frac{L}{K}$ equals the allowable f_s divided by the allowable f_c, without the use of compressive steel reinforcement. In making the chart for designing simple reinforced beams advantage was taken of this relationship, the procedure being as follows: From the comprehensive chart the value for $\frac{L}{K}$ at the points on the $p' = o$ curve, whose abscissas are 0.002, 0.003, 0.004, 0.005, etc., were found. Then evaluations of $f_s = \frac{L}{K} f_c$ for each f_c curve were made, and the f_c curves were then plotted on a rectangular co-ordinate system, in which values of f_s were plotted vertically and values of K horizontally. On this same system of coordinates the dotted Kf_s curves were plotted by assuming Kf_s equal to certain convenient values, such as 30, 100, 230, etc. On these Kf_s curves points were plotted which represented the product $Kf_s bd^2$ (the values of M), and since $Kf_s = Lf_c$, the chart may be regarded as a graphical representation of the two co-operating equations, $M = Kf_s bd^2$ and $M = Lf_c bd^2$, which underlie the designing of simple reinforced concrete beams.

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A detailed explanation of the devices and short cuts used by the author in the construction of the chart would be an instructive but a difficult undertaking. The fundamental ideas underlying the chart have been mentioned; they contain no theoretical approximations whatever. The degree of accuracy obtainable is entirely dependent on the scale of the chart, and the chart shown in Fig. 1 will give ample exactitude for practical purposes in spite of the fact that the interpolation of bd^2, Kf_s, f_c curves and p vertical lines often will be found necessary.

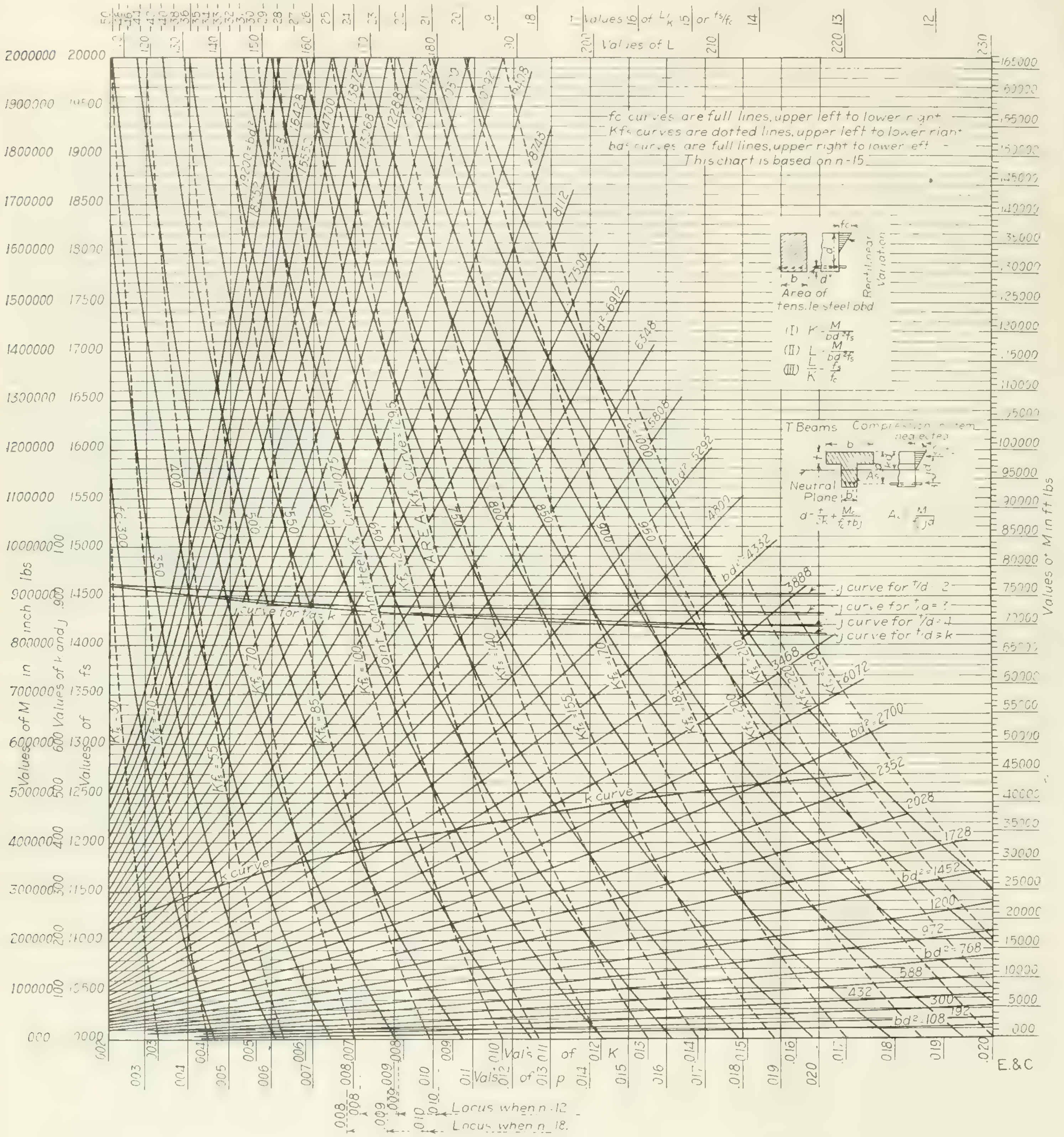


Fig. 1. Leffler's Chart for Designing Simple Reinforced Concrete Beams.

USE OF THE CHART.

The procedure to use to get results from the chart depends on which of the six variables, M, b, d, p, f_s and f_c, are given. In the four procedures following, note how the dotted Kf_s curves serve as transition curves to carry us from the intersection of two known and one unknown value to the intersection of two unknown and one known value of the six variables involved. In other words

TABLE I.—TABULATION OF bd² VALUES FOR DIFFERENT VALUES OF b AND d.

Values of bd²	When b = 12, d =	and bd =	When b = 10, d =	and bd =	When d = b	d =	and bd =	When d = 1.5 b, b =	d =	and bd =
108	3	36	3.3	32.8	4.8	4.8	23.0	3.6	5.4	19.8
192	4	48	4.4	43.7	5.8	5.8	33.6	4.4	6.6	29.0
300	5	60	5.5	54.8	6.7	6.7	44.9	5.1	7.7	39.2
432	6	72	6.6	65.7	7.6	7.6	57.8	5.8	8.7	50.1
588	7	84	7.7	76.5	8.4	8.4	70.6	6.4	9.6	61.5
768	8	96	8.8	87.5	9.2	9.2	84.6	7.0	10.5	73.5
972	9	108	9.9	98.5	9.9	9.9	98.0	7.6	11.4	86.7
1200	10	120	10.9	109.4	10.7	10.7	114.5	8.1	12.1	98.0
1452	11	132	12.1	120.2	11.4	11.4	129.9	8.7	13.1	114.0
1728	12	144	13.1	131.2	12.0	12.0	144.0	9.2	13.8	127.0
2028	13	156	14.3	142.3	12.7	12.7	161.3	9.7	14.6	141.6
2352	14	168	15.4	153.6	13.3	13.3	176.9	10.2	15.3	156.0
2700	15	180	16.4	164.0	13.9	13.9	193.2	10.7	16.1	172.0
3072	16	192	17.5	175.0	14.6	14.6	213.2	11.2	16.8	188.2
3468	17	204	18.6	186.0	15.2	15.2	231.0	11.6	17.4	202.0
3888	18	216	19.7	197.0	15.7	15.7	246.5	12.1	18.1	219.0
4332	19	228	20.8	208.0	16.3	16.3	265.7	12.5	18.8	235.0
4800	20	240	21.9	218.8	16.9	16.9	285.6	12.9	19.3	249.0
5292	21	252	23.0	229.8	17.5	17.5	306.2	13.3	19.9	265.0
5808	22	264	24.1	240.6	18.0	18.0	324.0	13.8	20.7	286.0
6348	23	276	25.2	252.0	18.6	18.6	345.9	14.2	21.3	302.0
6912	24	288	26.3	263.0	19.1	19.1	364.8	14.6	21.9	320.0
7500	25	300	27.4	274.0	19.6	19.6	384.1	15.0	22.5	338.0
8112	26	312	28.5	285.0	20.2	20.2	408.0	15.4	23.1	356.0
8748	27	324	29.6	295.8	20.6	20.6	424.4	15.8	23.7	375.0

the dotted Kf_s curves serve to get us from the intersection of two known values to the intersection of one known and one unknown value, since f_s, f_c and p form a group of variables so interdependent (and similarly for M, b and d) that in reality we have only two independent quantities in each of these groups. That this is true in the first group is apparent if it is noted that the fixing of the values of any two of the three variables definitely determines the value of the third; in the second group it is apparent if it is noted that b and d are merely factors in the product of bd^2, which is itself only one variable resolvable (if no consideration is given to the shearing area) into its constituent parts b and d, according as we may please.

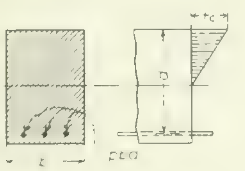
Procedure 1.—Usually M, the allowable f_s, and the allowable f_c are given, and it is required to find b, d, and p.

In this case find where the horizontal line of the allowable f_s (see Fig. 1) intersects the curve of the allowable f_c. The value of p to use is that represented by the p vertical line passing through this point of intersection. Moreover, this point of intersection lies on some dotted Kf_s curve along which we move until the horizontal line for the given M is met, where we find ourselves on some bd^2 curve. Taking the value of this bd^2 curve, the bd^2 table is entered and the values of b and d obtained.

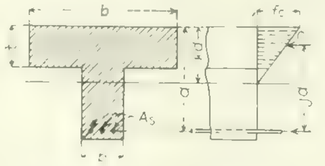
Procedure 2.—If M, b and d are known, and it is required to find f_s, f_c, and p, the steps to be taken are exactly the reverse of those taken in "Procedure 1" until we come to the dotted Kf_s curve. Then the direction and distance to travel along this dotted Kf_s curve depends on the value we may wish to assign to any one of the three variables f_s, f_c, or p. If the value of any of these three is fixed, the values of the other two can immediately be read off of the chart at the intersection of the assigned value and the dotted Kf_s curve. For example, assume the value of f_s to be fixed at 17,000. In this case we would travel along

TABLE II.—LEFFLER'S TABLE FOR DESIGNING SIMPLE BEAMS, T-BEAMS AND DOUBLE-REINFORCED BEAMS FOR n = 15.

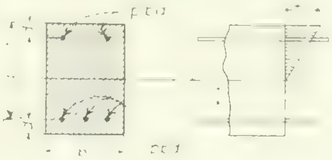
Simple Beams.



T-Beams—Compression in Stem Neglected.



Double Reinforced Beams. $\frac{d^1}{d} = 0.1$.



$\frac{L}{K}$ or $\frac{f_s}{f_c}$ $\frac{f_s}{f_c} = \frac{L}{K}$. $bd^2 = \frac{M_s}{Kf_s} = \frac{M_c}{Lf_c}$ $d = \frac{t}{2k} + \frac{M_c}{f_ctbj}$. $A_s = \frac{M}{f_sjd}$ $K = \frac{M}{bd^2f_s}$. $L = \frac{M}{bd^2f_c}$. $\frac{L}{K} = \frac{f_s}{f_c}$

$\frac{L}{K}$ or $\frac{f_s}{f_c}$	p	K	L	k	j	jt/d .2	jt/d .3	jt/d .4		.001‡	.0025‡	.005‡	.0075‡	.01‡	.015‡	.02‡
48.2	.0025	.00229	.110	.232	.917	.921	....	....	K = L =	.00229 .113	.00230 .123	.00231 .133	.00232 .142	.00233 .152	... ..	....
43.2	.003	.00274	.118	.258	.914	.920	. .	...		.00275 .123	.00276 .132	.00277 .143	.00279 .153	.00280 .163	....	....
39.5	.0035	.00315	.125	.275	.909	.918	...	....		.00316 .130	.00318 .139	.00320 .151	.00322 .162	.00324 .173	....	....
36.4	.004	.00360	.131	.291	.903	.916	...	....		.00360 .137	.00362 .146	.00365 .158	.00368 .170	.00369 .183	....	....
34.0	.0045	.00402	.137	.305	.899	.914	.900	. ..	K = L =	.00403 .143	.00406 .152	.00408 .166	.00409 .178	.00410 .191	....	....
31.6	.005	.00447	.142	.319	.894	.913	.898	....	K = L =	.00448 .148	.00450 .158	.00452 .172	.00454 .185	.00456 .199	.00458 .225	.00460 .249
30.1	.0055	.00489	.147	.333	.889	.912	.893	. ..		.00489 .153	.00490 .163	.00492 .177	.00495 .191	.00496 .205	.00499 .232	.00500 .257
28.7	.006	.00530	.152	.344	.885	.911	.889	...		.00535 .158	.00536 .168	.00540 .183	.00541 .197	.00542 .212	.00543 .240	.00544 .265
27.3	.0065	.00573	.156	.354	.881	.911	.887	....		.00575 .163	.00578 .173	.00580 .188	.00558 .203	.00583 .218	.00585 .247	.00587 .272
26.1	.007	.00617	.160	.365	.878	.910	.885	..		.00618 .167	.00621 .177	.00625 .193	.00629 .207	.00630 .224	.00631 .252	.00633 .280
24.8	.0075	.00657	.163	.374	.876	.910	.882	...		.00658 .170	.00661 .181	.00667 .198	.00669 .212	.00671 .228	.00672 .258	.00676 .287
*24.6	.0077	.00672	.165	.380	.875	.910	.882	.	K = L =	.00673 .172	.00680 .182	.00684 .199	.00689 .214	.00691 .231	.00692 .261	.00695 .290
23.9	.008	.00700	.167	.384	.872	.909	.881	...		.00701 .174	.00705 .185	.00710 .201	.00712 .217	.00716 .234	.00719 .265	.00721 .293
23.0	.0085	.00740	.170	.393	.871	.909	.880	..		.00741 .177	.00745 .188	.00750 .205	.00753 .221	.00756 .238	.00760 .269	.00768 .299
†22.7	.0088	.00762	.173	.397	.870	.909	.879	....	K = L =	.00768 .180	.00770 .190	.00775 .207	.00780 .224	.00782 .240	.00786 .271	.00792 .301
22.3	.009	.00780	.174	.402	.866	.909	.879	.867		.00781 .181	.00785 .192	.00790 .208	.00795 .225	.00800 .242	.00805 .274	.00810 .305
21.6	.0095	.00821	.177	.411	.863	.909	.879	.865		.00829 .184	.00831 .195	.00840 .212	.00845 .229	.00848 .247	.00855 .279	.00860 .311
20.9	.01	.00860	.179	.418	.861	.909	.878	.863		.00867 .187	.00870 .198	.00880 .215	.00885 .232	.00890 .250	.00895 .284	.00899 .315
20.2	.0105	.00900	.182	.426	.858	.909	.877	.860		.00903 .190	.00911 .200	.00920 .218	.00925 .236	.00930 .252	.00938 .288	.00945 .320
19.7	.011	.00940	.185	.433	.856	.909	.876	.859		.00942 .193	.00950 .203	.00960 .221	.00965 .240	.00970 .257	.00980 .292	.00990 .324
18.6	.012	.01020	.190	.446	.851	.909	.875	.854		.0102 .197	.0103 .208	.0104 .227	.0105 .246	.0106 .263	.0107 .300	.0108 .332
16.8	.014	.01180	.199	.471	.843	.908	.872	.848		.0118 .207	.0120 .218	.0121 .239	.0122 .257	.0123 .275	.0124 .312	.0125 .348
15.4	.016	.01330	.206	.493	.836	.907	.870	.840		.0133 .214	.0134 .226	.0136 .246	.0137 .265	.0138 .284	.0140 .322	.0141 .360
14.2	.018	.01490	.212	.513	.829	.906	.869	.839		.0150 .221	.0151 .234	.0153 .253	.0154 .273	.0155 .293	.0157 .332	.0158 .372
13.2	.02	.01650	.218	.530	.823	.905	.867	.830	K = L =	.0167 .228	.0168 .240	.0170 .261	.0172 .281	.0173 .301	.0175 .342	.0177 .382

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*Joint Committee.
†A. R. E. A.
‡Value of p^1.

the dotted Kf_s curve until it intersected the horizontal line for $f_s = 17{,}000$, which point of intersection would be on the curve of the actual f_c and also on the vertical line representing the value of p which must be used.

Procedure 3.—Suppose M, b, d and p are known, and it is required to find the actual values of f_s and f_c. In this case find the value of bd^2 from the bd^2 table. On the chart find the point where the curve for this value of bd^2 intersects the horizontal line of the given M, which point is on some dotted Kf_s curve. Move along this dotted Kf_s curve until the vertical line of the given p is intersected, this point of intersection being on the f_s horizontal line and the f_c curve of the actual f_s and actual f_c sought.

Procedure 4.—If f_s, f_c, b, and d are known, and it is required to find p and M, the steps to be taken are the same as in "Procedure 1" until we get to the dotted Kf_s curve. Then instead of traveling along the dotted Kf_s curve until we intersect the given M we move along it until the bd^2 curve of the given b and d is met. This meeting point is also on some horizontal M line, which gives us the value of M which the beam can exert under the given allowable values of f_s and f_c. The value of p to use is obtained as in "Procedure 1," this value being given by the vertical p line passing through the intersection of the horizontal line of the given f_s and the curve of the given f_c.

To show further the workings of the chart the following problem involving numerical values is given, the shearing area also being taken into consideration.

Suppose the given values of M and V are 940,000 in.-lbs. and 10,500 lbs., respectively. We find, from a shearing area diagram (constructed as beforementioned), or by computation, that if 35 lbs. is the allowable value for v, $bd = 300$. If the beam must be 12 ins. wide, the bd^2 table gives 25 as the value of d and 7,500 as the value of bd^2.

If we use the allowable unit stresses recommended by the American Railway Engineering Association ($f_s = 17{,}000$ and $f_c = 750$), and enter the chart on the $bd^2 = 7{,}500$ curve until we intersect the dotted Kf_s curve passing through the intersection of $f_s = 17{,}000$ and $f_c = 750$, we find the M that can be sustained by reading in the outer column of figures at the left side of the chart. This value of M we find to be 940,000 in.-lbs., which is the same as the given M, because the given M was so chosen for convenience. The values of $b = 12$ and $d = 25$ are then satisfactory, and the value of p to use will be that of the interpolated vertical p line passing through the intersection of the lines representing $f_s = 17{,}000$ and $f_c = 750$, which is 0.0088.

Suppose, however, the given M had been 1,130,000 in.-lbs. instead of 940,000 in.-lbs. Then we would need to follow the "A. R. E. A." Kf_s curve until we intersected $M = 1{,}130{,}000$, at which point we find ourselves on the $bd^2 = 8{,}784$ curve. Then with the value 8,784 we would enter the bd^2 table and find that with $b = 12$ ins., d would equal 27 ins. The value of p to use would be the same as before ($p = 0.0088$), because we are working both steel and concrete at their full allowable working unit values ($f_s = 17{,}000$ and $f_c = 750$).

But suppose the given M had been 750,000 in.-lbs. Then we would continue along the $bd^2 = 7{,}500$ curve until we intersected $M = 750{,}000$, at which point we would find ourselves on some Kf_s curve, which in this case happens to be the $Kf_s = 100$ curve. To obtain p we go up along the $Kf_s = 100$ curve until the line representing $f_s = 17{,}000$ is intersected. We find that this point of intersection lies on the interpolated vertical line representing $p = 0.0067$; and also that it lies about where the interpolated curve $f_c = 637$ would intersect $f_s = 17{,}000$. Therefore the actual value of f_c would only be 637 instead of 750, which shows that so far as moment is involved we could decrease d, and consequently bd; but before we do this we must alter the nature of our web reinforcement so as to permit v to have a greater value than 35. If we should alter the nature of the web reinforcement (and it might be the economical thing to do), we would go through the same process as before, but this process soon becomes so familiar that it is gone through with ease, accuracy and great rapidity.

The fact that $p = 0.0067$ is used in this third case, instead of $p = 0.0088$ as in the two preceding cases, is due to the external M (750,000 in.-lbs.) inducing in the beam a resisting M of only 750,000 in.-lbs., instead of the full M (940,000 in.-lbs.) that could be exerted by this beam if reinforced with $p = 0.0088$. It is therefore economical to put in only sufficient steel ($p = 0.0067$), working at its full allowable f_s, to have $M_s = M_c = M = 750{,}000$ in.-lbs.

SOME FEATURES OF THE CHART.

At the top of the chart values of L and L/K (or f_s/f_c) are plotted.

Note how the L of any point on any f_c curve multiplied by the value of the f_c curve always equals the value of the dotted Kf_s curve passing through the point on the f_c curve.

Also note how the vertical line through any value of L/K (say 20, for example) passes through all the intersections of the f_s horizontal lines and the f_c curves whose ratio f_s/f_c equals the value of the L/K chosen. But L/K always equals equals f_s/f_c, and is then the master key of the chart.

DESIGN OF T-BEAMS.

For designing T-beams *"j"* curves for various values of t/d can be plotted across the p vertical lines on the chart. Similarly a *"k"* curve can also be plotted, only one k curve being necessary, since k, being dependent only on the unit deformation, is not affected by variations of t/d.

The case most frequently encountered in the design of T-beams is that in which M_c, the allowable f_s, the allowable f_c, and t (the flange thickness) are known. The equation

$$d = \frac{t}{2k} + \frac{M_c}{f_c t b j}$$

(based on neglecting the compression in the web) can then be solved for d; k being obtained from the chart vertically below the intersection of the f_s horizontal line and the f_c curve; j approximated at 0.89; and *"b"* chosen from shear considerations, sufficient width being obtained for placing the tensile steel and rules governing the allowable width of flange being considered. After this first solution a more correct value of j can be obtained by reading on the vertical line passing through the intersection of the f_s horizontal line and the f_c curve for a value of j on the j curve of the value for t/d. The value of b can then be more intelligently fixed upon. A second solution, if needed, will give a sufficiently correct value for d.

It must be remembered that the above equation applies only when the neutral axis is in the web. If $t/d \geqq k$ the neutral axis is in the flange or at the edge of the flange, and the procedure is similar to that for simple rectangular beams. If $t/d < k$ the neutral axis is in the web, the above equation is the correct one to use, and amount of tensile steel required is determined by solving the equation, $A_s = \dfrac{M_s}{f_s j d}$.

If d also is known the equation is directly solvable for b.

The equation itself is only a rearrangement of the upper part of Formula 7, in Vol. I, p. 145, of Prof. Hool's "Reinforced Concrete Construction."

Note that it is unnecessary to find a value for p, because k is found by going directly back to the master key ratio f_s/f_c.

This method is less approximate and much more direct than the methods shown at present in the text books.

TABLE FOR DESIGNING REINFORCED CONCRETE BEAMS.

The data given in Table II make use of the master key f_s/f_c. By its aid the moment design of all simple beams and of most T-beams and double-reinforced beams can be accomplished. If, for example, in a simple beam, the value of M, the allowable f_s, and the allowable f_c are known, the table is entered by means of the ratio f_s/f_c. To the right of this ratio is found the required value of p, and in the next columns the values of K and L to use in the formulas,

$$bd^2 = \frac{M}{Kf_s} = \frac{M}{Lf_c}.$$

In double-reinforced beams the value of p to use is read out of the "p" column under simple beams.

Further explanation of Table II is believed to be needless as the charts are graphical representations of it, or the table is (at least partially) a tabular representation of the charts. It is sufficiently comprehensive and accurate for the problems commonly encountered. It can readily be made more complete if desired.

SUGGESTIONS.

As the ratio f_s/f_c is so very important it would be well to add the formula,

$$\frac{f_s}{f_c} = \sqrt{\frac{n}{2p} + \frac{n^2}{4}} - \frac{n}{2},$$

to those usually given for designing simple beams.

Charts in which values of L or L/K ($= f_s/f_c$) are used as abscissas (instead of K as in the chart shown) could be made. As nearly as they can be foreseen they would not be as valuable as the chart shown. The author hopes later to have such charts ready for publication.

The chart shown herewith is based on $n = 15$. If charts, to the same scale, for other values of n were made, and then superimposed on each other, a study of the effect of variations of n could be made.

The loci of a few of the vertical "p" lines based on $n = 12$ and $n = 18$ are shown at the bottom of the chart. Note that they shift only about 0.1 of a unit of K from their location based on · = 15. An attempt was made to show the locus of the $f_c = 700$ curve when $n = 12$ and $n = 18$, but it was found that with $n = 12$, it would almost coincide with the $f_c = 650$ curve based on $n = 15$, and that with $n = 18$ it would almost coincide with the $f_c = 750$ curve based on $n = 18$. Further investigation showed that this coincidence occurred throughout the chart. It therefore appears that a rough chart based on $n = 12$ or 18 could be obtained by changing, on the chart for $n = 15$, the value of f_c on the f_c curves by 50 lbs. and shifting the vertical "p" lines by about 0.1 of a unit of K. The loci of the Kf_s curves and the bd^2 curves would remain the same.

The chart shown in Fig. 1, and the comprehensive chart published in the Aug. 5, 1914, issue of ENGINEERING AND CONTRACTING, can be adapted for use in designing non-homogeneous beams other than steel-concrete beams.

(In its last report the Joint Committee recommends that the allowable f_c be taken at 32.5 per cent of the ultimate strength of the particular concrete used. The report contains a table in which the ultimate strength is shown as a function both of the aggregate and of the proportions used in mixing. The charts prepared by the writer make possible the adoption of the above recommendation without materially complicating the work in the designing room.)

Durability of Greenheart Timber.—Genuine Greenheart is said to be the most resistant wood to marine borers, and also the slowest to decay. It is very hard and surpasses iron and steel in durability when in contact with salt water. It has been known and used since 1769. Logs have remained intact under water for 100 years. Lock gates in English canals are made of it, and gates built in 1856 in the Liverpool canal and removed in 1894 to allow deepening and widening of the canal, were used over again. The sills and fenders of the lock gates on the Panama Canal are made of Greenheart timber.

Provisions of a Proposed Act to Provide for the Licensing of Structural Engineers, and to Regulate the Practice of Structural Engineering in Illinois.

Due to a growing insistence on the part of structural engineers in Illinois that the enactment of legislation is desirable in order that their interests be protected, the Western Society of Engineers authorized its legislative committee to draw up a proposed "License Law for Structural Engineers." This committee, consisting of H. J. Burt, chairman, W. L. Abbott, Andrews Allen, Joachim G. Giaver, Dabney H. Maury, and Ernest McCullough, has drawn up a bill, under the direction of a legal adviser. This bill has been approved by the Board of Direction of the Western Society of Engineers, which has directed the committee to endeavor to secure its passage at the present session of the Illinois Legislature. The bill is based on the power of the State Legislature to provide for public safety. During the time that the bill was being drawn up the committee send out a form letter to engineers throughout the state. Of the 600 replies received it is stated that about 95 per cent of those replying favored such legislation. The completed bill, which is entitled "A Bill for an Act to Provide for the Licensing of Structural Engineers, and to Regulate the Practice of Structural Engineering, is herewith given in full as a basis for decision and action on the part of engineers:

Section 1. Be it enacted by the People of the State of Illinois, represented in the General Assembly. That within thirty days after the taking effect of this Act the Governor of the State shall appoint a State Board of Examiners of Structural Engineers, to be composed of five members, one of whom shall be a Professor in the Civil Engineering Department of the University of Illinois, and the others shall be structural engineers of recognized standing, who have had not less than ten years practical experience, then practicing as structural engineers in the State of Illinois, to hold, regulate, supervise and control examinations of applicants for license to practice structural engineering in this State. Two of the members shall be designated to hold office until January 31, 1917, and the other three shall hold office until January 31, 1919; and thereafter upon the expiration of the term of office of the persons so appointed, the Governor of the State shall appoint a successor to each person whose term of office shall expire, to hold office for four years, and said person so appointed shall have the above specified qualifications. In case appointment of a successor is not made before the expiration of the term of any member, such member shall hold office until his successor is appointed and duly qualified. Any vacancy occurring in the membership of the Board shall be filled by the Governor of the State for the unexpired term of such membership.

2. The members of the State Board of Examiners of Structural Engineers shall, before entering upon the discharge of their duties, make and file with the Secretary of State the constitutional oath of office. They shall, as soon as organized, and biennially thereafter in the month of February elect from their number a President and a Secretary who shall also be the Treasurer. The Treasurer, before entering upon his duties, shall file a bond with the Secretary of State, for such a sum as shall be required of him by the Secretary of State, and in such form and with such sureties as may be approved by the Governor of the State. The Board shall adopt rules and regulations not inconsistent with this Act to govern its proceedings; shall adopt a seal; and shall cause the prosecution of all persons violating any of the provisions of this Act, and may incur necessary expense in that behalf. The Secretary shall have the care and custody of the seal; and shall keep a record of all the proceedings of the Board which shall be open at all times to the public.

The Secretary of the Board shall receive a salary to be fixed by the Board, and which shall not exceed the sum of Fifteen Hundred ($1,500.00) Dollars per annum; he shall also receive his traveling and other expenses incurred in the performance of his official duties, and each of the other members of the Board shall receive the sum of Ten ($10.00) Dollars for each day actually engaged in the performance of his duties, and all legitimate and necessary expenses incurred in attending the meetings of the Board and in conducting examinations, which together with all other lawful expenses shall be paid from funds appropriated therefor, as provided by law.

3. Three members of the Board shall constitute a quorum. Meetings of the Board shall be called by the Secretary upon the written request of the President or any two members, by giving at least seven days' written notice of such meetings to each member, counting from the day on which the notices are post-marked, telegraphed or personally delivered.

The Board shall adopt rules and regulations for the examination of applicants for license to practice Structural Engineering, in accordance with the provisions of this Act, and may amend, modify, and repeal such rules and regulations from time to time. The Board shall immediately upon the election of each officer thereof, and upon the adoption, repeal or modification of its rules of government or its rules and regulations of examinations of applicants for licenses, file with the Secretary of State and publish at least twice in at least one Engineering Journal of general circulation in the State of Illinois and in one daily newspaper published in the State of Illinois, the name and address of each officer, and a copy of such rules and regulations, or the amendments, repeal or modification thereof.

4. Provisions shall be made by the Board hereby constituted for holding examinations at such place or places as shall be appointed by the Board, and at least two in each year, of applicants for license to practice structural engineering. Notice of the time and place of the holding of such examinations shall be published in the same manner as is hereinbefore provided for the publication of the rules and regulations pertaining to such examinations adopted by the Board, provided that the last day of such publication shall be at least twenty (20) days prior to the date of holding such examinations. Each applicant shall pay to the Secretary of the Board, in advance, a fee of Twenty ($20) Dollars, and shall present his affidavit that he is of the age of twenty-one years, or above. Such examinations shall be held by the examiners as a body, a majority of whom shall constitute a quorum, or by a committee of two or more members selected and appointed by the Board. Examinations shall be conducted by written or printed interrogatories, in whole or in part.

Each applicant examined shall sustain a satisfactory examination in the design and construction of buildings and structures according to scientific principles and with special reference to strength and safety; the strength and properties of the various building materials; the principles of theoretical and applied mechanics; the principles of sanitation, including therein plumbing, heating, lighting and ventilation, as applied to buildings and building construction; the ability of the applicant to apply his knowledge to the ordinary requirements of structural engineering; and in such other matters and subjects as the Board of Examiners may require as suitable to fairly and thoroughly test the competency of the applicant to practice structural engineering in this State.

Every applicant for a license, except those who apply by virtue of the provisions of Section Five (5) and Six (6) of this Act, shall present to the Board of Examiners satisfactory proof, by affidavit, or otherwise, as the Board may direct:

(a) That at the time of the taking effect of this Act, he was actually engaged in the practice of structural engineering in this State, and did not apply for a license under Section Five (5) of this Act, and in such case the applicant shall be entitled to an examination without regard to the number of years he has practiced. Or,

(b) That within ten years next prior to his application, he has practiced structural engineering in some state or territory of the United States, or in some foreign country, for not less than six years, during at least two full years of which period he shall have been in responsible charge of work, as principal or assistant. Or,

(c) That within ten years next prior to his application, he has pursued a course of study and training in the theory and practice of structural engineering covering at least the subjects above specifically enumerated, for the period of not less than six years, in the employ or under the supervision, direction and tuition of one or more practicing structural engineers, during at least two full years of which period, every such applicant shall show that he has been in charge of work in designing or construction in the employ or under the direction of such engineer or engineers. Such applicants who have graduated from a college or school of engineering considered by the Board to be in good standing and requiring a course of study of not less than four years, during at least thirty-six weeks in each year, shall be credited two years upon the six-year period required above, the remaining four years to be pursued as hereinabove in this paragraph provided. The Board in its discretion may adopt rules providing for credit not exceeding two years on said six-year period to applicants who have pursued a course of instruction in schools or colleges of engineering approved by the Board, but who have not graduated.

If the result of the examination of any applicant shall be satisfactory to a majority of the Board, under its rules, the Secretary, upon an order of the Board, and upon payment by said applicant of the further sum of Thirty ($30) Dollars, shall issue to said applicant a license to practice structural engineering in this State, in accordance with the provision of this Act, which license shall contain the full name, birthplace, and age of the licensee, and shall be signed by the President and Secretary and sealed with the seal of the Board.

All papers received by the Secretary in relation to applications for license, shall be kept on file in his office, and proper index and record thereof shall be kept by him.

Any fraudulent act or representation by any applicant in connection with his application for examination, or for a license without examination, under this Act, or during the conduct of his examination, shall be sufficient cause for the withholding of the license by the Board of Examiners or for its revocation after it has been issued.

5. Any person who shall by affidavit or other proof as the Board may direct, show to the satisfaction of the State Board of Examiners of Structural Engineers that he was a resident of and engaged in the practice of structural engineering in this State, on the date of the taking effect of this Act, shall be entitled to a license without examination, provided such application shall be made within six months after the taking effect of this Act. Such license, when granted, shall set forth the fact that the person to whom the same was issued was practicing structural engineering in this State at the time of the taking effect of this Act and is therefore entitled to the license to practice the profession of structural engineering without an examination by the Board of Examiners, and the Secretary of the Board shall upon the payment to him by the applicant of a fee of Fifty ($50) Dollars issue to the person named in said affidavit a license to practice structural engineering in this State in accordance with the provisions of this Act.

6. The State Board of Examiners may in its discretion, issue a license, without examination, upon payment of a fee of Fifty ($50)

Dollars, to a structural engineer licensed under the laws of any other State or Territory of the United States, or any foreign country, provided it appear to the Board that in the State or Territory or Country in which such license was issued, the requirements for a license to practice structural engineering were equal to those prescribed in this State, and that such State, Territory or Country accord a like privilege to structural engineers who hold licenses issued under the provisions of this Act.

7. Every person holding a license to practice structural engineering in this Statae shall have it recorded in the office of the Secretary of State and the date of recording shall be endorsed thereon, and upon such recording said license shall be of force and effect throughout the State. The Secretary of State shall be entitled to receive a fee of $1.00 for the recording of each license filed for record. Until such license is recorded as herein provided, the holder thereof shall not exercise any of the rights or privileges conferred therein and thereby.

8. Every licensed structural engineer shall have a seal, the impression of which must contain the name of the Structural Engineer, his place of business, and the words, "Licensed Structural Engineer," "State of Illinois," with which he shall stamp all plans, drawings and specifications issued by him for use in this State.

9. No corporation or stock company shall be licensed to practice structural engineering, but it shall be lawful for them to employ licensed structural engineers; and it shall be lawful for one or more licensed structural engineers to enter into copartnership with one or more architects licensed under the laws of this State, for the practice of their professions.

10. Any person who shall be engaged in the designing, or supervision of the construction, enlargement or alteration of buildings and structures, as hereinafter defined, or any part thereof, for others and to be constructed by persons other than himself shall be regarded as practicing structural engineering within the meaning of this Act and shall be held to comply with the same. Buildings and structures within the meaning of this Act shall be construed to mean buildings and structures having as essential structural features, foundations, columns, girders, trusses, arches and beams, or some of them, and in which safe design and construction require that loads and stresses must be computed and the sizes and strength of parts must be determined by mathematical calculations based on scientific principles and engineering data. The designing and supervision of the construction of the plumbing, heating, lighting and ventilating features of such buildings and structures shall be regarded as within the meaning of this Act. Provided, however, this Act shall not be regarded as applying to: (a) Draughtsmen, students, clerks of work, superintendents and other employees of structural engineers duly licensed to practice under this Act, so long as they work and act under the instructions, control, direction and supervision of their employers; (b) superintendents of construction of buildings and structures employed and paid by the owners, provided such superintendents act under the control, direction and supervision of a structural engineer, duly licensed under this Act; but nothing contained in this Act shall be construed to prevent any person, mechanic or builder from making plans and specifications for, or supervising the construction, enlargement or alteration of any building or structure that is to be constructed by himself or his employees.

11. After six months from the taking effect of this Act, it shall be unlawful for any person to practice structural engineering without a license in this State, or to advertise, or to display a sign or card, or other device which indicates or represents that he is entitled to practice as a structural engineer in this State, and any person guilty of the violation of any of the provisions of this Act shall be punished by a fine of not less than Ten ($10) Dollars nor more than Two Hundred ($200) Dollars, for each and every offense.

12. It shall be lawful and be the duty of the State Building Commissioner appointed and acting under any State Building Code which is now or which may hereafter be in force and effect in this State, or of any Building Commissioner of any city, town or village organized under any general or special law of this State, which has adopted a building code or other ordinance or laws relative to the construction, alteration, repair, maintenance and safety of buldings and structures, and providing for the issuing of building permits by a Building Commissioner or other officer designated for that purpose, to issue permits for the construction, enlargement or alteration of such buildings or structures to any owner, or his agent, upon the filing with the State Building Commissioner or with the Building Commissioner of such city, town or village, of a true copy of the plans, drawings and specifications for the construction, enlargement or alteration of such buildings or structures, and a certificate signed by the structural engineer who executed them certifying under his seal that said plans, drawings and specifications are in accordance with the State Building Code, or the Building Code of such city, town or village, as the case may be, provided, such structural engineer shall be licensed under this act, and provided, such owner or his agent has complied with all other requirements of law requisite to obtain such building permit.

13. Every licensed structural engineer in this State, who desires to continue the practice of his profession, shall annually, during the time he shall continue in such practice, pay to the Secretary of the Board during the month of July, a fee of Ten ($10) Dollars, and the Secretary shall thereupon issue to such licensed structural engineer a certificate of renewal of his license for the term of one year. Failure by any licensed structural engineer in actual practice to cause his license to be renewed during the month of July in each and every year, shall constitute valid grounds for the revocation of his license. The failure to renew such license in apt time shall not deprive such structural engineer of the right of renewal thereafter; but the fee to be paid upon the renewal of a license after the month of July shall be Fifteen ($15) Dollars.

It shall be the duty of the Secretary of the Board to file with the Secretary of State on the 15th days of February and August in each year certified lists of all licenses then in force, upon the filing of each of which said lists, the Secretary of State shall be entitled to receive a fee of $1.00.

14. Licenses issued in accordance with the provisions of this Act shall remain in full force unless revoked for cause, as hereinafter provided. Any license so granted may be revoked by a four-fifths vote of the State Board of Examiners for gross incompetency; or recklessness in the construction of buildings or other structures; or for fraudulently affixing his seal to plans, drawings or specifications; or for any dishonest practice or practices on the part of the holder thereof; or for fraud in obtaining his license; or practicing without payment of the annual license renewal fee provided in Section Fourteen (14) of this Act; but before any license shall be revoked such holder shall be entitled to at least twenty days' notice of the charge against him, and of the time and place of the meeting of the Board for the hearing and determining of such charge.

For the purpose of carrying out the provisions of this Act relating to the revocation of licenses, the Board, and each member thereof, shall have the power to administer oaths, and said Board shall have the power to secure by its subpoena both the attendance and the testimony of witnesses, and the production of books and papers, relevant to any investigation by the Board for the purpose of carrying out the provisions of this Act, relating to the revocation of licenses. Witnesses shall be entitled to the same fees and mileage as witnesses in a Court of Record, to be paid in like manner. The accused shall be entitled to the subpoena of the Board for his witnesses, and to be heard in person or by counsel in open public trial. Any Circuit Court of this State or any judge thereof, either in term time or vacation, upon application of such Board, may in its discretion by order duly entered by such court or judge thereof, require the attendance of witnesses, the production of books and papers, and giving of testimony before such Board, and upon refusal or neglect to so appear and testify and produce such books and papers as commanded by such order of the court or judge thereof, may compel, by attachment or otherwise, as provided by law, the attendance of such witnesses, the production of such books, and papers and the giving of testimony before such Board, in the same manner as production of evidence may be compelled before said court. Every person who, having taken an oath or made affirmation before said Board, shall wilfully swear or affirm falsely, shall be guilty of perjury and upon conviction shall be punished accordingly. It shall be the duty of the Secretary of the Board to promptly give notice of all revocations of licenses to the Secretary of State who shall make an entry thereof in his records.

15. The State Board of Examiners shall have power to entertain and grant for good cause shown, petitions to vacate its orders revoking licenses and reinstate such petitioner to practice in this State, and to adopt rules and regulations governing the requirements and hearing of such petitions, provided that at least one year shall intervene between the date of the entry of the order revoking a license and the filing of such petition in cases involving gross incompetency, recklessness, dishonest practices, or fraud. The Board in its discretion may require petitioners whose licenses have been revoked for gross incompetency or recklessness to submit to an examination by the Board touching their professional qualifications and competency to practice, which shall at least cover the subjects required of applicants for a license by examination. Such petitions shall briefly state the date and cause of revocation, the grounds upon which petitioner seeks reinstatement, and such other facts as the Board by its rules may prescribe, and shall be verified by the petitioner. The Board in the hearing of such petitions shall, as near as may be, follow the practice required by this Act in relation to citations to revoke licenses. Any person interested may appear and contest such petitions. A majority vote of the Board shall be sufficient to reinstate such petitioners to practice.

Every petitioner shall pay to the Secretary of the Board, in advance, upon the filing of his petition, a fee of Ten ($10) Dollars.

It shall be the duty of the Secretary of the Board to promptly notify the Secretary of State of the reinstatement of any such applicant, and the Secretary of State shall note the same on his records accordingly.

16. It shall be the duty of the Secretary of the Examining Board to file at the close of each fiscal year with the Auditor of Public Accounts of the State of Illinois, a full annual report of the proceedings of the Board, including a statement of all funds received and disbursed, and he shall also pay over to the State Treasurer of the State of Illinois, quarterly, all license fees and renewal and other fees collected by him during the preceding quarter and take his receipt therefor. Said report shall be attested by the affidavits of the President and Secretary.

17. All acts or parts of acts inconsistent herewith are hereby repealed.

The drainage area of the Ohio River basin is 203,000 square miles, comprising parts of 14 states. No state lies wholly within the basin, the areas included ranging from 97 per cent in Kentucky to less than 1 per cent in Mississippi.

SEWERAGE AND SANITATION

Methods Employed in Manufacturing and Laying Reinforced Concrete Sewer Pipe at Philadelphia.

During the year 1914 the Bureau of Surveys, City of Philadelphia, awarded contracts for the construction of reinforced concrete pipe sewers on the combined system, that is, designed to carry storm water run off and domestic sewage.

The plans of these sewers called for two sizes of pipe: 36-in. diameter circular and 36-in. by 24-in. egg-shape; the alignments being long straight lines with a number of regular curves of 30 ft. and 50 ft. radius for extensions in intersecting streets and for outlet connections.

The design of both sections called for one line of triangular steel mesh to be placed 1¼ ins. from the inside face of the concrete shell; the shell for the 36-in. section to be 4 ins. and for the 36-in. by 24-in. section 3½ ins. thickness except at the base. The circular section was concentric throughout; the egg shape section was designed to have a base 8 ins. in width. The methods employed in manufacturing and laying this reinforced concrete sewer pipe are here described from information taken from a paper presented at the 11th annual convention of the American Concrete Institute, Philadelphia, Pa., by Mr. Henry T. Shelley, assistant engineer of sewer construction in Philadelphia.

Both sections were made in 4-ft. lengths with ends normal to the axis of the pipe; molded with socket and spigot ends, with the steel reinforcing projecting at each end a distance of 1½ ins., overlapped when laid to form an interlocking joint. Some 3-ft. lengths were made for the proper location of slants for house drainage connections and also for closures on curves. The curves were turned with 4-ft. and 3-ft. lengths with ends bevelled on a line with the radius of the curve, otherwise they were the same as for straight lines.

In this design the socket and spigot is formed in the shell of the pipe (without projection on the interior or exterior surfaces) so that when laid in the trench the projecting reinforcing can be overlapped in the socket and grouted, the grouting being done from a pouring hole molded in the top of the socket end of each length. By this means a continuous and uniform thickness of section is maintained throughout the length of the sewer barrel.

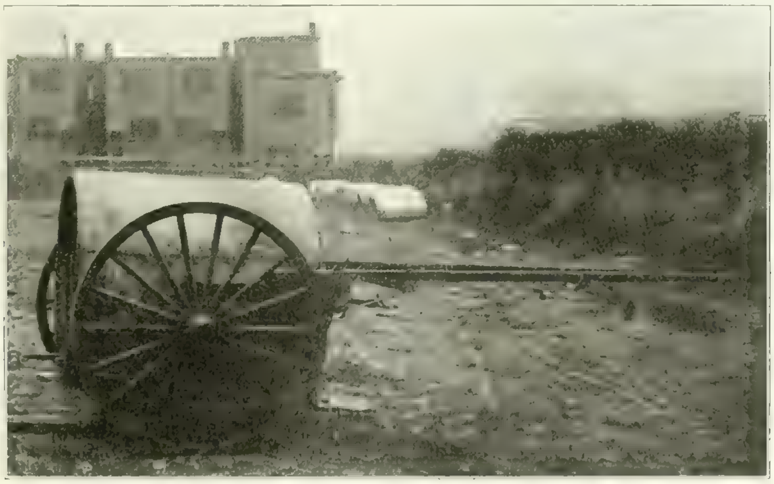

Fig. 1. View of One-Horse Cart Used at Philadelphia for Transporting 24x36-in. Egg-Shaped Reinforced Concrete Sewer Pipe from Yards to Trench.

The specifications required the concrete to be mixed in the proportion of 1 part cement, 2 parts sand and 4 parts crushed pebbles or broken stone. The steel for reinforcing was cold drawn, open hearth carbon steel having a tensile strength of between 80,000 lbs. and 90,000 lbs., external loading and internal hydrostatic requirements were specified as were the character and the design of the forms. It was also required that the pipe be made by an established manufacturer of reinforced concrete pipe.

A vacant lot, 60 ft. in width by 400 ft. in length was secured, convenient to the location of the sewers to be constructed, and a plant, consisting of a one bag batch mixer operated by a 4½ HP. gasoline motor, one 30 HP. boiler, measuring barrows and forms were provided. The lot had been excavated for cellars to a depth of about 6 ft. below the street surface except a section about 100 ft. in length on the east end which was at a slight elevation above the street surface and which was large enough to accommodate the mixer and provide for the storage of materials. The lower section was utilized for the manufacture and storage of pipe. The location of the mixer provided descending grades for the wheel barrow runs from the mixer to the forms. These runs were made in short sections and of a design that permitted their lengthening as the work progressed or removal to different locations as the location of the several lines of forms required.

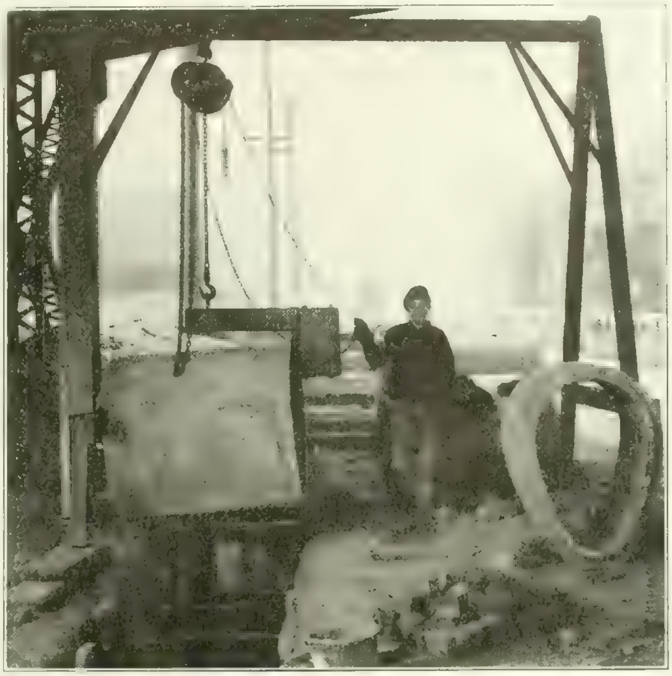

Fig. 2. View of Handling Device Used at Philadelphia in Lowering Reinforced Concrete Sewer Pipe Into Trenches.

The forms consisted of cast iron bottom and top rings shaped to form the socket and spigot ends, with sheet steel inner and outer casings rolled to true cylinders. The inner and outer casings were concentric when assembled. The forms were rigidly held together with clamps and bolts to guard against cracks through the inner and outer rings, and to prevent the leakage of the mix. Butt straps were provided to cover joints between adjacent sheets.

The forms were assembled in four lines of seven or ten forms each with 6-ft. lanes between lines. The bases forming the socket end of the pipe were first laid to line and carefull leveled, a slot being molded in this base to receive the reinforcing. This slot after receiving the reinforcing was filled with sand to serve as a stop for the concrete and provide for the projection of the reinforcing metal in the socket.

The reinforcing was placed after the inner steel casings were assembled and clamped to the base; the assembling of the outer casings immediately following. All surfaces exposed to the concrete being coated with paraffin oil.

A light steel angle, bent to shape, and bolted to the exposed face of the inner steel casing supported a thin steel plate covering the entire interior of the form. This plate or head served as a platform to receive the concrete from the mixer and from which it was evenly deposited and worked into the form.

The steel mesh was received in rolls of about 450 lbs. average weight and were of sufficient width to provide the reinforcing for the full length of pipe sections without splicing.

Giant Portland cement, Jersey gravel or Jersey bank sand, and Birdsboro trap rock aggregate, graded in size from ¾-in. to ¼-in., were used in the concrete mixture. The proportions were by volume although the mixture was occasionally changed to suit the grading of the sand and aggregate so that frequently a richer mixture was obtained than the 1-2-4 specified. Measuring barrows were used to serve the mixer. Sufficient water was used in the mix to cause the concrete to flow readily when dumped on the steel head in the center of the form. As soon as mixed the concrete was turned into the receiving pan in front of the mixer, hoed into barrows, wheeled to the forms, and dumped on the steel heads, from which it was shoved into the forms uniformly and spaded.

This work of placing and spading was performed by one man using a spade made of a steel mortar hoe blade slightly curved, fastened to a steel rod 4-ft. long to which was fitted a wood handle 3 ft. in length. The man employed was skilled in the work but with the exercise of every precaution, air pits on the surface of the pipe could not be entirely prevented. A whole line of forms were completed when once started. The forms were assembled in the morning and poured in the afternoon. The first 80 lengths of pipe made were allowed to harden in air; the casings being removed 24 hours after pouring, the pipe remaining on the base three days. Upon the removal of the casings it was frequently found that the concrete adhered to them. To overcome this adhesion each line of forms was subjected to a hot vapor bath for 12 hours. To provide this vapor, a pipe line leading from an upright 30 HP. steam boiler was run over the center of each line of forms, a canvas covering entirely encasing the forms served to condense the steam. The casings were removed in 12 hours but the pipes were allowed to remain on the bases for three days as in the air hardening process.

The uneven and great variation in temperature obtained at the top and bottom of the forms, unless the greatest care is exercised, makes this a very questionable process.

Tests were made to determine the age at which the pipe could be laid, and while excellent results were obtained at 7 days it was not considered advisable to lay it at that age and 14 days was made the minimum for laying.

LAYING THE PIPE.

A two-horse truck was used to convey the circular pipes from the yard to the work; a one-horse cart designed for the purpose being used for the egg shape pipes, each length was lined up along the trench in place and position for lowering when delivered. The one-horse cart is shown in Fig. 1. One side of the trench was reserved for and kept clear to receive the pipe as delivered, the opposite side being used for the deposit of the excavated material. In this way it was possible to deliver a large number of pipes to the work before the trench was ready to receive them.

The plans required the trenches to be excavated a width 12 ins. greater than the horizontal external diameter of the pipe to be laid in them and to a minimum depth of 3 ins. below the bottom of the pipe; this depth being increased when necessary to obtain a firm foundation. The design required all pipe to be supported in a concrete cradle covering the full width of trench and extending from the bottom of the trench to a height of 12 ins. above the bottom of the pipe. The concrete for the cradle was mixed in the proportion of 1 part cement, 3 parts Jersey gravel and 4 parts crushed stone.

Several methods for laying the pipe in this cradle were tried. The method adopted required the concrete to be placed in the trench to a depth sufficient to bring it to within ½ in. of the elevation of the bottom of the pipe when laid. This was allowed to harden for at least three days before pipe was placed on it. A bed of mortar about ⅝ in. in thickness was spread over this base to seat the pipe and bring it to its proper elevation. After the pipe was laid and jointed the cradle was completed to the required height.

Immediately previous to lowering the pipe the mortar bed was spread for each length; the pipe being shoved over it and settled into place. Each length was laid with the socket end forward, to exact line and grade with a snug fit at the joint.

The laying of the pipe was immediately followed by the "making up" of the joint. This was done by first overlapping the reinforcing projecting into the socket and pressing it into position, then applying a stiff mortar to the lower half of the socket from the inside of the pipe, and grouting the upper half from the outside through the "pouring hole" at the top. The mortar was pressed through the reinforcing until the lower half of the socket was completely filled when it was troweled to a smooth finish; a steel band 6 ins. in width was then sprung around the entire interior of the pipe and keyed tight to prevent the escape of the grout, the exterior being sealed with a coat of stiff mortar covering the joint on the entire upper half of the pipe and extending about 12 ins. below its center. While the grout was being poured a heavy steel wire was worked in the joint to prevent choking and to expel the air. This was continued until the joint was completely filled and the grout brought to the top of the pouring hole. The steel band was removed in 24 hours and the joint smoothed to a finish on a plane with the interior surface of the pipe. The mortar and the grout were made in the proportion of 1 part cement and 2 parts sand.

A very cheap and simple device was used to lower the pipe into place, as illustrated in Fig. 2. It consisted of a light 6-in. steel I-beam 14 ft. long supported at the ends on two wood "A" frames resting on 2½-in. plank runs. A small steel 4-wheel traveler supported on the lower flange of the beam carried a differential pulley to which was hung a wood U-shaped carrier. The "A" frame consisted of two 6-in. by 6-in. yellow pine legs, with a 4-in. by 6-in. strut bolted 2 ft. above their lower ends to prevent spreading; the upper ends being fitted under the upper flange of the beam and bolted to the web. The traveler consisted of a pair of steel wheels fitted to each side of the beam close to the web and seated on the lower flange so as to move freely over it. A light steel frame suspended from these wheels carried a hook from which was suspended the differential pulley.

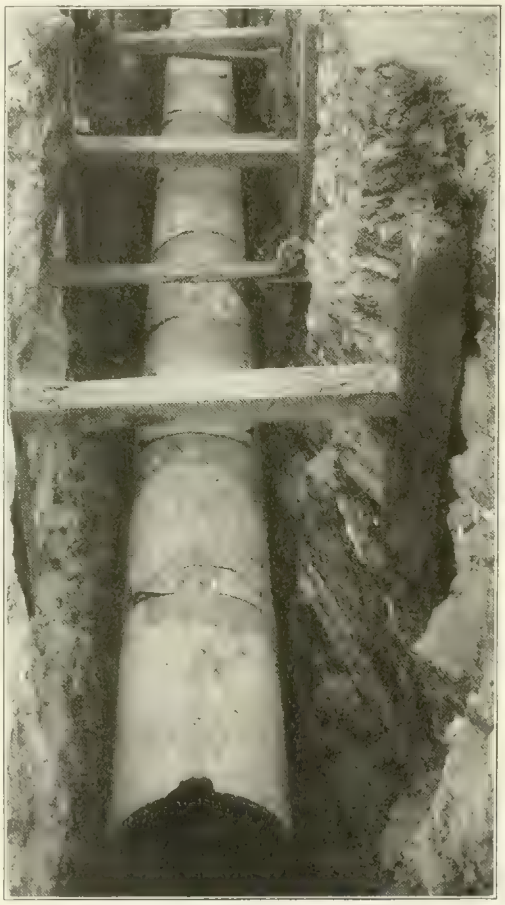

Fig. 3. View of 24x36-in. Egg-Shaped Reinforced Concrete Sewer Pipe in Trench Ready for Backfilling, Philadelphia, Pa.

The wood carrier was made of three pieces of 4-in. by 6-in. oak, 4 ft., 3 ft. 6 ins., and 12 ins. in length bolted together with 2¾-in. bolts. The short length served to separate the long pieces when bolted together and provided space between them for the entrance of the pipe shell. The pieces were bolted together on edge at one end; the ends being brought flush so as to make a variation in length at the free end. When in service the pipe was carried on the 48-in. piece and suspended by means of a heavy eye-bolt placed in the 36-in. piece, 10 ins. from its free end. This piece extended over the top of the pipe a distance sufficient to bring the eye-bolt over the center of the pipe. To insure greater strength a band made of 1½-in. steel ½ in. in thickness was fitted around the carrier at the inside end of the middle piece.

When placed in position for lowering the I-beam extended across the trench and over the pipe lined up along it. The "A" frames were supported on 2½-in. plank runs extending along both sides of the trench. By means of the traveler the carrier was moved directly over the pipe, engaged to the pipe shell which, after being raised, was moved by means of the traveler to a position directly over the center of the trench and lowered to a place on the bed of mortar spread over the concrete base. Before the carrier was disengaged each length was closely fitted at the joint and set to exact line and grade. The carrier was then raised, the "A" frames moved forward on the plank over the next length of pipe, and the laying continued. Pipe laying always commenced at the outlet end with the socket end forward. Figure 3 shows a section of the sewer ready for backfilling. Where necessary to provide for manholes and spur connections an opening of 4 ft. or the length of one section of pipe was made. Where manholes were to be built the openings were excavated a width of 4 ft. 8 ins. for a length of 6 ft., or 12 ins. from each end of the pipe. The area of the concrete manhole base had these same dimensions.

A steel form shaped to fit the inside of the lower half of the concrete pipe and extending 12 ins. in the pipe at both ends of the opening was used to form the invert of the manhole. The concrete was poured around the form to the center of the pipe, and after form extensions were placed, it was carried to an elevation of 7 ins. above the inside of the pipe at the top. The inside of the manhole base at the top was oval in shape, the diameters being 3 ft. and 4 ft. The 3-ft. diameter across the sewer was obtained for the egg-shape section by narrowing the side walls to a thickness of 10 ins. Above the concrete base the manholes were built of brick 9 ins. in thickness tapering to a 24-in. circle at the top or street surface. When connections for spurs were to be provided, wood invert and arch forms in addition to the steel invert form were used. These forms were assembled to form the entire connection before the concrete was poured, making a monolithic section throughout. This provided a square end on spurs for future pipe or brick extensions. The concrete mixture for manholes and spurs was the same as for the pipe.

Whenever possible locations for pipe drains were determined and openings for their connection molded in the pipe. When the location of drains could not be determined before molding the pipe, openings for their connection were cut through the shell with diamond point chisels when the pipes were in place.

Several years ago, but when the cost of labor and materials were about the same, bids were asked and received for these sewers of the standard brick construction; the sections and plans being identical.

The lowest bid received for the 36-in. circular section of brick was $7.95 per foot and for the 36-in. by 24-in. egg-shape section of brick $4.35 per ft. The lowest bid received for the 36-in. concrete section was $5.10 per foot and for the 36-in. by 24-in. egg-shape concrete section was $4.72; a reduction of $2.85 per foot for the 36-in. circular section and an increase of 37 cts. per foot for the egg-shape section. The price per foot includes in both constructions excavation, manufacture, delivery, laying the pipe, backfill, removal of excavated material and repaving over the sewer trench.

In sewers of larger section a greater saving could be made and a better structure obtained by the use of reinforced concrete pipe than by any other method of construction; this is particularly true where water is present in the trenches in great volume and when its exclusion is imperative, as no other method presents equal possibilities of obtaining the same density and imperviousness of either the barrel or the joint at the same low cost.

Method Employed in Placing a Neglected Sewage Treatment Plant in Successful Operation at Monticello, Arkansas.

Mr. Guy A. Watkins, of the firm of Dickinson & Watkins, of Little Rock, Ark., is authority for the statement that the operation of sewage treatment plants is a thing unknown to the city councils in Arkansas. The belief commonly held is that a septic tank digests all the sewage conducted to it and that the effluent is practically pure. In the last few years, however, a number of towns in the State have been made to realize that the general supervision of a sanitary engineer is essential to the successful operation of sewage treatment works, not only to prevent odors but to prevent law suits. In most of the small southern cities the operation of treatment plants is left in the hands of an unskilled negro.

The firm mentioned was engaged to operate the two plants at Monticello during 1914 and the present article describes the methods of overhauling neglected septic tanks and contact beds and of placing them in operation. Our information is from a paper by Mr. Watkins before the latest annual meeting of the Arkansas Engineering Society. The plant described was built in 1909-10 and was designed by Mr. Walter Kirkpatrick of Jackson, Miss. It was allowed to run without any attention, except when acute troubles arose. The following discussion is meant to show how much a plant of this kind needs the general supervision of a sanitary engineer and is not a criticism of the work of the designer. As the tanks and contact beds are similar in design to those which in the last five years have been built in Arkansas, a description of them will fairly closely fit any tank of the same general pattern, and their deficiencies seem to be common to all plants of their type. Figure 1 shows in plan and section one of the Monticello plants.

DESIGN OF MONTICELLO PLANT.

The tank proper is 40 ft. long, from 4½ to 5 ft. deep, below the flow line, and is divided into three sections, 5, 10 and 16 ft. in width. At the inlet end the sewage enters a small box 2 ft. long, 2 ft. wide and 18 ins. deep, then flows through a large grit chamber 15 ft. long, by 3½ ft. wide and 6 ft. deep, into the section or sections that it is desired to operate. At the flow line there is an opening into each section and at the bottom another opening drains the sludge back into the grit chamber where it is by-passed around the filter beds and discharged into a small branch. These openings are all fitted with 8-in. circular sluice gates, with screw control and are set on the inside of the chambers.

At the outlet there is a 6 or 8-in. opening from each chamber to a narrow trough, the flow from which is controlled and distributed by three air-lock feeds. The feeding syphons are intended automatically to distribute the effluent onto the three contact beds and were originally set so the beds were used in rotation.

OPERATION DIFFICULTIES.

However, things did not happen as planned. First, the big grit chamber filled with sludge in from six to eight weeks and had to be cleaned. When cleaning it the raw sewage was cut directly into the by-pass. The valves soon rusted badly and refused to work, which made the process of cleaning the chambers even more disagreeable.

Then the Superintendent of the Light and Water plant, who also has to look after the sewage disposal works, decided to cut the flow directly into the large section. This was done by placing a pipe from the small concrete box above the grit chamber across to a hole cut into the wall of the tank about 2 ft. from the bottom. This left the grit chamber dry and everybody was happy because it would not have to be cleaned.

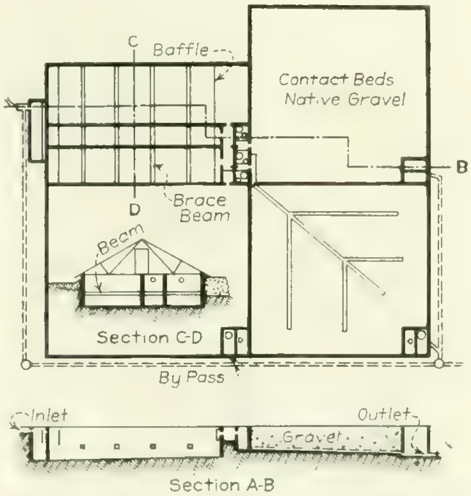

Fig. 1. Plan and Section of Sewage Treatment Plant at Monticello, Arkansas.

Then the air lock feed began to go wrong. The action of the acids in the sewage on the iron pipes and valves was disastrous to the automatic operation of the feed and it could not be depended upon to alternate the flow to the contact beds. Considerable money was spent trying to make this automatic device take care of the effluent properly. One expert was paid $25 per day to adjust the feeding syphons, but after he left it was found that his efforts had not met with any more success than had those of the other men who had been previously employed. A little attention each day would have prevented a great deal of this trouble and expense, but, supposing the apparatus to be automatic, the plants were left to run alone.

When we took over the operation of these plants in May, 1914, the contact beds had been in constant use since their construction in 1910. The gravel had not been washed in the first place, and with all the sludge that had been discharged onto the beds, all voids were completely clogged. The tanks were covered with a very thick scum and were almost full of sludge, so that the space left for the sewage was a very small part of the capacity required to retard the flow sufficiently to allow the solids to settle out. At times when the sludge became very active and gas formed more freely, large parts of sludge would be loosened, caught by the current formed by the reduced capacity and washed out onto the beds.

As there is no connection between the syphon emptying a bed and the one filling it, a great deal of trouble was caused by the filling syphon locking before the bed was full enough to trip the discharging syphon. This left the bed almost full of sewage the greater part of the time and prevented the air from entering the voids and resting the bacteria before another dose was received. This practically killed the effect of the contact beds and, after they became clogged, the standing water on top made excellent breeding places for mosquitoes. The loudest complaint was on account of the disagreeable odors. It was evident that something had to be done at once to prevent odors in order to stop two law suits that were then ready to be filed against the city.

METHOD OF OVERHAULING THE PLANT.

First we took a considerable quantity of scum from the tanks, which temporarily increased the capacity of the chamber in use, and then the gravel in all the beds was thoroughly washed. For this purpose a small gasoline engine and a centrifugal pump were purchased. A trench was dug to the floor of the bed from the outlet along one side. Two streams of water played against the face of the dirty gravel and men with shovels threw the washed gravel behind them, as shown in Fig. 2. The water carried the sediment with it out the by-pass. The gravel was cleaned and leveled for about 35 cts. per cubic yard.

After the beds were all cleaned and put back into service the effluent was very clear and contained practically no matter in suspension. No odors were noticeable and we hoped that with the small increased capacity of the tanks we would have no further trouble for several months. But in August the tank on the west side of town, without any warning, began to discharge large quantities of sludge. This scared the attendant so he by-passed the sewage and immediately cleaned the section. The sludge valve would not work so all the sludge had to be dipped out with buckets and wheeled to a pit where it was buried. The sludge was 4 ft. deep and it was no small or pleasant job to clean this tank in August.

In taking off the scum it was noticed that only the part near the water was offensive and only the top foot of the sludge gave off any disagreeable odor. Below that depth it was black, well decomposed and odorless. When the valve was reached it was cut out and the section washed clean. The opening was then stopped by placing a block over it from the grit chamber side and bracing it against the

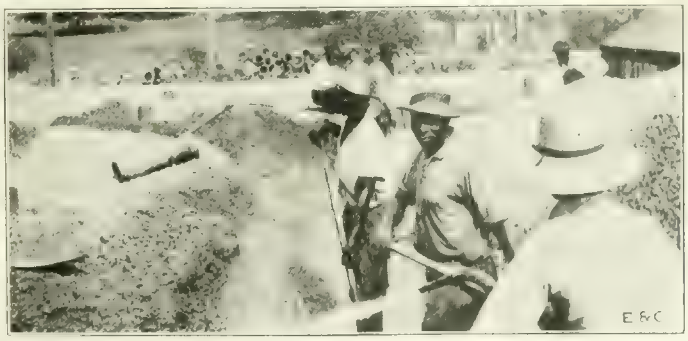

Fig. 2. Method of Washing Gravel in Contact Beds at Monticello.

(Foreign matter washed out and floated off. Clean gravel shoveled back of workmen.)

Fig. 3. Type of Structure Commonly Used to Cover Arkansas Septic Tanks.

(In addition, the Monticello Council built these over tanks of No. 1 yellow pine, tongue and groove, flooring to prevent escape of odors.)

opposite wall. Shear gate valves were ordered and placed from the grit chamber side where they can be more conveniently operated.

This tank was put back in service without seeding, though it was our intention to have this done, and in three weeks there was a good scum over almost the entire surface, which was thick enough in front of the first baffle board to support the weight of a man.

The greatest problem in the operation of a sewage disposal works is the handling and disposition of the sludge. The shallow tanks fill rapidly and to keep an approximately constant capacity must be cleaned oftener than is expected in most cases where they have been installed. To this fact is due a great deal of the disappointment found in most every town using this style of tank. The people are led to believe that a septic tank consumes all solid matter entering it when really it only partly reduces the organic compounds, leaving a large quantity of sludge to be taken care of, for which no preparation is made in the original plans. I'll venture that at no plant in the State, built three years ago, is there a sludge drying bed, nor is there any means provided for taking care of the sludge other than by-passing it directly into the small branch into which the sewage is discharged. When there is no water in the branch in the summer months, to by-pass a quantity of this sludge usually brings forth a storm of complaints.

The two-story tank has recently gained great favor for the reason that it separates the sludge-digestion chamber from the settling chamber and thus the velocity can be kept nearer constant and the sludge can have all the time necessary for its thorough digestion. As the bacteria beds are on the under side of the scum and on top of the sludge, in the two-story tank the decomposed sludge can be withdrawn from the bottom and the dry scum taken from the top, so that the bacteria beds need never be disturbed. This well rotted sludge is not only odorless, but is harmless and can be discharged directly into the stream at times of high water without causing any nuisance, though it is better to use a drying bed in the summer months.

Since odors are considered the greatest nuisance caused by a sewage disposal plant, it is very necessary that the causes of these be carefully studied and efforts made to prevent them. After the Monticello plants were cleaned up and put in better shape, there has been only two occasions on which the odors were perceptible beyond the limits of the plants. Each time it was at a very low stage in the flow and after several weeks of hot, dry weather. At these times the sewage was naturally strong and the high temperature encouraged fermentation. The escaping gas worked the scum into a homogeneous yellowish mass all around the inlet end of the tank, and the odor of sulphuretted hydrogen was very apparent.

The first time this occurred was in July, and as the hook-worm field doctor was there, I had him examine some of this yellow scum and also some of the tank effluent to ascertain if any hook-worms were present or were passing through the tank. He found no worms, but did find good strong live eggs in both this yellowish scum and the tank effluent. And in a bottle of raw sewage taken the first of this month were quite a number of small live worms, closely resembling the hook-worm, which lived for several days after the bottle was brought to the office. It is known that the germs of all the intestinal diseases are not materially affected by septic action, but are found in the effluent as well as the influent of the tank.

In the design of sewage disposal plants, whether they are to be operated by skilled or unskilled men, a close study should be made of all possible conditions under which the tanks and filter beds might in the future have to be operated and the simplest means of caring for the sludge should be devised. The tanks should be fitted with only the best non-corrosive metal parts that can be purchased. If automatic distributers are used they should be set with great care and placed so the attendant can get to them—not set deep down in a snugly fitting concrete pit. Any apparatus that is to be used must some time or other be adjusted and enough space should be left around it to permit the workman to use his tools with ease. No valves should be placed inside the tank if it is possible to put them outside.

Where the ground water seepage is great enough to seriously affect the operation of the plant, as it sometimes is at Monticello, a jumping wier or some other device should be installed at the inlet to by-pass the surplus water. From the wiers we placed at the tank there, we find that over 5 ins. on a 4-in. wier, which is 194,000 gals. per day, overloads one contact bed, necessitating the use of two. To remedy this we intend making the wier into an orifice 4 by 5 ins. in diameter, so that if the flow gets above 5 ins. it will by-pass. At present we adjust the side opening in the small concrete box so as to by-pass the surplus water.

It may be well enough to build some kind of structure over the tanks, but they should not be covered with a floor. The type of structure used to cover Arkansas tanks is shown in Fig. 3. Every part of the whole plant should always be easily accessible. The premises should be kept clean, the buildings painted white and the grounds parked. This is not always possible, but there is no plant in the state that could not be greatly improved with practically no more energy on its maintenance than is now expended. If the ground is fenced with an ugly lot of posts and wire this could be covered a greater part of the year with some flowering vine, and other parts of the ground could be planted with bright, sturdy flowers. Flowers not only look well but aid considerably in preventing odors. As the sensitiveness of the public nose is greatly reduced by removing the knowledge of the source of odors small expenditures for parking have been found well worth while.

DRAINAGE AND IRRIGATION

Measuring Devices for Irrigation Water Tested at the Davis Field Laboratory, University of California.

There are described here a number of measuring devices for irrigation water. These devices are those tested at the laboratory installed at Berkeley, Cal., jointly by the Office of Experiment Stations, U. S. Department of Agriculture, the State Engineering Department of California, and the California Agricultural Experiment Station. The descriptions and records which follow are from Bulletin No. 247 of the Agricultural Experiment Station.

MEASURING DEVICES FOR UNDERGROUND DISTRIBUTION SYSTEMS.

When irrigation water is distributed in underground pipes measurement is usually accomplished at the hydrant through which the water is brought to the surface. Three of the measuring hydrants used in southern California have been installed at the field laboratory.

Azusa Hydrant.—This hydrant (Fig. 1) is chiefly used in the vicinity of Azusa, Cal., and provides for measurement through one or more orifices on the center of which a pressure head of 4 ins. is maintained by means of a sheet-iron spill crest set at right angles to the orifice plate. The hydrant is in the form of a concrete box placed over the supply pipe line. The openings in the orifice plate are 4 ins. high and 2½, 3¾, 6¼ and 12½ ins. wide, giving areas of 10, 15, 25 and 50 sq. ins., respectively. When the water surface on the upper side of these openings is held 4 ins. above their centers they will discharge respectively 10, 15, 25 and 50 ins. By using different combinations of these openings several different amounts up to 100 ins. can be measured. The water enters through the pipe shown in the drawing. The orifices for the desired amounts to be turned out are opened and the others closed with slides. By adjusting the gate below the spillway the water can be brought to the crest of the spillway, the area of the orifices in square inches being then equal to the number of inches turned out. If the water rises above the openings a large part of the increase will be carried back to the supply line over the spillway, but any increase in depth on the openings will also increase the amount turned out.

The Azusa box as shown has walls 6 ins. thick, all sides being vertical and flat. The forms required in making are therefore simple. The box contains 78.3 cu. ft. of concrete. This can be made of 1 part cement to 4 parts coarse sand. As the walls are 6 ins. thick it is better to use some gravel when it can be obtained. A good mixture when using gravel is 1 part cement, 3 parts sand, and 4 parts gravel. The gravel should not be larger than 1½ ins. The concrete for this box, including forms, will cost from $18 to $20 under a large contract and about $30 if made singly. The plate with the openings and slides can be bought already made for $12 from foundries in the vicinity of the places the hydrant is used. The gate can be any of the usual types of slide gate.

The average of all tests made of this hydrant showed the amounts in inches being carried through the openings to be 1 per cent more than their area in square inches. This difference includes all errors in the measurements so that these openings are seen to be very accurate. The tests showed all openings or combinations of openings to be equally accurate. The box will therefore measure as accurately as is required. The openings are not as closely adjustable to the amounts turned out, however, as they are in the case of the box of the Riverside Water Co.

Gage Hydrant.—This hydrant (Fig. 2) has been developed, and, so far as is known, is only used by the Gage Canal Co. of Riverside, Cal. The main box is of mortar 2 ins. thick and is made in the material yard and seasoned before setting. The concrete is made of 1 part cement and 3 parts coarse sand, mixed quite dry and thoroughly tamped. The bottom is cast separately and the top cemented to it in the field. The dimensions of the box are shown in the drawing. The weir crest consists of ⅛ x 1½-in. iron cemented to the sides, giving a final opening of 10 ins. wide and 10½ ins. high. One man makes two boxes in a day. In making one box 2 2/7 sacks of cement are used. The company charges $10 per box, with weir not installed. The outlet chamber into which the water goes after passing over the weir is omitted from the drawing. In the hydrant installed at Davis a half section of 18-in. pipe is used for this purpose, as shown in the photograph. When the hydrant is not in use the valve shown in the drawing at the end of the pipe is kept closed. When in use the valve is opened to the desired extent and the water rises from the valve and flows over the weir. The amount flowing is determined by measuring the depth of the water in the box above the crest of the weir and either figuring the discharge or taking it from a table. The depth of water on the crest is usually obtained by measurement from a bracket set level with the crest at the back side of the box. After the water passes the weir it can be caught in various ways and carried to its point of use. Generally this is done by letting it fall to a pipe below and carrying it through pipe distributing systems or directly into a distributing flume.

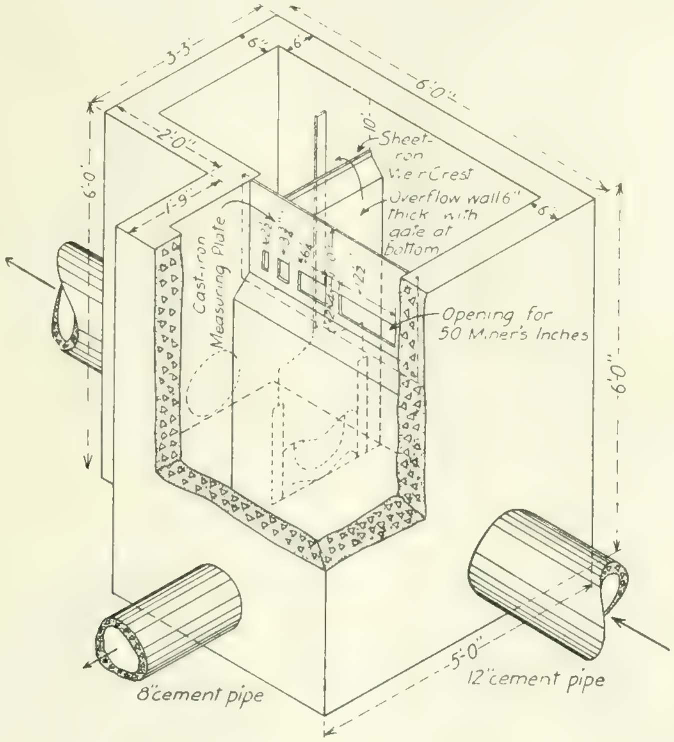
3'-5"
6"
6"
6'-0"
2'-0"
1'-9"
6'-0"
10"
Sheet-iron Weir Crest
Overflow wall 6" thick with gate at bottom
6"
Cast-iron Measuring Plate
Opening for 50 Miner's Inches
6'-0"
5'-0"
8" cement pipe
12" cement pipe

Fig. 1. Detail of Azusa Hydrant.

In the tests with this hydrant it was found that the amount of water discharged for any given depth was greater with this box than it would be with a standard 10-in. weir. This is due to the nearness of the sides of the box to the sides of the weir and to the velocity conditions in the box. The amount of this difference increases as the head increases, being as much as 35 per cent at the higher heads. In practice the principal source of error in using this box will be the difficulty in measuring the depth over the weir closely. In the tests this was done with special gages enclosed in stilling cans, but even then it was difficult to get the depths correctly. Measurements in open water with a rule would vary much more.

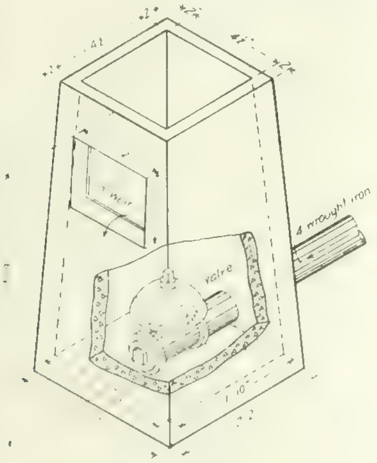

Fig. 2. Detail of Gage Hydrant.

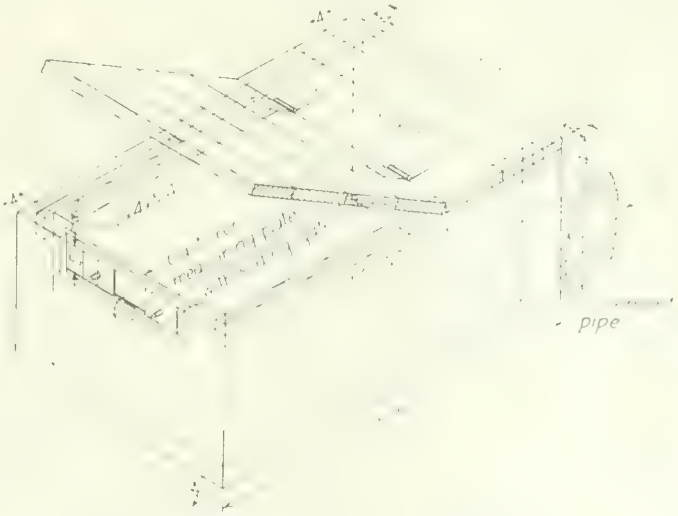

Fig. 3. Design of Riverside Measuring Box.

Riverside Box.—This box is shown in Fig. 3. It consists of a shallow box set over the end of the delivery pipe line. The water enters through the bottom of the box and is measured out through an adjustable castiron measuring plate in the end. The opening in this plate is 5 ins. high and by moving the iron slide gates it can be varied in width up to 14 ins. With this gate, however, there is no provision for holding a constant head or pressure above the opening. The top of the plate is 4 ins. above the center of the opening. Thus if the slides are set so as to hold the water surface at the top of this plate the discharge in inches will equal the area of the opening in square inches. The area of the opening is the width in inches multiplied by 5. Marks 1 in. apart are made on the plate to assist in measuring the width. The method of carrying the measured water away is not shown on the drawing but is shown in the photograph. The water is usually dropped into another pipe system to be distributed for use. Care should be taken so to place the outlet chamber that water passing through the gate will always have a free fall.

The Riverside box is made of concrete 4 ins. thick and contains 18.4 cu. ft. of concrete. The concrete can be made of 1 part cement, 3 parts sand, and 4 parts of gravel not larger than 1½ ins. in diameter. This will require three sacks of cement for the box. The box can be made with a cover as shown in the drawing. The plates containing the orifice can be purchased already made. The forms for making the concrete walls are simple as there are no curves and all sides are vertical. The cost of the plate is $2.25, the concrete will cost from $3.50 to $5 for material, forms, and labor, and the cover will cost about $1.50 more. These boxes are made and installed by the company for $10.

In the tests of this device the average difference between the number of inches actually received and the area in square inches of the opening was about 2 per cent. Some of these tests gave more and some less than the measured amounts. For all tests the area in square inches of the opening averaged 1 per cent greater than the inches actually received. The tests show that where care is used to adjust the width of the opening to the amount running this box will measure water very closely.

While the Riverside box is of the type used on underground pipe systems, the measuring plate used in it can be set in open ditches if desired. The box is sufficiently large so that the water passes through it without much agitation and can be brought to the top of the opening plate quite closely. There will generally be some leakage around the slides but these can be wedged tight if necessary. The box shown will measure amounts up to 75 ins.

FOOTE INCH BOX.

This structure is shown in Fig. 4. It consists of a box having two principal parts, the larger part being merely a section of flume set in the main channel of the supply lateral and the smaller a spill and measuring chamber. On one side of this smaller portion there is a discharge opening in which a slide moves horizontally. The other side of this side box or flume is a spillway. Gates are arranged as shown at the upper end so that water can be turned into this side box as desired. This is done by putting in as many flash boards across the supply lateral as are needed to crowd the water into the side box. The slide on the miner's inch opening is then set so that the water in this side box stands level with the crest of the spillway. The crest of this spillway is placed 4 ins. above the center of the opening. The opening is 4 ins. high. Thus when the water stands level with the spillway the width of the opening of the slide multiplied by four gives the number of inches flowing.

This box does not require much fall in the supply lateral. The crest of the spillway should be set so that the water in the main channel will be at least 3 to 4 ins. below it. The water in the ditch above can then be checked up with the flashboards until the water in the side box comes level with its crest. The ditch into which the measured water is turned must be lower than the main channel by over 1 ft. The water in the outlet flume should not rise within about 3 ins. of the bottom of the slide opening. If the water in the outlet flume does rise above the bottom of the slide opening, the conditions for measurement are changed and the discharge is smaller than with free fall.

In the test of this device the amount of water supposed to have been passed, as measured by taking the area of the slide openings, averaged 4 per cent greater than was actually run. The error did not vary with the amount of the discharge. From these tests it appears that the slide can be set within an average 4 per cent of correct if care is used.

This box will measure water up to 150 ins. satisfactorily under conditions to which it is adapted, although it is not in general an economical box to use. It requires as much fall from the supply lateral as a weir, besides some fall in the lateral itself. It also takes as much lumber as is required for a check and turnout in the supply later and a weir below. The weir will give more satisfactory measurements and has no slides to leak if too loose or to stick if too tight. The inch box was used a good deal in the earlier days when water was measured mainly for mining but is built but little now for irrigation use. It has one advantage over a weir in that the amount being measured can be determined directly from the area of the slide opening, no tables or figuring being needed. With a weir, tables must be used giving the discharge for weirs of different lengths at different depths.

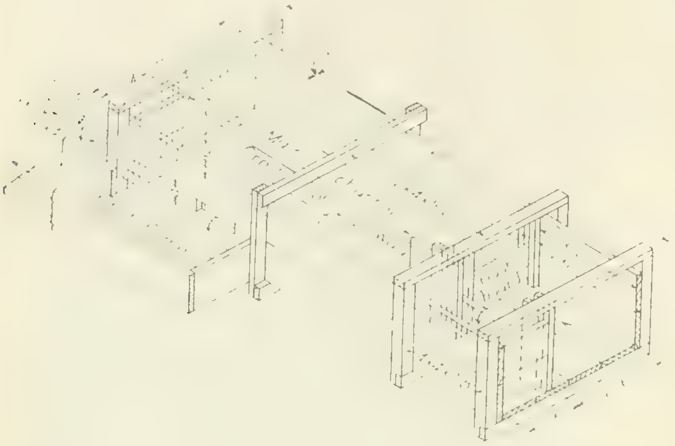
Fig. 4. Detail of Foote Inch Box.

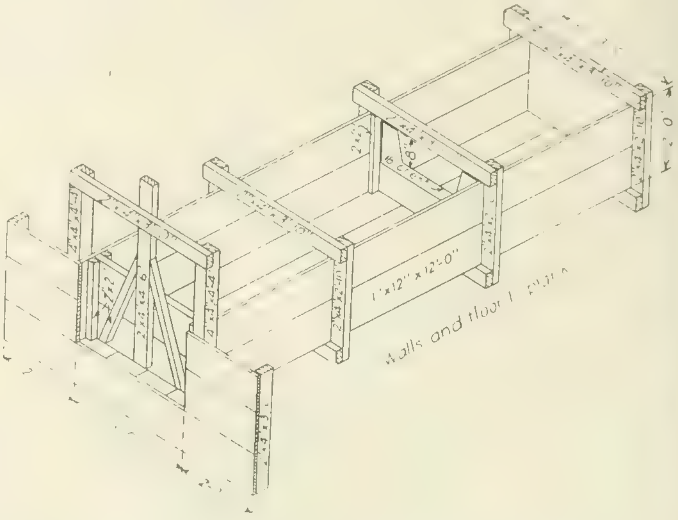

Fig. 5. Detail of Cipolletti Weir and Weir Box.

WEIRS.

In sections where the irrigated lands have a considerable slope, so that water can very easily be led from the supply ditches or laterals to the land without having to check the water nearly as high as the ditch banks, some form of weir is the most common type of measuring device. Taken singly, however, a weir, like other non-mechanical meters, measures the rate of flow and does not indicate the total quantity delivered. In conjunction with a water register, which graphically records the depth of water passing over the weir, or in conjunction with such a device as the Hanna meter, which may be arranged to read directly in acre-feet, measurement by means of a weir gives entirely satisfactory results. Where conditions permit its use the weir is thus far the generally accepted device for measuring lateral diversions from main canals. It is also an accepted standard device for testing the rate of flow from pumping plants, just as it has been the standard device in the tests that have been made of the various devices installed at Davis. Small movable weirs are convenient for use by farmers for measuring the water carried in their individual ditches or discharged by pumping plants.

Three types of weirs are chiefly in use in irrigation practice, viz.: the Cipolletti weir, the weir extending the entire distance across the ditch or flume carrying the water measured, known as the weir without end contractions, and the rectangular weir that does not extend entirely across the ditch or flume, known as the rectangular weir with end contractions. The first two only of these are installed at Davis and described in this bulletin.

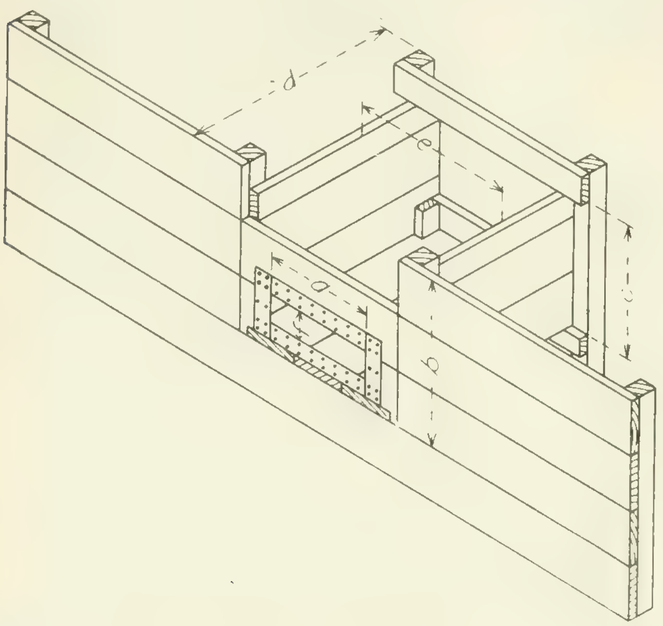

Fig. 6. Design of Submerged Orifice Used by U. S. Reclamation Service.

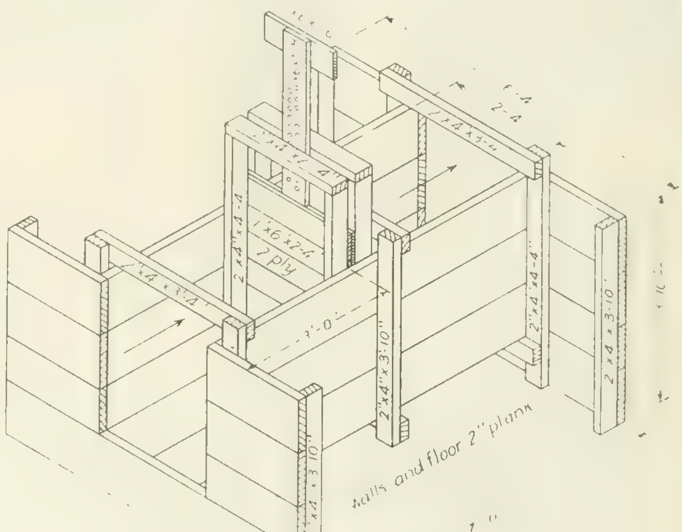

Fig. 7. Design of Submerged Orifice Headgate.

Cipolletti Weir.—This weir, as installed at Davis, is shown in Fig. 5. The length of weir and size of box to make are of course dependent on the quantity of water to be measured. In general, it may be said that a Cipolletti weir should be small enough so that the amount of water to be measured will never give less than a depth of 1 in. over the weir crest, and large enough so that the depth will never need to be much more than one-third of the crest length. Care should also be taken to see that the weir crest is long enough so that the water can be measured without raising it higher over the weir crest than is permitted by the available fall. A number of other conditions are usually laid down as necessary for the weir. The most important of these, briefly paraphrased, follow:

1. The distance from the crest of the weir to the bottom of the canal or floor of the weir box should be at least three times the depth of water on the weir. That is, with an 18-in. weir intended to measure up to 2 cu. ft. per second, which requires a depth on the weir of about 6 ins., the crest of the weir should be about 18 ins. above the floor.

2. The distance from the ends of the weir crest to the sides of the weir box should be about twice the depth of the water on the weir, or, say, from 10 to 12 ins. in the case of an 18-in. weir measuring about 2 cu. ft. per second.

3. The bottom and sides of the weir notch should be bevelled on the down-stream side to give a narrow edge. The use of a galvanized iron crest is quite common and very satisfactory, but not necessary. Sometimes thin pieces of strap iron are fastened on the upstream side of the weir notch. In other cases the board in which the weir notch is cut is merely bevelled down to a crest thickness of one-eighth or one-quarter of an inch.

4. Water should not be allowed to approach the weir with a velocity exceeding 6 ins. per second. Also, it should flow to the weir in a smooth stream free from eddies or

swirls. Both of these conditions are most easily met by placing the weir in a straight section of the ditch.

5. The water passing over the weir should, if possible, have a free over-fall. Where necessary, however, it may rise to the level of the weir crest without appreciable error in the measurement.

6. The depth of water on the weir crest must be measured sufficiently above the weir to be free from the downward curve of the water as it passes over the weir. For convenience in making this measurement of depth a stake with its top level with the crest of the weir is usually set at one side of the ditch 2 or 3 feet above the weir, the measurements of depth then being made from the top of this stake to the top of the water.

The bill of material given below covers what is necessary for an 18-in. Cipolletti weir box and weir as installed at Davis. This box is long enough and of such other dimensions as to meet the general conditions that have been named. In some situations the box might be made somewhat shorter, but the additional cost required for a 12-ft. over, say, an 8-ft. box is not sufficient to justify using the shorter box where only a small number of weirs are involved. This box is suitable for measuring from about 0.25 to about 1.75 or 2 cu. ft. per second, equivalent to 12½ to 100 customary California miner's inches.

Weir Without End Contractions.—This is different from the Cipolletti weir just described mainly in having the weir board extend the full width of the weir box. The same bill of material can therefore be used except that more or less lumber will be necessary according to the width and height of the weir chosen. This type of weir can only be used in a channel of constant cross-section and vertical sides directly above the weir, such as is provided in the box shown. This weir must be so constructed as to allow free access of air to the under side of the falling sheet of water. This can be accomplished by making a horizontal notch in the side of the weir box directly below the crest and extending down stream to the end of the wall. The water must not be allowed to approach the weir with an appreciable velocity. The velocity of approach is largely governed by the height of the weir board above the bottom of the box. It has been suggested by Professor Richard R. Lyman, of the University of Utah, that a weir of this type 1 ft. or less long should be 6 ins. high, that with lengths of 1.5 to 2.5 ft., it should be 9 ins. high, that with lengths of 3 to 4 ft. it should be 1 ft. high, and that with lengths of 5 to 7 ft. it should be 1.5 ft. high.

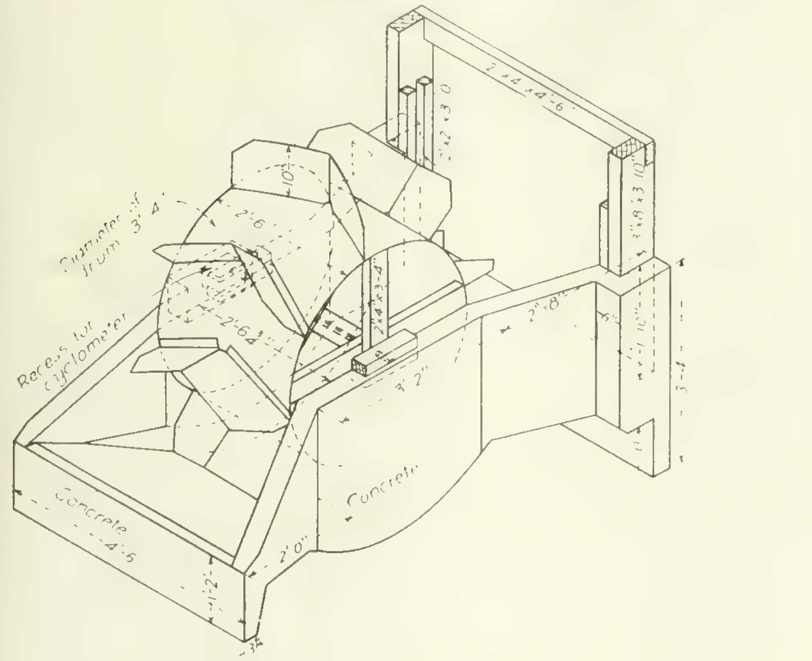

Fig. 8. Design of Dethridge Meter.

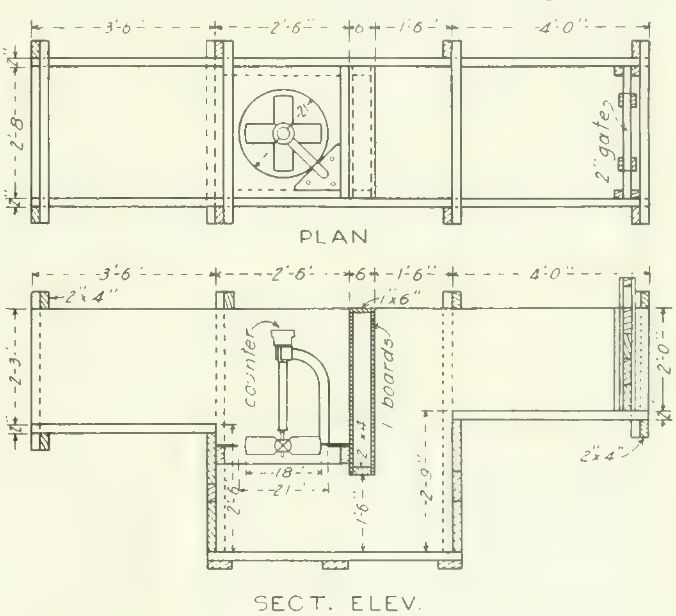

Fig. 9. Plan and Elevation of Installation of Grant-Mitchell Meter.

SUBMERGED ORIFICES.

The measurement of water through orifices has long been common in irrigation practice and various forms of orifices have been developed. The essential condition in the use of an orifice, eliminating the question of form, is that the water on the up-stream side of the orifice shall completely submerge it. If, when in use, the surface of the water on the lower side of the orifice is below the bottom thereof, the orifice is said to have a free discharge. If the surface of the water on the lower side of the orifice is above the top of the orifice, completely submerging it, it is classed as a submerged orifice. Except in the case of the miner's inch box, which is really but a form of orifice with free discharge, use of the orifice in irrigation practice is confined to the submerged form.

Submerged orifices as used can be divided into two general types, viz.: those with orifices of fixed dimensions (Fig. 6) and those built so that the height of the opening may be varied (Fig. 7). Orifices with fixed dimensions are usually made with sharp edges similar to the crest of a weir. The most usual type of the second class is the simple head gate (Fig. 7), which is also used as a submerged orifice, the height of opening and loss of head being adjusted to the amount which it is desired to turn out and to the loss of head available. Of these two types, the sharp-edged orifice with fixed dimensions is much the more accurate.

BILL OF MATERIAL FOR CIPOLLETTI WEIR BOX.

	Board feet.
4 pc. 1" x 12" x 2' (cut-off walls)	8
1 pc. 1" x 12" x 7' (cut-off walls)	7
4 pc. 1" x 12" x 12' (main walls)	48
7 pc. 1" x 12" x 12' (floor)	84
[illegible] pc. 2" x 4" x 3' (posts)	16
2 pc. 4" x 4" x 4'-4" (posts)	12
8 pc. 1" x 2" x 2' (cleats)	3
1 pc. 2" x 4" x 4'-6" (gate stem)	3
1 pc. 2" x 2" x 6' (gate stem brace)	2
2 pc. 2" x 12" x 3' (gate)	12
2 pc. 2" x 12" x 3' (weir board)	12
8 pc. 2" x 4" x 3'-10" (caps and sills)	21
Total	228

Submerged Orifices With Fixed Dimensions.—This type of submerged orifice is used for measurement only, the fixing of the size of the opening preventing its use as a headgate. The experiments which have been made by hydraulic engineers to determine the coefficient of discharge for the standard sharp-edged orifice approach in accuracy and number those that have been made for sharp-edged weirs. These experiments have shown the coefficients to vary slightly with the size of the orifice. For the sizes used in the measurement of individual deliveries of irrigation water this variation may be overlooked and one formula used for all sizes.

In order that the known formula for the discharge through such orifices shall apply, certain standard conditions must be observed in the construction and use of these orifices. The edges of the orifice must be sharp and definite in shape. It is preferable to use a thin metal plate as this is not subject to wear and change. The edges of the orifice should not be too near to the sides of the box on either the upper or lower sides; a distance equal to twice the least dimension of the orifice is sufficient. The orifice should be vertical with the top and bottom edges level. The ditch above the orifice should be sufficiently large so that the velocity of approach will be small, as is necessary in the case of a weir. Corrections can be made in the computations for any velocity of approach but such corrections are more or less uncertain.

The principal sources of error in measurements with this type of orifice are due to errors in the gage readings to determine the difference in the elevation of the water on the two sides, this being the head or pressure that forces the water through the orifice. As these orifices are generally used where there is but little loss of head available, the opening is usually made sufficiently large to require as little loss of head as is practicable. Any error in reading this loss of head is thus a larger percentage of the whole than it would be for greater total differences.

In the use of the submerged orifice two gage readings are required, one above and one below the orifice. The reading above the orifice should be taken back from the edge of the orifice. In the type of structure shown in Fig. 5 this can be taken on the side wing wall. The measurement below the orifice should be taken at least 2 ft. below it and farther if the discharging water is rough. A convenient method of obtaining the difference in the elevation of the water above and below the orifice is to set marks at equal elevations above and below the orifice or to set a board with its top level extending above and below the orifice sufficiently far to give good points for measurements. The difference in measurements from this level board to the surface of the water above and below the orifice gives the head or pressure under which the water is passing through the orifice.

The type of orifice described above has been adopted by the U. S. Reclamation Service for use where sufficient loss of head is not available for weirs. The cost of one of these devices installed will vary from about $5 to about $15.

One of the orifices described above, 2.0 ft. wide and 0.5 ft. high, has been installed at Davis and a series of tests made with discharges of from 1 to 2.2 cu. ft. per second. The mean of all tests gave a coefficient for use in the formula given with the table of 0.61, which is the same as has been found in other experiments. When properly installed this type of submerged orifice should give dependable results if the difference in head is correctly measured. Care should be taken to prevent silting in front of the orifice or the catching of drift.

Submerged Orifice Headgates.—This type of submerged orifice (Fig. 7) has been used to a large extent on systems where the small loss of head available makes a combination of headgate and measuring device necessary. While all such devices have many points of similarity, different canal companies have adopted slightly different forms as their standard.

The accuracy of measurement of water through a submerged opening depends on the measurement of the loss of head, the area of the opening, and the selection of the coefficient for use in the formula of discharge.

Measurements of the pressure for such gates are made in the same way as described for the submerged orifice with fixed opening. The best method is to make the measurements sufficiently far from the gate to avoid any sucking of the water on the upper side or rough water below. The pressure sometimes is determined by measuring down to the water surface on the upper and lower sides of the gate. This is a poor method as the water is liable to be drawn down below its true level above the gate and to shoot out from the gate below. The area of the opening is generally measured between a fixed mark on the gate stem and the top frame of the gate, the mark being placed so that it is even with the top of the frame when the gate is closed. The width is the same for any height of opening.

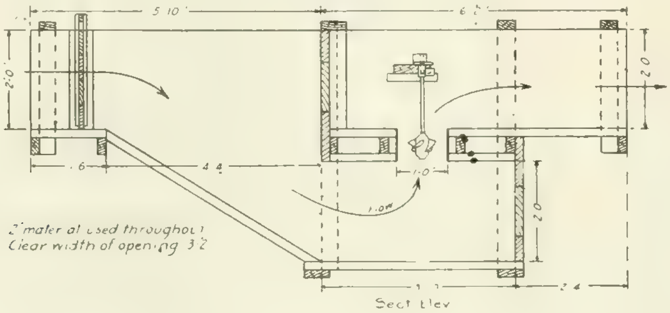

Fig. 10. Sectional Elevation of Installation of 12-in. Hill Meter.

The proper coefficient to use in computing the discharge through such orifices is uncertain. Within general limits for any fixed set of conditions, the coefficient is probably nearly constant, but the actual coefficient to use may depend on many variables. For this reason discharge tables are not included. The values for sharp-edged orifices 0.61 or 0.62 have been used by some canal companies. It is certain that these values are too low for the orifices made of either 1-in. or 2-in. lumber. The Yolo Water & Power Co. have adopted a standard form of headgate 3 ft. wide with spreading wing walls, the bottom of the gate being 1 in. above the floor. Experiments made with this gate under the direction of Professor B. A. Etcheverry gave a mean value for the coefficient of 0.73, which has been adopted by the company for use in the delivery of water.

Tests of a submerged orifice gate under two conditions were made at Davis. One gate 3 ft. wide with the bottom 6 ins. above the floor were set at the upper end of the turnout box diverting from a concrete flume. This gate is similar in type to the one shown in Fig. 6. It was tested with discharges of from 0.50 to 4.25 cu. ft. per second. The height of the side walls prevented the use of larger discharges, although the gate can handle much larger heads. The loss of head was determined by measuring down from a level board above and below the gate and also on the gate. The mean of all measurements using the level board gave a mean coefficient of 0.80; the measurements on the gate gave a mean of 0.72, but were more variable than the others.

A similar gate set across the 3-ft. wide concrete flume of the field laboratory was also tested, giving a mean value of 0.79 for the coefficient with level board readings. The discharges varied from 1.6 to 6.9 cu. ft. per second in these experiments.

From these results it is seen that the coefficient for such measuring gates varies with the type of gate. It is possible that the coefficient would have been lower for higher rates of discharge at Davis if such tests could have been made.

There are several types of these gates in use in California. The gate used by Imperial Co. No. 1 is set 4 ft. back from the front of the box. In the box used by the Kern County Land Co. the gate is set at the front, flush with the side of the canal.

Where the lack of sufficient fall for the use of a better measuring device makes the use of this type of submerged orifice necessary, a standard size and structure should be adopted, and special discharge tables prepared. This should then be rated under the condition in which it will be used. As long as the conditions of use can be maintained, fairly satisfactory measurements can be made. Care should be taken to prevent the deposit of silt or sand near the gate as this will change the conditions of discharge and affect the rating. The velocity above the gate should also be made as small as practicable.

BILL OF MATERIAL FOR SUBMERGED ORIFICE HEADGATE.

	Board feet.
12 pc. 2" x 12" x 2' (cut-off walls)	48
2 pc. 2" x 12" x 6'-4" (cut-off walls)	26
6 pc. 2" x 12" x 7'-4" (main walls)	88
2 pc. 2" x 12" x 7'-4" (floor)	30
1 pc. 2" x 4" x 7'-4" (floor)	8
6 pc. 2" x 4" x 3'-10" (posts)	15
4 pc. 2" x 4" x 4'-4" (posts)	12
4 pc. 2" x 4" x 4'-4" (gate posts)	12
3 pc. 2" x 4" x 3'-4" (caps)	7
3 pc. 2" x 4" x 3'-4" (sills)	7
2 pc. 2" x 4" x 2'-4" (gate caps)	3
3 pc. 2" x 12" x 2'-4" (gate)	14
1 pc. 1" x 6" x 7'-6" (gate stem)	4
Total	274

The cost of one of these orifice headgates in Imperial Valley is given by the Superintendent of Mutual Water Company No. 1 as about $20. The items making up the total are, lumber about $9; labor, exclusive of excavation, about $8; excavation and incidentals, about $3.

MECHANICAL DEVICES THAT MEASURE AND REGISTER TOTAL FLOW.

It is stated in the introduction of this bulletin that to be fully satisfactory for measuring individual deliveries of irrigation water a device should register the total amount of water passing, rather than the rate of flow. Three devices of this character—Dethridge, Grant-Michell, and Hill meters—have been installed at Davis and tested.

Dethridge Meter.—This meter is shown in Fig. 8. It was invented by Mr. J. S. Dethridge, of the State Rivers and Water Supply Commission of Victoria, Australia, and has been extensively installed in Victoria, where 5,000 are now in use. It has also been used quite extensively in New South Wales.

The Dethridge meter consists of a wheel or drum to which projecting pieces of sheet metal are fastened. The drum is placed with its axle horizontal and is set so that the projecting blades are in the current of the ditch to be measured. A special box is built around the wheel so that all water in passing has to strike against the blades. In this way the wheel turns in proportion to the amount of water passing. Knowing the number of revolutions of the wheel the amount of water passed can be determined.

The illustration given shows one of these wheels set in a concrete box, but wooden boxes of similar form can be used. The whole structure is set just below the turnout gate, which is shown in the drawing. The bottom of the box is curved to fit the shape of the wheel. About ⅜ in. of clearance is left between the box and the blades. In use the water comes against each blade and pushes it around until the next blade strikes the water. In this way the space between the blades is filled with water, which is carried through the meter. The meter shown seems to have a normal capacity of 4 cu. ft. per second and can be crowded to carry 5 cu. ft. per second. This higher quantity, however, causes splashing over the top of the box. The fall needed to turn the meter varies with the amount being measured, from ½ in. for 1 cu. ft. per second to 2½ ins. for 4 cu. ft. per second. This small required fall makes the use of this meter practicable in ditches with low grade. A counter is attached to one end of the axle and this indicates the number of revolutions which the meter has made at any time. The difference in the reading of the counter at any two times gives the number of revolutions the meter has made between the times of reading. By multiplying this number of revolutions by the number of cubic feet passed per revolution, the total quantity of water received can be determined. It is most convenient to transfer the water received into terms of acre-feet.

If it is desired, with the Dethridge meter, to know the rate at which water is being received at any time it is only necessary to time the meter for one or more complete revolutions and divide the quantity passed per revolution by the time for one revolution. Thus, if it takes 30 seconds for the meter to make one complete turn and it is known from its rating that it passes 30.5 cu. ft. for each turn, the rate of flow is 30.5 divided by 30, or a little over one cubic foot per second.

The walls of the box in which the Dethridge meter is set are 4 ins. thick when made of concrete. Care should be used in getting the bottom curved to the correct circle so that the leakage around the meter will be small. This meter is somewhat complicated in construction and it is better for it to be placed by canal companies than by land owners. It will probably cost less in this way as the drums can be bought in quantities. In Australia the concrete box is made in parts and seasoned in the material yard, the parts being then cemented together when placed in the field. When built of concrete as shown in Fig. 8, 22.8 cu. ft. of concrete and 40 board feet of lumber are required. The drums are best made by some sheet metal works. A special counter should be used made of rust resistant metal as the ordinary counters have been found to rust out rapidly in use. Where installed in large numbers in Australia the cost has been about $40 per meter; the cost of the meter installed at Davis was about $60.

The tests of this device made at Davis showed the meter to be quite accurate under constant ditch conditions between rates of flow of 1 to 3.5 cu. ft. per second. For both larger and smaller discharges the meter passes more water than it does between these limits. The amount of water going through the meter varies with the depth of drowning. A meter set high in the ditch will discharge less water per revolution than one set low. Checking up the ditch below a meter so that the depth is increased at the meter may increase the discharge by as much as 10 per cent in some cases. This is discussed in detail in the appendix.

The Dethridge meter of this size is adapted for accurate measurement of streams varying from 1 to 3 or 4 cu. ft. per second; in Australia it is considered satisfactory up to 5 cu. ft. per second. Where the quantities are either larger or smaller than these amounts the error will be in favor of the water user. While rather expensive to install there are no parts which will wear out except possibly the counter. The bearings are merely oiled wooden blocks. Variations in the friction will not alter the discharge; if the bearings are tight a greater fall will be needed to drive the wheel, but unless tighter than they will become if not tampered with, the discharge per revolution will not change. Where larger amounts are to be turned out, larger meters can be built or more than one installed. The meter has the advantage of being easily understood. The wheel stands up in the air and has a clumsy appearance, yet it is some advantage to be able to look across the field to the turnout and see by the turning of the wheel that water is still coming. When users realize that every turn of the wheel means so much water charged to them they will be more liable to economize in its use. In addition to the 22.8 cubic feet of concrete required for this meter and the galvanized iron wheel, the following lumber is necessary:

BILL OF MATERIAL FOR DETHRIDGE METER.

	Board feet
1 pc. 3″ x 4″ x 4′-6″	4
2 pc. 3″ x 8″ x 4′	16
1 pc. 2″ x 4″ x 4′-6″	3
4 pc. 2″ x 1½″ x 3′	3
4 pc. 2″ x 4″ x 1′	3
1 pc. 2″ x 8″ x 4′-6″	3
1 pc. 1¼″ x 6″ x 4′	3
1 pc. 1¼″ x 6″ x 5′	3
1 pc. 1¼″ x 6″ x 2′-4″	2
Total	40

Grant-Michell Meter.—This meter is shown in Fig. 9. It consists of a wheel turning in a horizontal circular opening through which the water is made to pass. This opening sets a little below the bottom of the ditch. The water in entering drops into a box set below the ditch bottom, passes under a cross wall, rises through the circular opening in which the meter is set, and passes on down the ditch. The meter consists of four flat blades set so that the water in flowing through the circular opening strikes against them at an angle. In this way the wheel is turned similarly to a wind mill. On the upper end of the shaft carrying the wheel is a counter which records the number of revolutions of the wheel.

This meter is made in four sizes, 12-in., 18-in., 21-in. and 39-in. The size to be used is determined by the size of the circular opening. The rated capacities for these sizes given by the makers are 1.66, 3.75, 5.83 and 16.66 cu. ft. per second, respectively. The wheel, counter, and standard for holding the wheel are sold and controlled by the patentees or their licensed agents. The prices quoted for Pacific Coast delivery, in lots of not less than 6, with freight but not duty paid, are $52.25, $66.75, $74.20 and $170.30, respectively, for the four sizes. The meter was invented by the two Australian engineers for whom it is named and has been used to some extent in that country, but it has been but little used in the United States. The box for the meter can be built of either wood or concrete; that installed at Davis is of wood. The standard for holding the meter is arranged so that the meter can be removed when not in use. On systems where the flow through each meter is not continuous, the meter can be used on more than one ditch, being moved around as water is turned out.

The tests made at Davis of a 21-in. Grant-Michell meter showed that for discharges of over 2 cu. ft. per second and up to 6.5 cu. ft. per second, the meter makes one revolution for every 6.1 cu. ft. of water passed. More water is passed per revolution on lower rates of discharge. The 24 tests made show that the meter will probably register within 2.5 per cent of the true quantity. The fall required in the ditch to get the water through the meter varies with the rate of flow. It is about 1 in. when the discharge is 3 cu. ft. per second and rises to 4 ins. with a flow of 5 cu. ft. per second.

This meter is not as much affected by changing the depths of water on the lower side as some others. The tests at Davis were made with varying depths but showed no regular differences. This is an advantage when used on a ditch which is sometimes checked up. Its high cost, however, is against its general use.

Hill Meter.—This device is shown in Fig. 10. It consists of a circular opening set horizontally in the floor of a box through which the water to be measured is made to pass. The meter consists of curved vanes set on a central drum. It sets in the center of the opening and is turned by the water as it strikes the vanes on rising through the opening. The turning of the meter drives the gears of a counting device which records the water passed in acre-feet. Different sized openings and meters are used for different sized quantities of water. The box in which the meter is set resembles a siphon.

The Hill meter is patented and must be bought of the patentee or his licensed agents. While it has not been used to any extent as yet, and has not been pushed commercially, it is estimated that the meter alone, when manufactured in quantities, should cost about $10 each for the 12-in. size and about from $12 to $15 for the larger size, with a probable reduction with very large quantities. The cost of the structure for holding the 12-in. meter will vary from $10 to $15. It is stated by those who have developed this meter that any kind of orifice in which the meter can be inserted so that its axis is vertical will do very nicely after the meter has been calibrated to suit that type of orifice.

From a test of a 12-in. Hill meter at Davis it appears that this size of the meter will register the quantity passed within 1.5 per cent for discharges of from 1 to 3.5 cu. ft. per second. For discharges of less than 1 cu. ft. per second, more water passes the meter than is registered. For discharges of 3.5 cu. ft. per second the water boiled up through the opening so as to submerge the counter of the meter tested. By increasing the length of shaft of the meter higher discharges than this can be crowded through the 12-in. meter, but the greater loss of head required makes the use of larger meters preferable.

The loss of head or fall in the water required for this meter varied from 1 in., when carrying 1 cu. ft. per second, to 6½ ins., when carrying 3.5 cu. ft. per second.

The Hill meter seems adapted to use under the usual conditions of irrigation practice. It is simple and has few wearing parts. The head required for the different sizes is less than that needed for the use of weirs. The record of the total quantity of water passed can be read in units of .001 acre-foot.

Substitute for Danish Pebbles.—The engineers on the Boise irrigation project in Idaho have discovered a serviceable and economical substitute for Danish flint pebbles used in grinding tube mills for grinding sand and cement materials. The Danish pebbles cost $26.25 per ton at Boise. Lava rock pieces found in the vicinity of the Government railroad were found to be equal or even superior when the angles were worn off, and can be obtained at a cost of about $2 per ton, including 50 cts. a ton for rocks which quickly wear out. There is a plentiful supply of lava rock chunks in the neighborhood. They are heavier than the Danish flint pebbles, break up less and wear longer.

Progress in Kansas in Pumping for Irrigation.

Specific data of interest relating to irrigation pumping practice in Kansas are given in a paper by H. B. Walker, State Irrigation Engineer, Manhattan, Kan., presented to the Kansas Engineering Society at its recent annual meeting.

Internal combustion engines have come into general use within recent years in the development of irrigation pumping. By the use of such power individual pumping plants of large capacities have been constructed. In 1894 there were five pumping plants in the state of Kansas where gasoline was used as a fuel. Since that time there have been a large number of improvements made in oil engines and today practically all of the power plants use some type of an internal combustion engine. In comparison with the five power pumping plants in Kansas in 1894-95, Finney County alone had fifty pumping plants in 1912. This gives some idea of the rapid development of pumping for irrigation in this state.

The fifty pumping plants in Finney County in 1912 were furnishing water for practically 4,000 acres of land, while the five little gasoline plants which were in operation in 1894-95 were capable of irrigating about 250 acres of land. Finney county has perhaps made greater progress in pumping for irrigation than any other single county in the state, but within the past five or six years many other counties have installed a large number of plants. For instance Pawnee county, which is considered to be in the central part of the state, now has twelve pumping plants which are capable of irrigating approximately 1,500 acres of land.

The improvement in machinery has had its effect upon the economy of pumping. For instance in 1895-96 the State Board of Irrigation experimented with two pumping plants where gasoline power was used. The plant consisted of a 10-HP. gasoline engine and a simple plunger pump. The following is taken from the report of these plants:

> In considering this power the board found an unexplored field, and so far as could be learned no deep-well pumps of large capacity were in operation. A contract was let to Fairbanks, Morse & Co., of Kansas City, for a gasoline pumping plant to be erected at Sherman County Station No. 4. This plant operates a 6-in. Cook pump in a 166-ft. tubular well, with a water lift of 133 ft. As will be seen by report of W. G. Russell, C. E., ante, this engine pumped 787,600 gals. in 208 hours, using 265 gals. of gasoline. With gasoline at 13.5 cts. per gallon, the cost per acre foot is about $15.20. After making these tests the engine was removed to Logan County Station No. 5 at Oakley, where the lift was about 100 feet. Here a larger pump was to be operated and it was hoped better results could be obtained. In 415 hours the pump lifted 1,007,025 gallons, using 388.62 gallons of gasoline. This, with gasoline at 13.5 cts. per gallon, would make the cost about $14 per acre foot. In calculating the cost of water at Goodland and Oakley, it will be observed that freight on gasoline from Kansas City, oil, waste and repairs, and salary of engineer were not taken into consideration. These items would add very materially to the cost and would vary in every locality according to circumstances.

Plant No. 4 which was located in Sherman county pumped the water, therefore, at a fuel cost for gasoline alone of 11.4 cts. per acre-foot per foot of lift, while the cost for fuel alone at the Oakley plant was 14 cts. per acre-foot per foot of lift. Since the time these plants were installed the manufacturers of internal combustion engines have made improvements which permit the use of low grade oils for fuel. This quite naturally reduces the cost of pumping. Moreover twenty years ago it was necessary to use quite largely the plunger type of pump. These were operated in wells of small capacity and the plant efficiencies were usually quite low. With our modern methods we are able to construct wells capable of high yields and in such wells the improved types of centrifugal pumps are installed to lift the water.

To make a comparison of the above with our present conditions the following data are taken from a test in 1913 on the deep well irrigation pumping plant at the State Experiment Station at Garden City, Kansas. These data were secured by Mr. Geo. S. Knapp, U. S. Government Irrigation Engineer. The plant consists of a 75-HP. oil engine and a two-stage turbine centrifugal pump with the bowl placed 120 ft. below the surface. The pump is equipped with a 9-in. discharge pipe and an 8-in. suction pipe. The pumping head during the test was 110.8 ft. and fuel costing 3¾ cts. per gallon delivered at the plant was used in the engine. Approximately $3.30 worth of oil was used to dump one acre-foot of water or in other words the fuel cost was 3 cts. per acre-foot per foot of lift. The total cost of operation, including besides the fuel, lubricating oil and attendance to plant was 5.1 cts. per acre-foot of lift. On account of lack of power in the engine the pump could not be run at its greatest efficiency. This probably makes the fuel cost higher than it would otherwise have been.

The following data were secured from private plants in 1913, by Mr. H. E. Murdock, Irrigation Engineer, U. S. Department of Irrigation Investigation:

(1) Finney county plant. Total lift, 19.7 ft.; coal oil used to pump one acre-foot, 11.4 gals.; cost of coal oil, 86.8 cts.; coal oil required per acre-foot per foot of lift, .58 gals., costing 4.41 cts.

(2) Finney county plant. Total lift, 69.0 ft.; fuel oil costing 3 cts. per gallon was used in engine; fuel oil required to raise one acre-foot one foot, .497 gals.; cost of fuel oil per acre-foot per foot of lift, 1.491 cts.

The above costs by Mr. Murdock include only the cost of oil delivered at the plants. Comparing the extremes for the 28-year period we have a fuel cost of 14 cts. per acre-foot per foot of lift in 1895, compared with a cost of 1.491 cts. per acre-foot per foot of lift in 1913, or in other words the fuel cost of lifting water has been reduced to approximately 10.5 per cent of the cost in 1895. This reduction cannot be credited entirely to the improvement in engines but our development in pumps must also be taken into consideration.

In 1895 a centrifugal pump was used to test the underflow at Garden City, Kan. In 1912 Finney county reported 50 power pumping plants and all but two of these plants were equipped with some type of centrifugal pump.

The centrifugal pump has made its progress by actual performance in the field. The pump efficiencies are usually below 40 per cent for the average farm installation, but this drawback is overcome in a measure by their ability to lift larger quantities of water containing frequently a considerable per cent of solid matter. These pumps are durable and reliable in operation and undoubtedly the pioneer pump in well irrigation development on a large scale.

ROADS AND STREETS

Notes on the Use of Concrete and Brick As Paving Materials on Illinois Highways.

A discussion of some of the economic factors influencing the use of concrete and brick in the paving of Illinois state roads was presented before the Illinois Society of Engineers and Surveyors at the last meeting of that society by H. E. Bilger, road engineer, Illinois State Highway Department.

DENSITY OF POPULATION AND RURAL DEVELOPMENT.

It should be noted that among the states of the Union, Illinois ranks second in value of mining products, third in value of its manufactures, third in population, tenth in density of population, twenty-third in size and twenty-third in the percentage of its improved roads. In density of population, Illinois has 101 persons per square mile, as compared with 31 persons per square mile for the United States as a whole. An idea as to the unequal distribution of this population throughout the 102 counties of the State, can be gotten from the fact that Cook County, having the greatest density of population, has 2,578 persons per square mile; while Henderson County, having the lowest density of population, has only 26 persons per square mile.

The variation in the trend of the population is as marked as that of the density. Between the last two census reports, the population of Chicago increased 29 per cent, while the population of the State increased only 17 per cent, and during the same period the rural population in 68 counties actually decreased. Of the counties that increased in population, the extremes are found in Fayette County, which increased only one per cent, and in Williamson County, which increased 62 per cent; while the counties that decreased, DeWitt decreased one per cent and Pope, 17 per cent.

No less marked than the unequal distribution of the Illinois population is the stage of development throughout the several counties. In the light of this fact, it is evident that the intelligent development of the rural highway problem requires a full appreciation of the local condition in each county of the State. It is only by such an appreciation that methods and types of road improvement can be worked out to adequately satisfy the needs of the local communities with expenditures within their comfortable reach.

TYPES OF CONSTRUCTION UNDERTAKEN.

Pursuant to the new road law, which went into effect July 1, 1913, there has been designated by the several counties some fifteen thousand miles of rural public highway for State-aid improvement. Without entering into a discussion of the economical types of construction to fit the wide variation of conditions, the following will be confined to a consideration of the types that have up to this time been contracted for. This new road law provides for rural road improvement with State-aid to the amount of 50 per cent of the total cost; the remaining portion being paid by the counties. The work up to this time has been let on the lump sum contract basis.

During the latter half of the year 1914, the Illinois Highway Commission entered into contract for the construction of 75 separate State-aid roads, of which 18 were vitrified brick and 57 Portland cement concrete. These roads are almost invariably of either 10 or 18 ft. widths. The 18 brick roads aggregate 114,188 sq. yds. in 17.7 miles, and are located in eleven counties. The 57 concrete roads aggregated 539,933 sq. yds. in 75 miles and are located in 37 counties. The surface of the brick roads is made up of 4-in. vitrified paving bricks, with a 6 in. concrete curb flush on each side. The bricks are grouted with a 1 to 1 Portland cement filler and are cushioned on 1 in. of compacted sand. The foundation consists of a 1-3-5 concrete base supported upon the natural soil. The thickness of the base at the edges is 4 ins., but on the center line it is 5 ins. for 10 ft. roads, and 6 ins. for 18 ft. roads. The concrete roads are of a 1-2-3½ mixture of one course construction. The thickness of the slab at the edges is 6 ins., but on the center line it is 7 ins. for 10 ft. roads, and 8 ins. for 18 ft. roads. The slab is supported upon the natural soil.

COST OF WORK COMPLETED.

The average amount of excavation on all 75 jobs was 3,800 cu. yds. per mile. Nearly all of the jobs were awarded practically at the estimate of the State Highway Department. From the actual cost record of constructing these roads, we are assured that the itemized estimates were reasonably well balanced with respect to the value of the several items of work entering to make up the total job. By excluding all rough grading, drainage structures, and the like, and prorating the estimated value of the pavement proper to the contractor's bid, we are enabled to get not only relative figures but almost absolute prices on the concrete or brick pavement proper. From the experience obtained from the award of these 75 contracts, it would appear that where the haul does not exceed 2 miles, the brick pavement proper has been built at a cost to the tax-payers of $2 per square yard; and the concrete pavement proper at a cost of $1.20 per square yard. The greatest variation from these averaged figures is not great, and they may be taken as substantially correct, save that with slight changes in the specifications, the price of the brick pavement proper, including the concrete curb, could have been $1.90. Having these two figures in mind, $1.90 for brick and $1.20 for concrete, it will be interesting to consider some economic features with regard to these two modern types of pavements.

FINANCING, ANNUAL COST AND RESURFACING.

If we assume for road improvement the issuance of 20-year serial bonds, payable annually, and rating interest at 5 per cent, the interest charges on the value of one square yard of brick pavement would be one dollar. Reliable data on the maintenance and repair expenses for brick roads in rural territory are not available. From the information that is available, however, and from the experience of small cities with this type of pavement, it would appear that a charge of 1 ct. per square yard per year would be sufficient to cover all maintenance and repair on a brick road in rural territory for the first 25 years. These three costs, namely, first cost, interest and maintenance total up to $3.15 as the actual cost to the tax-payers of a brick road for the first 25 years. Maintenance charges on the shoulders and right-of-way are excluded from this consideration, inasmuch as they apply equally whatever the type of pavement adopted. The corresponding interest charges on the value of one square yard of concrete pavement would amount to 63 cts. Cost data on the maintenance and repair of concrete roads are even more meager than on brick, and estimates as to the probable life of the road are still more at variance. One would be presumptuous, indeed, to assume under our mixed traffic conditions the probable life of a concrete road as long as that of a brick road. However, from the experience with the concrete roads that have been constructed in recent years under the supervision of this department, and from my own personal observation elsewhere, there is every indication that the concrete road is amply capable of rendering a service fully commensurate with its cost of construction.

It is quite probable that after a service of some 15 years under mixed traffic, the road would economically admit of a resurfacing. From present knowledge it would appear that the most practicable low first cost resurfacing for a concrete road, unevenly worn, would be a bituminous concrete some three inches in average thickness. In consideration of the necessarily high quality that this surface would need to be, it is quite likely that its application would incur an expenditure by the taxpayers of as much as 75 cts. per square yard. To meet this expense, if we issue five-year serial bonds, payable annually, and computing interest as before, we get a total maintenance and interest charge per square yard of $1.36. Included in this is an estimated upkeep charge of 2½ cts. per square yard per year throughout the 25 years.

It is hardly probable that the maintenance and repair charges under the conditions in question, could fall below this figure. These three costs, namely, first cost, interest and maintenance, total up to $3.19 per square yard, as the total cost to the taxpayers for a concrete pavement for the first 25 years.

It goes without saying that there are elements of uncertainty in the foregoing consideration of both types of pavement. These uncertainties relate particularly to the estimated cost for upkeep and to the probable life of the pavement; and moreover, the other estimates of cost will be somewhat modified by local conditions. Economic considerations with regard to all features of the highway problem can be worked out only in the light of local conditions in the particular community, so for the purpose at hand there will be considered some of the general features relating to the use of concrete and brick as pavements on main traveled county roads in Illinois.

TOPOGRAPHIC, CLIMATIC AND TRAFFIC CONDITIONS.

Next only to the states of Louisiana and Delaware, Illinois is the most level state in the Union. This topographic condition admits of the free use of both concrete and brick for public highway paving materials. It is quite probable that of the public highways designated for state-aid improvement, as much as 70 per cent of the total mileage will economically admit of grades not to exceed 3 per cent. From this fact, it is plain that the relative extent to which these two types of modern pavement will be employed must hinge upon considerations other than topographic. Nor are there any traffic or climatic conditions generally in the rural districts of Illinois that would materially invite the adoption of either of these types of pavement to the exclusion of the other. Generally, it can be stated that the consideration that should measure the relative magnitude of the adoption of these pavements, are, (1) their intrinsic merits, and (2) their total cost to the taxpayers.

THE CONCRETE PAVEMENT.

In all highway improvement the consideration of first cost bears tremendous weight with the taxpayers. Available funds almost invariably fall short of being sufficient to carry out the proposed improvement. Because of this condition, the public looks with great favor upon the types of construction that are less expensive in first cost. In view of our rapidly changing traffic conditions, with the consequent development of road types to meet them, it is quite probable that in order to meet future traffic conditions, there will be developed some economical form of resurfacing for the concrete pavement. There is to be considered also the fact that with a given amount of money available, the mileage of highways to be improved with a concrete pavement is somewhat greater than the mileage that could be improved were the brick pavement to be adopted.

In the construction of a concrete pavement, homogeneity of the concrete is the prime requisite. Uniformity of wear on the pavement is not possible when the concrete is not homogeneous throughout its exposed surface. The quality of the coarse aggregate commercially available is a vital governing condition in concrete road construction. While it would be highly advisable that the French coefficient of wear of this material be not less than 10, yet there are extremely few quarries in Illinois that can comply with this requirement. Inasmuch as the requirements of the specifications must be in harmony with commercial practicabilities, it becomes necessary at times to admit such material in road construction as the laboratory pronounces not to be of the first class. In the light of these conditions, there are many sections in Illinois where the available material is hardly satisfactory for concrete roads but entirely so for the concrete base for brick roads. In these particular sections the taxpayers would do well to look deeply in the real economics of the concrete and the brick roads before adopting the type less expensive in first cost. The possible development for the concrete road is very promising, and because of the extent to which the availability of local materials govern its cost, these developments will probably take the form of a relatively temporary surfacing with an adequate system of maintenance.

When a satisfactory method of surfacing the concrete pavement has been worked out, the troubles now arising from joints and cracks will have been reduced to a minimum. With regard to the spacing of transverse joints in a concrete pavement, our experience has been that the matter is not yet susceptible of mathematical analysis. True it is that computations have been made involving such factors as physical properties of the concrete, and friction coefficient between the concrete and the sub-grade, but experience seems to indicate that the behavior of the pavement in actual service is not such as to be predicted by mathematical computations. The occurrence of transverse cracks has been almost as erratic in pavements with joints spaced 50 ft. apart, as in those spaced 100 ft. apart. Past experience now points to the advisability of building concrete pavements with no transverse joints whatever, except that at the end of each day's work the end of the slab should be faced with a piece of wool felt, possibly ⅛ in. in thickness. This would permit concreting to be resumed the next day, with the least disturbance to the concrete previously placed. It is not to be expected that a slab of concrete some 7 ins. in thickness, and several hundred or several thousand feet in length can undergo the process of setting up hard without yielding to the shrinkage stresses necessarily introduced by the high consistency of the concrete. I believe that the occurrence of transverse cracks cannot be entirely forestalled by any considerations of the sub-grade when a concrete of high consistency is used, and that the occurrence would be almost equally probable and erratic if the concrete pavement were uniformly supported upon a liquid bearing throughout its entire length. It would seem that the difficulties are inherent in the nature of the material, but in all probability can be reduced by using a lower consistency, and by the addition to the cement of a percentage of inert material, as hydrated lime, for the purpose of reducing the voids in the concrete, without effecting its physical qualities.

The degree of homogeneity required in a concrete road is difficult to get under actual construction conditions. It is evident that the prevailing practice of shoveling the fine and the coarse aggregates directly from the earth sub-grade, is such as to permit lumps of foreign material to enter the concrete. While a high degree of inspection can reduce the probability of this occurrence considerably, yet it cannot wholly eliminate it.

The concrete pavement should welcome our rapidly changing traffic conditions. While the design of motor vehicles continues the use of rubber or some similar material for tires, the increasing popularity of the concrete pavement will be commensurate with the increase in traffic of this character.

THE BRICK PAVEMENT.

As a construction proposition in the way of providing a serviceable pavement with low expenses for its upkeep, the merits of vitrified brick have become established by many years of experience. It would seem that were it possible to reduce the first cost of brick construction by some 30 per cent, the extent of the near future adoption of this pavement for Illinois roadwork would be limited only by the capacity of the brick plants to furnish the material.

By the provision of a slightly higher percentage of the construction for engineering services, a more detailed study of the local conditions would be made, to the end that the requirements of the specifications would be better adjusted to meet the varied physical conditions encountered. Without a detailed study of the actual conditions of each particular piece of work, and the arbitrary requirement of such dimensions and materials as will almost certainly provide so-called fool-proof construction, expenditures for highway improvement cannot be conducted along the most economical lines. It would seem that by the present revision of our specifications for brick pavement construction, such economy will be brought about as will promote a somewhat more general adoption of this type of pavement.

With due consideration having been given to the sub-grade, there appears no necessity for the concrete base having other than uniform 4-in. thickness for ten-foot pavements, and 4½ ins. for 18-ft. pavements. For pavements of no greater width than some 18 ft., practicability and economy provides the pavement crown by crowning the sub-grade, rather than by increasing the thickness of the concrete base at the center. It is not to be expected that sub-grade conditions will be uniform throughout the length of any pavement construction job, and consequently the close study of details during construction, as well as while making the survey, will enable exceptional conditions to be provided for by increasing the thickness of the base, or by some other means.

It is believed that a concrete mixture of 1:3½:6 for the base will in the end prove more economical than the 1:3:5 mixture which has heretofore been used. In the light of our requirements as to the fine and the coarse aggregate, the practice of specifying a very rich concrete throughout the entire length of the pavement, in order to care for possible weak spots in the sub-grade, is not economical. All isolated weak spots in the sub-grade should be treated as individual matters, and should be taken care of by special treatment. With proper and practicable workmanship in striking off the surface of the concrete base, there appears no reason why the sand cushion after compaction should have a thickness of more than one inch. A greater thickness of sand cushion, and failure to compact it are conditions that permit the sand to enter the spaces between the bricks and thereby seriously reduce the efficiency of the grout filler.

With respect to the bricks themselves, it would seem that the first opportunity for lowering the construction cost would concern their quality rather than their size. For average rural traffic requirements, it is not always economical to require the hardest bricks commercially available for this purpose. A condition that makes for a serviceable brick pavement is not the absolute hardness of the brick, but rather the uniformity of quality. For most all rural traffic conditions in Illinois, bricks that are satisfactory in other respects should provide a serviceable and economical pavement, providing the loss by abrasion does not exceed an average of 22 per cent, and on any individual brick 26 per cent.

There is every reason to believe that without noticeably reducing the quality of the pavement, our revised specifications will permit the construction of brick pavements at a figure some 15 or 20 cts. per square yard lower than the prices gotten in 1914. It is not apparent that under the conditions in question, the first cost of the brick pavement can be reduced materially below $1.80 per square yard. The pavement in its very nature has certain items in its construction cost practically fixed, and aside from what has heretofore been mentioned, further reductions in its first cost must be brought about by the adoption of more economical means and methods of handling and transporting the materials.

However, even with the present cost of construction, expenditures for brick pavements to be built in accordance with modern specifications are amply justified by the assured serviceability inherent in the very makeup of the pavement.

River and Harbor Improvements in Canadian Provinces.—The budget prepared by the Dominion Parliament provides for the following river and harbor improvements in Alberta and Saskatchewan: Pigeon Lake, improvement, $2,500; Prince Albert, protection works, $9,000; Saskatchewan River, improvements, $50,000; Sturgeon River, improvements, $9,000.

Methods and Mixtures Used in Constructing Tar Concrete Pavements.

Earlier types of bituminous concrete pavements used coal tar cement and some of the pavements constructed resembled closely present day Topeka specification mixtures. In New England, also, tar concrete has been used for many years. In a paper before Section D of the American Association for the Advancement of Science at the Philadelphia meeting, December, 1914, Philip P. Sharples, chief chemist of the Barrett Manufacturing Company, discussed some of the features of the use of tar concrete and his paper is given here.

The bituminous material usually called for in specifications is an asphalt resembling the asphalt cements used in asphalt pavements. Coal tar cement has, however, been recognized as a suitable material and is provided for in the specifications of the Society for Standardizing Paving Specifications. The greater ease of using coal tar cement and the very simple apparatus that can be used has raised the question of the comparative durability of coal tar cement in this form of construction and of the chances of failure as compared with asphalts. Relatively speaking, the coal tar cements have proved of so much worth in penetration methods that their development for mixing methods has to a large extent been neglected.

EARLY TAR CONCRETE PAVEMENTS.

The Topeka specification as now standardized has been in use for such a short time that no conclusions in regard to lasting qualities of pavements recently built can be drawn. A study of some of the older coal tar pavements shows that the Topeka mix is not a new discovery but only a revival and that much can be learned from the old experiments. Many forms of coal tar pavements have been proposed and the patent office shows much activity during the early seventies both along penetration and mixing methods. The statement of methods in these old patents is so often at variance with the pavement actually laid that it is difficult to decipher the intent of the patentee. Some of the survivals show, however, a close resemblance to the Topeka mix.

In Pittsburgh, Pa., many streets were laid 18 to 25 years ago under the name of Vulcanite pavement, using coal tar pitch or mixtures of coal tar pitch and asphalt as a bituminous cement. The mineral aggregate varied greatly in different streets but might be said to follow in general the Topeka mix. Lang Ave. is an example of the true Topeka mix and was laid in 1892. The cement used was 120° F. melting point (half-inch cube method in water) coal tar pitch with about 30 per cent free carbon with some small percentage of Trinidad asphalt.

The street is residential with a residential street traffic and would be classed as in good condition at the present time, with only nominal repairs during its 22 years of use. Many other streets of the same nature, some intact, some resurfaced with asphalt, are extant in Pittsburgh today. Economic factors alone led to the abandonment of this class of pavement.

NEW ENGLAND METHODS OF CONSTRUCTION.

In New England coal tar pavements are known as tar concrete pavements or tar and gravel pavements and their widest development has been in sidewalk and private driveway work but a certain amount of street work has been done during the last thirty years, notably at Concord and Manchester, N. H. This work shows many successes in spite of crude methods both in choosing the gravels and in mixing the coal tar cement.

The gravels were those locally available and were chosen wholly by the look and feel based on the tar concreter's experience. Coal tar cement was made of a mixture of crude coal tar partially refined by cooking in open kettles and coal tar pitch of 150° melting point (½-in. cube method in water). The cement had the defect of retaining a large amount of volatile oils from the tar, giving at the start

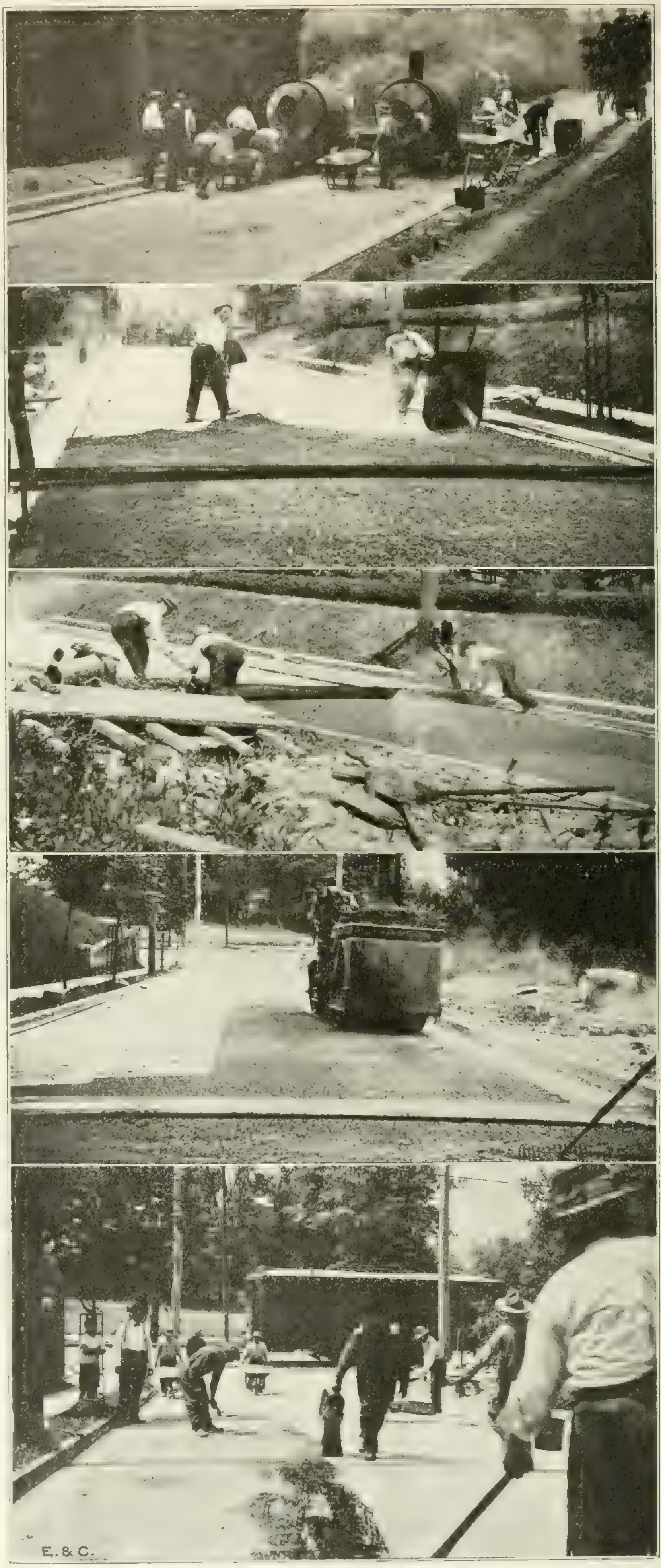

Fig. 1. Views Illustrating the Mixing Plant and Different Stages in the Construction of a Tar Concrete Pavement.

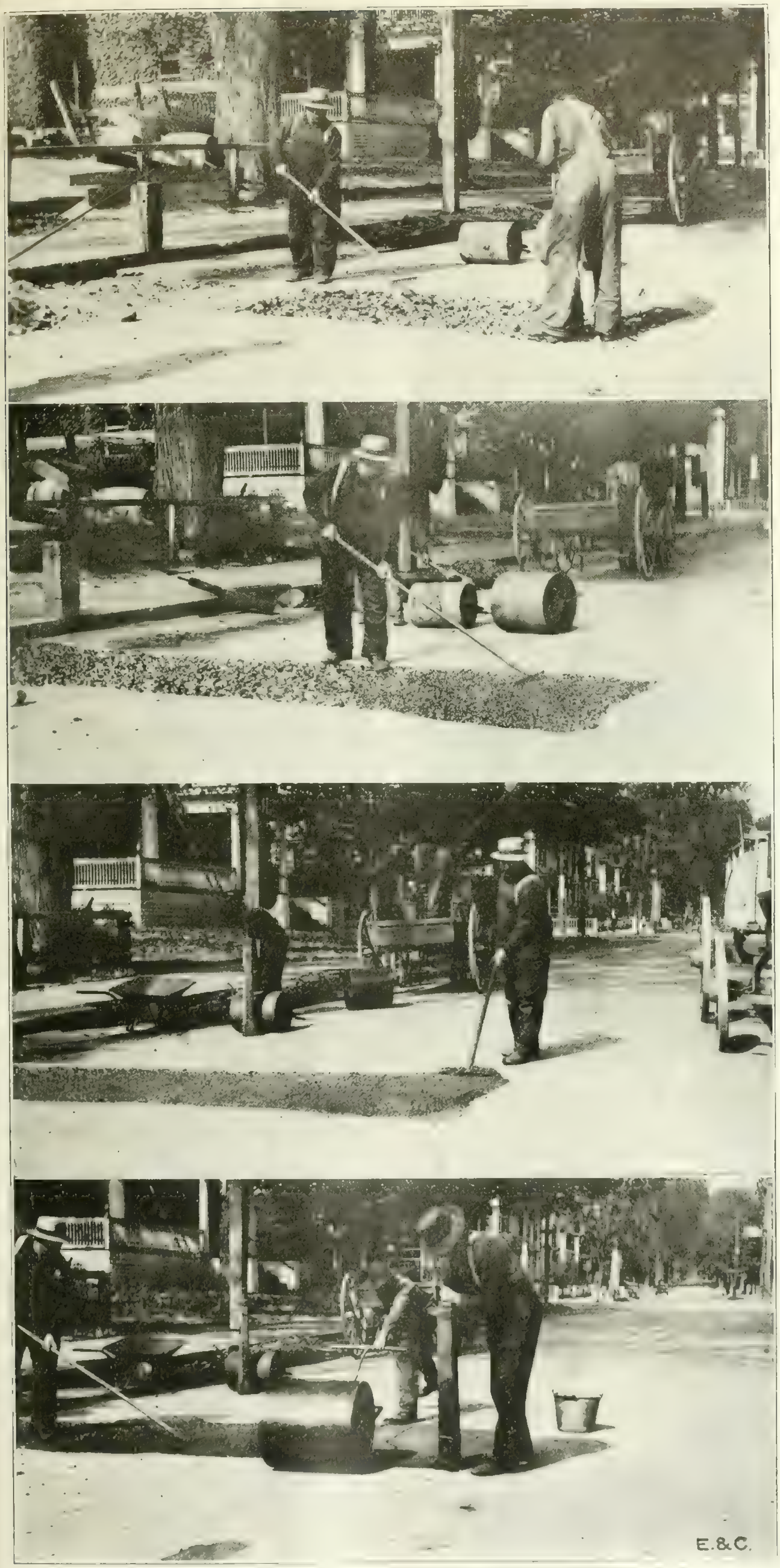

Fig. 2. Views Illustrating Different Stages in Patching a Tar Concrete Pavement in Concord, N. H.

a very soft pavement, which grew very hard with age. The relative cost of the two materials also tempted the concreter to skimp the pitch on which the success of the pavement depended and use a surplus of tar, giving too great a preponderance of volatile oils. At the present time many of the best tar concreters have adopted a prepared cement. Usually, a melting point of 110° F. (½-in. cube method in water) is preferred for street work and 90° F. (½-in. cube method in water) is preferred for sidewalk work.

Much of this tar concrete work resembles closely Topeka mix with the ½-in. crushed stone replaced by pebbles. The screening analyses of typical New England tar-concrete sands, Table I, show that sands in Newton and Brighton, Mass., fall within the Topeka specification. The permissible variation in sand may be larger, however, with the tar cement than asphalt, as the Manchester sand, essentially a one size grain sand, gives excellent results in tar concrete. A sand with a sharp aggregate seems more essential than a carefully graded sand.

The percentage of tar cement used in New England is usually larger than called for in the Topeka specification. The exact amount is varied to suit the particular sand used, but often runs as high as 12 per cent. It was believed that a large excess provided a reservoir of tar cement which was drawn upon as needed. It would seem from more recent work that a smaller percentage of refined tar in the mix with provision for seal coats as needed was more economical in the long run. Based upon this principle, work has been done with as little as 6 per cent cement. With this small percentage, it has been definitely proved that a seal-coat protection is a necessity. Eight per cent would seem to be a better starting point, and modifications in the percentage should be made to suit local conditions.

Tar concrete street pavements in New England, although not extensively built, have been built without interruption for many years, and where good workmanship has prevailed, have held the confidence of the public. Some of the old concreters take great pride in their work and give every step personal supervision. In Concord, N. H., for instance, one man has done practically all the work and every square yard has been raked out by his own hand. Under the circumstances, it is little to be wondered that the percentage of successes has been extremely high. Manchester, N. H., Laconia, N. H., Kennebunk, Me., Shelburn Falls, Vt., are other centers of good work.

A study of successes and failures in New England tar concrete shows that the requisites for success in using coal tar cement in Topeka mix are:

(1.) Carefully prepare foundations with due attention to drainage.

(2.) Suitable sands. Either too fine or too coarse sands are to be avoided. A sharp sand gives better results than rounded grains and a mineral aggregate which has structural strength in itself is to be aimed at.

(3.) A carefully prepared straight run coal tar cement with a melting point of 100 to 120° F. (½-in. cube method in water), (varied to suit traffic conditions and local mineral aggregate available).

(4.) Careful handling of the coal tar cement. Coal tar cement, like other bituminous materials, is easily changed by heating to a high temperature or by holding a long time at a comparatively low temperature (220° F.) in open kettles. Refined tar, mineral aggregate and the mix should be kept at or near 220° F. This point must be especially insisted upon when high melting point materials have previously been used.

(5.) Expert supervision is just as essential as in all other paving work. The exact method best for local handling, the exact percentage of bitumen required, the correct proportion of mineral aggregate, are matters requiring judgment and experience.

TABLE I.—ANALYSIS OF TYPICAL NEW ENGLAND TAR CONCRETE SANDS.

Mineral aggregate.	Topeka.	Manchester, N. H.	Falmouth, Mass.	Lynn.	Manistee, Mich.	Newton.	Brighton	Ivy street, Pittsburgh.†	Springfield, Mass.*
Passing 200 mesh..	5-11	2.0	4.2	0.5	0.9	4.9	5.0	10.1	8.5
Passing 40 mesh..	18-30	9.5	12.4	13.7	19.7	24.8	18.5	33.0	42.5
Passing 10 mesh..	25-55	78.0	68.1	61.5	53.7	55.0	54.8	39.2	15.9
Passing 4 mesh..	8-22	7.5	7.9	6.9	14.6	12.4	17.1	16.7	24.2
Passing 2 mesh..	‡	3.0	7.4	17.4	8.1	2.9	4.6	1.0	
Held 2 mesh......	...	...	....	....	3.0	....	....	....	....

*Laid 1914. Excess of fine particles. Practically asphalt paving sand with ½-in. peastone added.
†Courtesy M. S. Evans, Pittsburgh.
‡Less than 10.

TABLE II. — TYPICAL REFINED TAR CEMENTS USED IN NEW ENGLAND TAR CONCRETE.

	Free carbon percentages.	(1) Distillation, total to 315° C.	(2) Melting point, ° F.	Schutte penetrometer, Sec	at ° F.	Viscosity, Engler, 100 cc. at 100° C. Sec.	(3) Float test at 50° C. Sec.
For sidewalk work		14.4	11.9	86.9	85	208	75
For street work.	18.2	10.4	108.7	88	80	431	170

(1) Am. Railway Eng. Assoc. 250 cc. retort.

(2) One-half inch cube method in water starting at 40° F.

(3) New York Testing Laboratory.

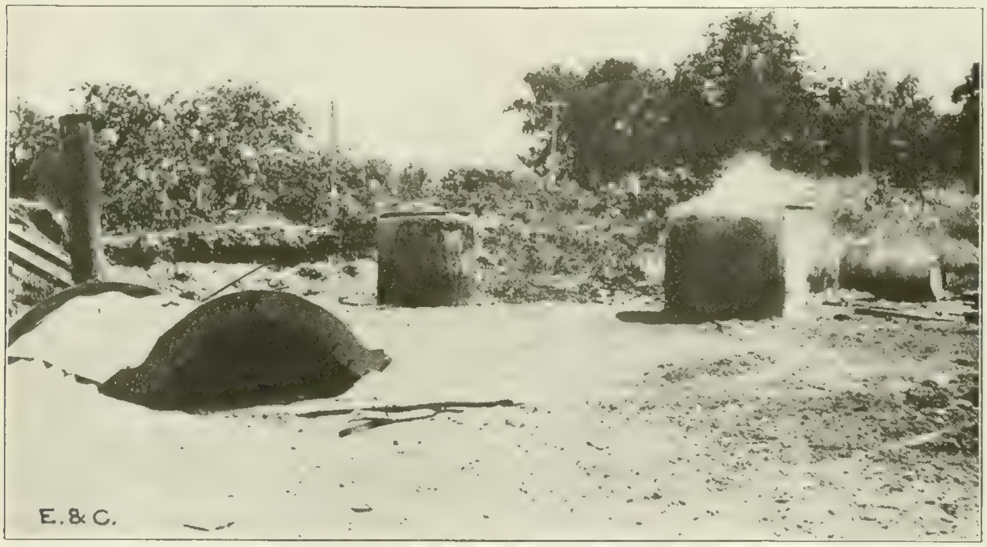

Fig. 3. Kettles and Sand Heater Used in New England Tar Concrete Work.

Road Reconnaissance and the Application of Sound Engineering Principles to Road Location in California.

This journal has always contended that the application of sound and well established engineering principles to road location was entirely practical and that such principles were not adhered to as closely as they should be in the practice of road location and construction. Recent reports from the state of California indicate that in the road work there an excellent combination of engineering principles and old precedent in the practice of road construction has been established.

In discussing the lateral road problem of the state in the last issue of the California Road Bulletin the following statement of conditions and methods is made:

The primary demand of the California Highway Act is for trunk line construction; for two roughly parallel lines, one through the coast counties and the other through the great interior valleys, the Sacramento and the San Joaquin, "serving county seats and connecting centers of population by the most direct and practical routes." In the skeleton system of highways outlined by the act, these constitute the backbone. The secondary demand of the act is for lateral road construction; to connect with the highway those county seats which are not directly served by either trunk line.

More highway was built this year in California than was ever attempted in a single year in any other state. And yet, the roads can not all be built in a season—the money is not available, contractors are not available, right of way questions take time; and there is a limit to the capacity of any organization, however efficient, beyond which speed is obtained only at the cost of efficiency and economy—therefore, trunk lines first.

We are now ready to take up the lateral roads as a comprehensive, distinct road problem. The Highway Commission and its engineers in charge in each division have finished 2,000 miles, traveling by automobile, through these mountain counties, studying their location, needs and desires at first hand. These county seats, for the most part, lie to the east of the Sierras. Their connecting roads to the valley cross elevations of from 4,500 to 7,500 feet, and are snow blocked for months on end. The problem is to build laterals to these points which will utilize the lowest passes through the mountains and be useable through the winter months. Following the inspection by the Commission, the engineering force will study every detail of this problem, examine every possible or suggested route, in order that the needs, the wishes, and the rights of these communities under the law may be met. That actual work upon the mountain laterals has not been begun does not indicate that the mountain counties have been forgotten, or will be neglected. The spring of 1915 will see this portion of the highway scheme under active headway.

The relation of the lateral to the trunk line expresses itself also in character of construction. The standards of trunk line construction have been set high—no grade in excess of 7 per cent, no curves with shorter radii than 50 ft., a 21-ft. roadbed, and with ideal alignment, etc. The type of construction has been fixed—the concrete base, permanent type. The lateral roads, however, warrant a much more flexible policy. Some of them will carry sufficient traffic to warrant trunk line type of construction. On the purely mountain laterals such construction would be folly. No one wants, expects, or needs city streets through the Sierras. An accurate study, therefore, of this problem will demonstrate the necessity of varying types of construction to meet varying situations. Grades steeper than on the main routes, narrower roadbeds, surfacing of native materials, and similar reasonable economies will be necessary in handling this lateral problem without a prohibitive cost; and at the same time the resulting roads will be godsends to communities where 25 per cent grades and narrow, dangerous roads without benefit of sound engineering are today the rule.

It will be the policy of the Commission to apply sound engineering to this problem first, that these laterals may be permanently placed where they belong; to expend the apportionment for these roads where it should be spent, eliminating excessive grades, dangerous curves, etc.; to take under maintenance the entire mileage and, where the cost of a perfect road can not be met with the available funds, to lay the foundation for a perfect road and out of our maintenance fund gradually perfect such roads by the addition of guard rails, culverts, retaining walls, surfacing, etc. By such a system the mountain counties will be opened up by roads that lend themselves to safe and economical traffic, and the mountain counties will become a part of California practically the whole year round.

The bulletin further states that the state highway engineer and members of the commission personally inspected 6,800 miles of road in advance of preparation of actual plans for road construction. "As each county was visited an approximation was made of the probable total mileage of state highway in the county and information was secured from supervisors, county surveyors and others interested, which served as the basis, in conjunction with additional data collected at the office in Sacramento, for a rough apportionment, county by county, of the $18,000,000 provided for state highway construction. From this skeleton plan was worked out the working scheme for building the state highway. The visits to the various counties, which were made while awaiting the first sales of bonds, also proved valuable to the commissioners in giving them first-hand information about the country through which the state highway must be built.

"Similar studies of the lateral lines which will be built to connect the county seats not on the principal routes were undertaken by the commissioners during the past summer. These lines may be considered the second great phase of the state highway work, the building of the system through the valleys and along the coast being the first. Since the latter was well under way this year the commissioners took up the former, initiating that work by a series of personal studies similar to those made on the main lines in 1911.

"At the meeting on September 22, 1914, the following instruction was voted by the Highway Commission: 'That the Highway Engineer be and he is hereby instructed to cause to be made through the several Division Engineers and their assistants such reconnoissances and studies of the lateral state highways connecting the county seats with the trunk lines as may be necessary in anticipation of the construction surveys.' Such reconnoissances were made or are being prosecuted as fast as the regular work of the division engineers will permit."

While the problem of road location in California may vary somewhat in detail from that in other states, the fundamentals are the same for all locations. It may be stated that the reconnoissance and study of road projects as a whole is fundamental to economical road construction and maintenance. Methods followed in California may be studied with profit by other states.

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The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Electric Cranes.—Bids will be opened about April 30 for supplying seven 5-ton and one 10-ton electric cranes for a port in Africa. The plans, specifications, etc., may be examined at the Bureau of Foreign and Domestic Commerce and its branch offices. No. 15868. [For address see first paragraph.]

Pipe.—Construction company in Europe wants quotations on 2,000 tons of pig iron pipe f. o. b. New York, or c. i. f. destination, for waterworks construction. No. 15781. [For address see first paragraph.]

Oil Well Supplies.—Firm in Russia wishes the names and addresses of American manufacturers and exporters of oil-well supplies. It is stated that deposits will be placed in Government banks to cover all transactions. Correspondence may be in Russian, French, or German. Prices, etc., should be stated in Russian equivalents, and c. i. f. Russian ports. No. 15943. [For address see first paragraph.]

Cement.—Business man in Canada wishes names and addresses of American exporters of Portland cement. No. 15944. [For address see first paragraph.]

Oil Well Machinery.—Business man in Russia wishes catalogues, prices, etc., on American oil well machinery. No. 15947. [For address see first paragraph.]

Wireless Plant.—Government of Latin American country is contemplating the erection of wireless stations. Full information is desired relative the apparati, supplies, etc., and installation of complete wireless plants. Correspondence, etc., should be in the Spanish language. No. 15892. [For address see first paragraph.]

Mining Machinery.—Merchant in Russia wishes to represent American manufacturers of milling and mining machinery, and machinery to be used in the tobacco and paper industries. Catalogues, correspondence, etc., should be in the German or Russian language. No. 15905. [For address see first paragraph.]

Well Drilling and Oil Field Machinery. —South American Government official is scheduled to arrive in the United States about the end of March for the purpose of looking over American oil machinery and studying operating methods in this country, with a view to increasing the efficiency of the work which his Government is now carrying on. Further details relative to the proposed visit may be had on application to the Bureau of Foreign and Domestic Commerce or its branch offices. No. 15909. [For address see first paragraph.]

Metals, Building Materials, Etc.—Quotations are wanted by firm in Latin-America on electrical supplies, metals, building materials, etc. No. 15912. [For address see first paragraph.]

Drilling Machinery.—Business man in Spain wishes to secure catalogues and price lists of American manufacturers of drilling machinery, especially machines which may be employed in mining districts. No. 15917. [For address see first paragraph.]

INDUSTRIAL NOTES

The Underpinning & Foundation Co., 290 Broadway, New York City, has been awarded the foundation work at 438 East 91st St., New York City. The foundation consists of our standard Hercules steel pile installation. Wm. P. Cunningham, E. 95th St., owner; John P. Boyland, Architect, and Alexander Brociner, Consulting Engineer.

The Stark Rolling Mill Co. of Canton, O., has appointed The Dearborn Steel & Iron Co. as its selling agents in Chicago, Northern Illinois and Wisconsin. The Dearborn Steel & Iron Co. is a new company, composed of H. C. Perrine and E. L. Lyon. Both were formerly connected with Jos. T. Ryerson & Son, and Mr. Perrine more recently was associated with The Fred Gardner Co. Offices have been opened in the Peoples Gas Bldg., Chicago.

The Sanderson-Cyclone Drill Co. has taken over the Cyclone Drill Co. of Orrville, O. The new concern will continue the manufacturing plant at Orrville—the change involving simply a change in management. The officers of the new company are: R. R. Sanderson, President and General Manager; Will Ford, Vice-President; Paul Hildebrant, Secretary and Treasurer. Associated with the above men are: C. H. McCarthy, New York City; W. T. Kershner, Orrville, Ohio; J. F. Munn, Chicago, Ills. All members making up the new organization are practical manufacturing and well drill men.

NEW CATALOGUES

Lubricators.—Paper, 6x9 ins.; 30 pp. McCord Manufacturing Co., Detroit, Mich.

Catalogue No. 12, describing McCord force feed lubricators. Shows views of the various types and gives tables of dimensions and price list of parts.

Bar Benders.—Paper, 3½x6½ ins.; 8 pp. Wallace Supplies Mfg. Co., 412 Orleans street, Chicago.

Illustrated catalogue and price list of the various bar, rod and pipe bending and cutting tools handled by the above company.

Stokers.—Paper, 6x9 ins.; 20 pp.; Combustion Engineering Corporation, New York City.

Bulletin B-2 devoted to Type "E" stokers, describing the construction, installation operation and regulation in detail; illustrated.

Excavators.—Paper, 6x9 ins.; 16 pp. Gade Excavating Co., Iowa Falls, Iowa.

The design, operation, capacity and low operating and maintenance expenses of the Economy Excavator are briefly described and views of the machine are shown in this booklet.

Tie for Wall Forms.—Paper, leaflets. Unit-Wall Construction Co., Inc., 1324 Broadway, New York.

Leaflets calling attention to the qualifications of "Tyscru," a form tie and anchorage which also acts as spacer and extra reinforcement in concrete wall construction.

Electric Drills.—Paper, 7½x10½ ins.; 4 single leaf bulletins. The Electric Tachometer Co., Spring Garden street, Philadelphia.

Bulletins Nos. 200 to 203, inc., describing and illustrating "Locke Electric Drills" and giving a list of users and records of drilling.

Oil Tractors.—Paper, 9x12 ins.; 14 pp. The Joliet Oil Tractor Co., Joliet, Ill.

Describes the destinctive features of the Joliet Oil Tractor, such as simplicity of construction, light weight, three-point spring tension, roller bearings, selective type transmission, kerosene-burning engine, road speed of 8 to 10 miles per hour, steering device, etc. Illustrated.

Caterpillar Tractors.—Paper, 6¾x10 ins.; 8 pp. The Holt Manufacturing Co., Stockton, Cal.

Describes and illustrates the "Caterpillar 18," the "Littlest Caterpillar of All." Gives specifications for this small tractor, points out the many ways in which it can be used and its particular advantages, and shows views of operations in various fields.

Concrete Mixers.—Paper, 10¾x8 ins.; 24 pp. The Cement Tile Machinery Co., 124-132 Rath street, Waterloo, Iowa.

The various models of "Winner" and "Money-Maker" Concrete Mixers are shown and brief descriptions of their specific applications and qualities, with general specifications are given. Also describes the drum, engine and other features common to the entire S. & S. line.

CATALOGUE REVIEWS

Concrete Roads.—Paper, 7x9 ins.; 40 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

"The Concrete Road" is the title of an interesting and useful booklet prepared by Mr. Arthur C. Newberry of the Sandusky Portland Cement Co., and sent out with the compliments of that company.

Beginning with a brief summary of the arguments in favor of or against the construction of concrete roads, the author takes up detailed costs, durability and resistance to wear, maintenance costs, construction methods, shrinkage cracks, reinforcement, asphalt and bituminous surfaces and specifications of American Association of Cement Manufacturers. He has collected data from all parts of the country and the booklet is practically a summary of the experience so far attained in this branch of concrete work.

The illustrations are numerous and consist of views of various finished roads and of work underway.

Contractors' Equipment.—Paper, 6x9 ins.; 72 pp. Whitman Agricultural Co., St. Louis, Mo.

Catalogue No. 71 describing the improved Sultan automatic gasoline engine, giving full information relative to design, construction, operation and range of utility. Also describes the Sultan electric lighting system, water supply systems, galvanized brazed pneumatic pumps, Atlantic force pumps, "Imp" force pumps, pneumo-hydro water systems, Atlas pumping plants, centifugal pumps, diaphragm pumps, reversible hoists, bricklayers' hoist, belt-driven hoist, self-dumping concrete buckets, double cage material elevators, all-around wood worker, Midget portable saw rig, portable drag cross-cut saw, tilting cross-cut saw, slide saw table, all-around dump car, and the gaso-electric drilling and grinding plant. General descriptions and specifications, with illustrations showing design or operation of these machines render this a neat, carefully compiled and comprehensive summary of Sultan equipment.

Air Compressors.—Paper, 6x9 ins.; Loose Leaf. Blaisdell Machinery Co., Bradford, Pa.

A new general catalogue describing Blaisdell equipment and containing much useful information and tables of interest to users of compressed air. It comes in a loose leaf binder in which future bulletins may be inserted as issued by the company.

The numerous uses of compressed air, and its application to various industries, the different kinds of compressors, comparison of single and duplex compressors, and full instructions for air compressor installation and operation are among the subjects handled. Cuts showing the compressors, and diagrams of construction and operation are included.

The tables occupy the greater part of the book, and give data on volumes of air required, atmospheric pressure, power transmission, loss in pressure due to friction in pipes, capacities of compressors, air consumption of various tools, etc. Much miscellaneous information as to steam consumption, globe valves, tees and elbows, hoisting engines, and various pneumatic tools is also given.

CURRENT NEWS

The Doings of the Week.

The past week has shown a continued expansion of industry and commerce throughout the United States. Some authorities state that the week brought out the most pronounced activities in these lines that have been observed since last July. Foreign trade continued to make records. In one day last week merchandise shipments amounted to $10,500,000, while the shipments for the first week of March showed an excess of exports of nearly $26,000,000. There was a slightly more cheerful stock market tone, and a heavy investment demand for bonds. New York state disposed of a $27,000,000 block of 4¼ per cent bonds. Further gains were reported in the steel trade and railroad earnings showed an increase. In the construction field there was some increase of activity over the previous week, as indicated by new work coming up for bids. The largest earth moving job so far this year was placed under contract a week ago last Monday. Several other big construction works also were let, while bids were opened on a number of important undertakings. In the road and street and bridge fields a large amount of work is now ready for contractors. In the Metropolitan district of New York City there has been a general improvement in building activity. Speculative building is increasing, this indicating an easier money market. Continued improvement has been shown in the iron and steel trade. Buying by manufacturing consumers of iron and steel has been light so far this month but hope is held out that the spring demand will soon be an important factor. Structural steel demands are showing some signs of spring betterment. Rail buying is still light and no particularly heavy orders have been placed during the past week. The steel works of the Steel Corporation last week were running at 67 per cent of ingot capacity. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending March 10 were as follows:

Finished Iron and Steel. Per lb. to large buyers.	Mar. 10. Cts.	Mar. 3. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia........	1.15	1.15
Iron bars, Pittsburgh..........	1.10	1.10
Iron bars, Chicago.............	1.10	1.10
Steel bars, Pittsburgh.........	1.15	1.15
Steel bars, New York...........	1.319	1.319
Tank plates, Pittsburgh........	1.10	1.10
Tank plates, New York..........	1.269	1.269
Beams, etc., Pittsburgh........	1.15	1.15
Beams, etc., New York..........	1.319	1.319
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh........	1.25	1.25
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No. 28, P'gh....	3.40	3.40
Wire nails, Pittsburgh.........	1.60	1.60
Cut nails, Pittsburgh..........	1.55	1.55
Fence wire, base, P'gh.........	1.40	1.40
Barb wire, galv., P'gh.........	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 cts.

Railways.—Nothing of importance leading to the beginning of any large amount of railroad construction appears to have taken place last week. Bids have been taken on two or three small railroad jobs, and this work will be placed under contract soon. The Illinois Central Ry. probably will let a contract this week for work near West Frankfort, Ill. The first earth moving job in connection with the new $65,000,000 Union terminal in Chicago was awarded last week. Post & McCord, Inc., New York City, have been awarded a $734,000 contract for Section 1 of the Jamaica Ave. elevated extension for the New York Municipal Ry. Corp.

Roads and Streets.—State and county highway construction this week are offering many opportunities to contractors. Connecticut has begun calling for bids on the first work of this season. Massachusetts already has taken proposals on several jobs, and Maine will soon come into the field. Ohio is advertising a number of improvements, and California shortby will take bids on several undertakings. Two or three counties in New Jersey are asking bids on good sized road improvements, while on the Pacific Coast counties in Washington are especially active at this time in placing road work. A fair amount of street paving also is ready for bids. Charleston, W. Va., is asking proposals on 75,000 sq. yds. of pavement, and Pulaski, Va., on 7 miles of macadam and concrete streets. The contracts let recently include a $354,294 grading and paving job for Pittsburgh, Pa., an $80,261 contract for 40 miles of road near Bremond, Tex.; and many other contracts ranging from $40,000 up.

Bridges.—A large amount of bridge construction came up for bids during the past week. Many of these structures, however, are small. The County Bridge Commissioners at Clinton, Tenn., open proposals March 25 on three steel or reinforced concrete bridges, 525 ft., 600 ft. and 625 ft. in length; Colusa County, California, is calling for bids on 37 bridges, including a 2,600 ft. concrete trestle; Kansas counties are calling for bids on small structures that will require an aggregate of 1,300 cu. yds. of concrete. Seattle, Wash., voted to issue bonds for $1,364,000 for construction of three bridges over the Lake Washington Canal.

Drainage and Irrigation.—The principal development in the drainage field during the past week was the awarding of the contract for the St. Lucie Canal of the Everglades Drainage District of Florida. This work involves some 20,000,000 cu. yds. of earth excavation. Furst Clark Construction Co., Baltimore, Md., secured the contract. Mendenhall, Straw & Bird Co., Springfield, Utah, at $100,000 were low bidders for 9 miles of main canal and 65 miles of laterals in the Grand Valley Project, Colorado.

Waterworks.—A number of contracts for small municipal water works and extensions for smaller cities are now being advertised. Jefferson, Ga., is calling for bids, for material and equipment, for waterworks and sewers, as is Winnsboro, S. C. Maywood, Ill., opens bids May 25 on 21,000 ft. of water main; St. Louis, Mo., is calling for proposals for laying 38,650 ft. 6-in. and 8-in. water main. Akron, O., voted a $600,000 bond issue for completing its water works; bids on the work already have been taken.

Alien Labor Law.

The state legislature of New York has passed a bill repealing the law prohibiting the employment of alien labor on public works. Before taking this action, however, the Assembly and Senate tacked on amendments that may make a lot of trouble for contractors. The amendments provide, among other things, that American citizens shall have preference on all work of a public nature. If citizens are not available, then aliens may be employed. The contractor is required to file a list of his employes with the State Commissioner of Labor, indicating those that are aliens and those that are citizens. He also must specify the date and place each citizen had been naturalized and his nationality. The punishment provided for a contractor who wilfully falsifies his report regarding men in his employ or who does not give American citizens preference is a fine of not less than $50 nor more than $500, or imprisonment for not less than 30 days nor more than 90 days. The old alien labor act was placed on the statute books mainly through the efforts of labor unions. The amendments to the bill repealing this legislation also probably had their origin with the unions. The new law, thanks to this, seems to contain some excellent trouble making possibilities.

A 20,000,000 Cu. Yd. Job.

A job was let last week that will make dirt movers sit up and take notice. The Commissioners of the Everglades Drainage District of Florida, awarded a contract that requires the removal of 20,000,000 cu. yds. of earth. The work covers the construction of a 24-mile canal and the widening and rectifying of a portion of the St. Lucie River. The canal will have a bottom width of 120 ft. and a depth of cut of 14 ft. at the Lake Okeechokee end and will gradually widen to a bottom width of 160 ft. at the river end. The greatest depth of cut will be 28 ft. The carrying out of this work will involve the use of land excavators for removing a sufficient amount of the material from the canal section to clear it of roots, stumps, brush and other debris. The material will be used to construct a levee on each side of the canal behind which the remaining excavation will be pumped by a suction dredge. A 20,000,000 cu. yd. earth moving job is some undertaking.

Railway Construction.

These are dull days in the railroad construction field. The big jobs that were expected to come up have not made their appearance. The embargo on extensions, double-tracking and new lines is still in force. A 10-mile electric railway contract, with the grading so light that it could almost be done with a spoon, is an event nowadays. The letting of such a piece of work brings out enough contractors to build a transcontinental railroad. Ditch jobs, irrigation and drainage, receive close attention from contractors who heretofore have specialized in railway work. Business is indeed slack at the present time in the earth moving line for the carriers. But the season is young, and everybody familiar with the situation is confident that the railroads soon will come into the construction field with at least a fair amount of work.

8-Hour Day on Road Work.

The State Senate of Washington has taken a common sense attitude regarding the 8-hour day for public works. It has passed a bill exempting highway construction from the provisions of the act. The House some time ago passed a similar bill, so that it is probable that legislation will be enacted that will permit a longer working day on public road constructions in this state. The 8-hour day for work of this sort never has been particularly popular with laborers. The majority of highway jobs are at points distant from cities or large towns, in many cases necessitating the housing of the men in construction camps. When their work is finished they have nothing to do, nor nowhere to go. Delays on account of weather conditions are frequent in highway operations. Under the 8-hour act the men are prevented from making up this lost time and as a result their earnings are reduced. A vote on the question by the men directly affected undoubtedly would show a big majority in favor of a longer working day for improvements of this kind.

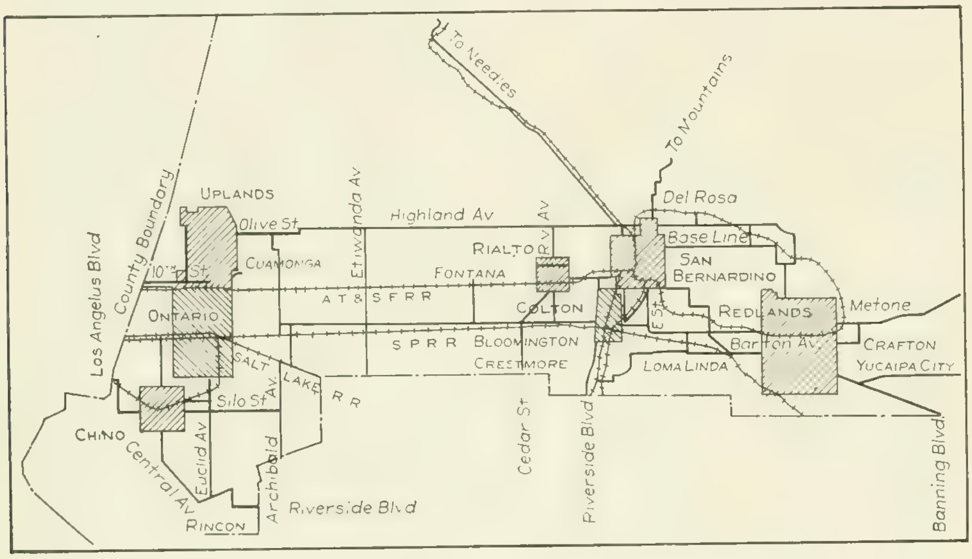
HIGHWAY SYSTEM OF SAN BERNARDINO COUNTY, CAL.

Expenditure of $1,750,000 Contemplated.

90 Miles of Concrete Road; 88 Miles of Macadam.

San Bernardino County, California, as noted in our last issue, is about to begin construction work on a system of highways that will call for an expenditure of $1,750,000. The greater part of this sum will be spent for the improvement of the roads lying south of the San Bernardino Mountains. North of the mountains about 238 miles of highway will be improved, but for this work only about $125,000 has been allotted. The location of the highways south of the mountains is shown on the accompanying map.

The aggregate length of these roads is 188 miles and of this mileage 90 miles will be 5-in. macadam and 88 miles 5-in. concrete. Both types will be finished with an asphaltic oil and screenings wearing surface. This division of concrete and macadam is due largely to soil conditions. The paved portions of all roads will be 16 ft. wide, with 2-ft. shoulders on each side. These shoulders vary in class and construction but will be of a substantial character.



Location of Highways in System of San Bernardino County.

The sections of highways to be improved in accordance with the report of the County Highway Commission are as follows:

Road.	Miles.
Base line to Church St	6.75
Highland Ave. to Church St	6.50
Mountain Ave.	.56
Palm Ave. to Highland Ave	1.00
Church St.	1.30
Orange St.	1.30
Redlands to Mill Creek Canyon	7.50
Mentone Ave. to Crafton Ave	1.00
Redlands to county line	5.50
Road No. 9 to Yucaipe City	5.00
Redlands to Colton Ave	4.75
Loma Linda to Colton Ave	5.50
Barton Road to San Bernardino	5.50
Redlands to Colton	6.90
South E St. to Colton Ave	1.70
Mt. Vernon Ave. to Colton Ave	.70
Colton Ave. to Riverside County	2.70
Colton Ave .to Ontario	17.00
Cedar Ave. to Riverside	2.60
Etiwanda Ave. to Riverside County	7.00
Archibald Ave. to Colton Ave	3.50
Archibald Ave. to Riverside County	4.50
Turner Ave.	2.00
Euclid Ave. to county line	8.50
Along Riverside County line	.70
Central Ave. to Chino	4.40
Central Ave. to Holt Ave	2.30
Chino Ave. to Euclid Ave	1.25
Silo Ave. to Los Angeles County	2.70
Silo Ave. to Archibald Ave	4.30
Tenth St. to Los Angeles County	3.00
Tenth St. to state highway	.60
Mountain Ave. to Twentieth St. upland	2.50
Nineteenth St. to Archibald Ave	2.70
Olive Ave. to Etiwanda Ave	5.50
Highland Ave. to Mt. Vernon Ave	11.00
Riverside Ave. to Highland Ave	1.50
Riverside Ave. to Colton Ave	1.30
Perris Ave. to San Bernardino	2.25
Bloomington Ave. to Colton Ave	1.70
Magnolia Ave. to Colton Ave., Fontana	2.10
Rancho Ave. to Colton	.50
Mt. Vernon Ave. to San Bernardino	1.30
San Bernardino to Waterman Canyon	3.30
Highland Ave. to Cajon Pass	22.00

It is the present intention of the Commission to let some of the work by contract and to do some of it by force account. For the contract work the Commission will furnish cement, rock and oil f. o. b. cars at the nearest available railway siding. The system will be constructed under the direction of the San Bernardino County Highway Commission, with offices on the second floor, Old Court House, San Bernardino. R. H. Mack is the Secretary and J. S. Bright, Jr., is the Engineer.

HORSE SHOE RESERVOIR PROJECT, ARIZONA.

Proposed Conservation of Flood Waters from Verde River.

Expenditure of $800,000 to $2,000,000 Proposed.

The Salt River Valley Users' Association of Phoenix, Ariz., has had an investigation made as to feasibility of building a dam on the Verde River for the conservation of its flood waters not already utilized for irrigation on the project of the association. The surveys and studies were conducted by Mr. W. R. Elliott, Water Users' Bldg., Phoenix, the engineer of the association, and his report was submitted early this year. The report was accepted by the association, but no definite action as to construction has been undertaken. There is reason to believe, however, that a dam will be built in the near future at the site considered. The following details of the undertaking are taken from Mr. Elliott's report:

The proposed reservoir, generally known as the Horseshoe, is located in Tp. 8 N., range 6 E., Gila and Salt Rivers base and meridian. The dam site is a canyon just north of the line between Tps. 7 and 8 N. of range 6 E., and will be in section 35. The site lies in a northeasterly direction from Phoenix, the distance by the Camp Creek road being about 55 miles. The reservoir when full (205,000 acre feet), will have a surface area of about 4,100 acres and will be approximately 8 miles long and 1½ miles wide at the greatest width, which is in Deadman's Canyon.

The dam site is between two rock hills which form a neck to the valley above. These two hills will serve as the east and west abutments to the proposed dam. The distance from abutment to abutment at the top of the 170 ft. dam would be about 1,250 ft., and the distance at the river bottom would be 450 ft. Both abutments are composed of basalt rock. This rock could be used in the construction of the dam. It is handy to the site and could be transported on cableways. The bed rock is basalt with an occasional stratum of closely cemented volcanic tuff. The greatest depth of bed rock, according to borings, was 40 ft. The dip was not in an ideal direction, but the excavation has been figured to extend well into the bed rock so as to give a horizontal plane for the dam to rest upon.

It has been assumed that a natural spillway existed to the west of the dam site about 2,500 ft., but upon investigation it was found to be too low by an average of 8 ft. To use this location it would be necessary to build a concrete spillway and rock fill to the elevation of the dam. Consideration also has been given to building a spillway on each side of the dam, the rock excavated from the spillway to be used in the dam construction. The total length of spillway, if constructed west of the dam, would be about 1,000 ft.; if constructed adjacent to the dam it would be about 700 ft. in total length.

The estimates for the dam cover three types: gravity section masonry structure, multiple arch, and rock fill. The scheme adopted to control discharge from the reservoir is a well with gates at various elevations to permit of their opening under low pressure. Three estimates have been prepared. Estimate No. 1 covers a gravity section masonry dam, straight in plan, with spillway located west of the dam about 2,500 ft. The height of the spillway above river bed is 150 ft. and the maximum height of dam above river bed it 170 ft. Estimate No. 2 provides for rockfill dam with concrete face. The water control is to be by outlet well with three gates. The spillway is to be located 2,500 ft. west of the dam. The dam is to be 14 ft. wide on top; the face slopes 2 to 3 and the down stream slopes 1 to 1. The rock fill is to extend to bedrock, and there is to be a concrete cut-off wall to bedrock. Estimate No. 3 covers a reinforced concrete multiple arched dam, with spillway located 2,500 ft. west of the dam. The water control and outlet is to be a well with three gates at different elevations. The estimated costs under these plans are as follows:

ESTIMATE NO. 1.

	Total.
Excavation, main dam section, 37,544 cu. yds	$ 37,544
Masonry in main dam, 276,269 cu. yds	1,657,614
Excavation for walls, 3,277 cu. yds	4,915
Concrete in wing walls, 795 cu. yds	7,950
Backfill behind wing walls, 2,345 cu. yds.	1,759
Excavation for spillway, 556 cu. yds	834
Concrete in spillway, 869 cu. yds	13,035
Fill, 1,151 cu. yds	1,151
Outlet Water Passages and Control:	
Lining tunnel	10,000
Outlet well, 1,056 cu. yds	10,560
Three gates, 4 by 8, and operating machinery	3,225
Freight and installing	5,000
Foot bridge, 50-ft. span	600
Roads around damsite	10,000
Lands submerged (assumed)	50,000
Engineering, incidentals and office expense, 15 per cent	272,328
Total estimated cost	$2,086,515

ESTIMATE NO. 2.

Excavation, 50,000 cu. yds	$ 75,000
Concrete facing, 4,125 cu. yds	61,875
Rockfill, 524,730 cu. yds	524,730
Water control and outlet	*29,385
Spillway	*15,020
Roads around dam	*10,000
Lands submerged (assumed)	*50,000
Engineering, contingencies and office expense, 15 per cent	38,300
Total estimated cost	$ 804,310

ESTIMATE NO. 3.

Main dam (estimated)	$1,000,000
Roads around dam	*10,000
Spillway	*15,020
Water well and control	*29,835
Lands submerged (assumed)	*50,000
Engineering, contingencies and office expense, 15 per cent	167,161
Total estimated cost	$1,271,566

*Same as in estimate No. 1.

It is reported that construction will be started next month on a railway between Peking and Jehol, China. The work, it is said, will call for an expenditure of $12,000,000, which will be provided by the Perking-Hankow and Peking-Mukden Rys.

HIGHWAY CONSTRUCTION IN MICHIGAN.

Details of Work to Be Done This Year in Fourteen Counties.

Earth Roads—Gravel—Macadam—Concrete.

Highway improvements in Michigan are carried out under four systems: County, road district, township-county plan and township. In counties where the last mentioned system is in force the work is in charge of township highway commissions. These men handle the maintenance of all earth roads in their townships and also construct state reward roads under the supervision of the State Highway Commissioner. Under the county system the highway work is in charge of county road commissioners. These commissioners are in charge of all highways taken over from the counties and also build state reward roads.

The following statistics relate only to the work that will be undertaken this year by counties operating under the county road plan. Table I gives a summary of the construction contemplated by 14 counties. Further details regarding these improvements follow.

Alger County has $10,000 available for construction purposes and proposes to build 6 miles of macadam. No contracts will be let. L. E. Adams, Munising, Mich., is Engineer.

Calhoun County has $60,000 available for construction purposes and will build 12 miles of gravel road and 6 miles of road with crushed stone base and gravel top. Bids on this work were opened March 15. Alexander McKay, Battle Creek, Mich., is Engineer.

TABLE I.—ROAD WORK CONTEMPLATED FOR 1915 BY 14 MICHIGAN COUNTIES.

	Type of road.			
County.	Earth. Miles.	Gravel. Miles.	Macadam. Miles.	Concrete. Miles.
Alger	..	..	6	..
Calhoun	..	12	6[1]	..
Charlevoix	..	8	3	..
Clinton	..	12	5.25[2]	..
Delta	22	..	12[3]	..
Dickinson	9	3	3[4]	
Genesee	..	50	..	..
Gogebic	3.5	..	..	
Houghton	..	..	4.5[5]	
Iron	20	5	6.5	
Mackinac	30	..	7	
Marquette	18	..	..	..
Oakland	19[6]	..	..	6
Wayne	..	..	..	30

[1] Crushed stone base with gravel top. [2] Stone or slag base, gravel top. [3] Also resurfacing 12 miles additional. [4] Bituminous. [5] Also 8.5 miles bituminous carpet coat. [6] 19 to 23 miles.

Charlevoix County will construct 8 miles of gravel road and 3 miles of macadam during the present year. Contracts will be let about April 1. The county has $33,000 available for construction purposes. H. L. Winters, East Jordan, Mich., is Engineer.

Clinton County has $33,000 available for construction work this year. It will build 12 miles of gravel roads and 5¼ miles of roads having stone or slag base and gravel top. Part of the improvements will be carried out by contracts, the letting to be held probably this month. E. G. Hulse, St. Johns, Mich., is Engineer.

Delta County proposes to construct during 1915 22 miles of earth road and 12 miles of macadam. It also will resurface 12 miles of macadam. Part of the work will be done by contracts. These were let in January. The county has $80,000 available for construction purposes. R. P. Mason, Escanaba, Mich., is Engineer.

Dickinson County's construction program includes 9 miles of earth roads, 3 miles of gravel and 3 miles of bituminous roads. The work will be done by contracts, which will be let about April 1. The county has $28,000 available for construction purposes. G. V. Carpenter, Iron Mountain, Mich., is the Engineer.

Genesee County has $120,000 available and will construct about 50 miles of gravel road. The work will be done by contract. Geo. H. McVanel, Flint, Mich., is Engineer.

Gogebic County will construct 3½ miles of earth road, the work including approximately 24,500 cu. yds. of excavation. The improvements will be carried out by contract. The letting is to be held about May 15. C. F. Winkler, Bessemer, Mich., is Engineer.

Houghton County proposes to construct 4½ miles of macadam and also contemplates about 8½ miles of bituminous work (carpet coat). No contracts will be let. The county has $29,500 available for construction purposes. R. Martin, Houghton, Mich., is Engineer.

Iron County has $120,000 available for this year's construction. It will build 20 miles of earth road, 5 miles of gravel and 6½ miles of macadam. The work will be done by contracts, bids for which were to be opened March 15. A. L. Burridge, Iron Falls, Mich., is engineer.

Mackinac County proposes the construction this year of 30 miles of earth road and 7 miles of macadam. The work will be done by contract, the lettings to be held in June. The county has $70,000 available for construction purposes. Ernest Weaver, St. Ignace, Mich., is engineer.

Marquette County has $50,000 available for its highway construction this year. It will construct 17 to 18 miles of earth road by contract. The lettings will be held early in May. V. S. Hillyer, Ishpeming, Mich., is engineer.

Oakland County will construct 19 to 20 miles of gravel road and 6 miles of concrete. The work will be done by day labor and contract. Contracts will be let in April or May. The sum of $129,000 is available for construction purposes. M. De Glopper, Pontiac., Mich., is engineer.

Wayne County has $432,000 available for construction purposes this year. It will construct 30 miles of concrete road with county forces. Edward H. Hines is Chairman Board of County Road Commissioners.

A 20,000,000 CU. YDS. EXCAVATION CONTRACT.

Required in Construction of St. Lucie Canal, Everglades, Florida.

To Be 24 Miles Long, with 120-ft. to 160-ft. Bottom.

One of the largest single excavation contracts of the past three or four years was let last week. The contract provides for the construction of the St. Lucie Canal for the Board of Commissioners of the Everglades Drainage District of Florida. The Furst-Clark Construction Co., Baltimore, Md. secured the work.

The contract contemplates the construction of a canal from the east shore of Lake Okeechobee to the south fork of the St. Lucie River, and the widening and rectification of a portion of the river. The quantity of material necessary to be removed will amount to 20,000,000 cu. yds. of earth excavation. The canal will be 24 miles long, will have a bottom width of 120 ft. and a depth of cut of 14 ft. at the lake end, and will gradually widen to 160 ft. on the bottom at the river end. The greatest depth of cut will be 28 ft. The normal water section at the lake end will be 1,480 sq. ft.; at the river end it will be 2,200 sq. ft. The river below the entrance of the canal has an average depth of 11 ft. with good sections and reaches and lends itself well to improvement.

The canal is being constructed to provide the principal unit of a control plan for controlling the waters of Lake Okeechobee, preventing their overflow and inundating the Everglades. It will provide the main outlet for the drainage of the wet lands through which it will pass. It also will provide such navigation and other features as may be reasonably and economically harmonized with the canal constructed for lake control purposes.

A dam with adjustable crest will be constructed near the lower end of the canal. By means of this considerable flexibility of lake control will be possible. A lock also will be provided for harmonizing the navigation features of the waterway. The construction of the lock and dam is not a part of the contract just let.

The Furst-Clark Construction Co. in carrying out this work propose to remove a sufficient amount of the top material with land excavators to clear the canal section of roots, stumps, brush and other debris so as to leave comparatively clean earth. With the material thus excavated it is proposed to construct a levee each side of the canal, beyond which the remaining material is to be pumped as excavated by a suction dredge. The contract calls for beginning excavation within three months and for completion within four years from date of contract.

The project was reported favorably in August, 1913, by the Acting Chief Drainage Engineer, F. C. Elliot, and in December of the same year by the Everglades Engineering Commission, composed of Isham Randolph, M. O. Leighton and Edmund T. Perkins. A summary of the latter report was given in the Jan. 28, 1914, issue of ENGINEERING AND CONTRACTING.

The improvements will be carried out under the direction of the Board of Commissioners of Everglades Drainage District of the State of Florida, of which Gov. Park Trammell is President and F. C. Elliot, Tallahassee, Fla., is Chief Drainage Engineer.

AN $800,000 IRRIGATION PROJECT—CALIFORNIA.

District to Be Formed Near Terra Bella, Cal.

Diversion Dam—Reservoir—Canals—Pipe Lines.

An $800,000 irrigation project is proposed by property owners in the Terra Bella section of Tulare County, California. The district will be known as the Terra Bella Irrigation District and it will be organized under the Wright Irrigation Act. This Act provides for the formation of a district by the County Supervisors upon petition of a majority of the property owners representing a majority in value of the lands concerned. The district is authorized to issue bonds for the construction or acquirement of works and water rights. A preliminary report on the Terra Bella project has been submitted recently to the organization committee by Stephen E. Kieffer, Consulting Engineer, San Francisco. The following details of the undertaking are taken from the report.

The proposed district comprises the territory south of Deer Creek and between the Southern Pacific R. R. and the hills, capable of being irrigated from stored and conserved waters of Deer Creek. The proposed work consists of a diversion dam on Deer Creek, 4 miles of diversion canal, a storage reservoir of 28,000 acre-feet capacity, a gravity outlet or main distributing canal and a system of riveted steel pressure pipes to carry the water to every tract of land. The net duty of the water assigned to the land will be 1.5 acre-feet during the irrigating season. The district is to include 12,500 to 13,500 acres. For the first acreage the estimated cost of the project is $828,800 or $66 per acre; for 13,500 acres the estimated cost is $839,000 or $62.50 per acre.

It is proposed to divert the flow of Deer Creek by means of a diversion dam and large canal to the main storage reservoir. From the reservoir an outlet canal will skirt the eastern boundary of the district, from which pressure pipe lines will traverse the district from east to west and deliver water in the highway opposite each tract of land. Each owner will be required to convey the water from the street main into his own property.

The diversion dam will be located in the bed of Deer Creek near the northeast corner of Section 5, T. 23 S, R. 29 E, M. D. B. & M. It will be built of reinforced concrete and will be of the hollow Ambursen type. The maximum overflow height will be 27 ft. with an additional 5 ft. at the headgates. The total length on the crest will be 229 ft. The diversion site is located at a solid granite ledge which crosses the canyon at this point.

The diversion canal will have a length of about 4 miles, made up approximately of 3 miles of concrete-lined excavated canal (including 875 ft. of tunnel) and 1 mile of iron flume. From the dam to the tunnel the canal will have a grade of 5.28 ft. per mile, a bottom width of 7 ft., side slopes ½ to 1, and a water depth of 4 ft. The flume will have a grade of 7.92 per mile, a top width of 8⅓ ft., and a water depth of 4 ft. The tunnel will have a clear section of 5 ft. by 8 ft., on a grade of 26 ft. per mile. Below the tunnel, the canal will have a bottom width of 4 ft., side slopes ½ to 1, water depth 4 ft., and grade 30 ft. per mile.

The canal will be lined throughout with concrete. Most of the length will be excavated on a sidehill of moderate slope, in a decomposed granite soil overlying solid granite, which outcrops heavily. The entire line is near and easily accessible from the county road. The dams for the storage reservoir will be of the earthen type, the material being placed by the hydraulic process. Materials and physical conditions are stated to be admirably suited for this method of construction. The outlet or main distributing canal from the reservoir to the land and from which the distributing pipe lines will be supplied, will have a grade of 4 ft. per mile, bottom width from 3 ft. to 1½ ft., side slopes ½ to 1, water depth 2½ ft. to 1½ ft., capacity 40 to 7 second feet. The size decreases as each lateral is taken out. The canal will be lined throughout its length with ¾-in. reinforced cement mortar. Suitable breast and diversion gates will be provided at each lateral for the delivery of water from the open canal to the pipe lines.

A portion of the land to be irrigated lies above this gravity canal. To reach this land booster plants will be required to lift the water from the canal. The cost of these plants will be borne by the property owners and is not included in the general cost estimates. A system of riveted steel pipes has been designed to deliver water in the road opposite every piece of property in the district. These pipes will start in the gravity outlet canal and will follow the subdivided roads from east to west, with cross connections on some of the north and south roads. These pipe lines will be so gated and interconnected that any portion of them may be cut out for work or repairs without interfering with the balance. The diameter of the pipes will range from 16 ins. down to 4 ins. Under conditions of maximum irrigation use a sufficient pressure head will be maintained to give good domestic service.

The estimated cost of the project for 12,500 acres is $824,800. If the gross area of the district is 13,500 acres it is estimated that the work will cost $839,000. The distribution of the cost of $824,800 would be about as follows: First year, land, etc., diversion works and distributing system, $413,800; dams, $200,000. Second year, completion of dams, $211,000.

Bids Asked on 71,000 Sq. Yds. of Pavement at Charleston, W. Va.

A 71,640 sq. yd. pavement contract is now being advertised for bids by the city of Charleston, W. Va. The work involves the paving of 15 streets and includes approximately 40,700 lin. ft. of curb. The approximate quantities in the improvement are given in Table I. Bids will be received on all well known classes of paving materials. The specifications provide for brick with cement grout filler or tar or asphalt filler; for concrete pavement, sheet asphalt, wood block, bituminous concrete and bitulithic. In addition contractors will be allowed to bid upon classes of pavement other than those specified. The curbing will be either stone or concrete. If the latter, it will be 6 in. thick by 18 in. deep, made of a 1:2:4 mix, with a 1:2 facing. Combined curb and gutter will be 6 in. by 12 in. with a 24-in. base, and will rest on a 6-in. foundation of broken stone or gravel. The concrete base for the pavement, unless otherwise specified, will be 5 in. thick of a 1:2½:5 mix. If a crushed stone or gravel base is used it will be 7 in. thick.

The specifications for the concrete pavement provides for a 7-in. thickness, the mix to be 1:2:3. Concrete pavements wider than 20 ft. may be reinforced with metal fabrics at the option of the engineer. Transverse expansion joints will be at intervals not greater than 35 ft. All expansion joints will be of the premoulded type; all transverse joints will be protected by soft steel protection plates. The concrete also may have a bituminous wearing surface.

TABLE I.—APPROXIMATE QUANTITIES FOR STREET PAVING AT CHARLESTON, W. VA.

Street.	Paving, sq. yds.	6x18-in. curb or 6x24-in. curb and gutter, lin. ft.	6x12-in. edging, lin. ft.	Excavation, cu. yds.	*Extra concrete in street contracts, sq. yds.	Street car track, lin. ft.
Charleston	14,900	9,740	240	6,500	4,000	4,500
Florida	2,860	2,030	140	790	130	144
Virginia	3,060	1,860	65	420	.....	.....
Park	5,050	2,550	220	580	640	720
Central	11,850	7,020	226	4,970	3,390	3,810
Fourth	3,820	2,240	150	1,600	1,000	1,125
Ruffner	980	660	29	140	....	.....
Jackson	3,770	2,220	...	320	..	..
Beauregard	3,400	650	29	140	.	.
Elizabeth	4,500	1,365	100	1,600	. .	...
McClung	3,650	2,300	80	1,952	...	...
Kentucky	2,640	1,270	...	750	...	.
Quarrier	7,110	4,310	58	2,635	.	.
California	2,750	1,670	87	785	.	..
Jefferson	1,270	830	30	40	..	.

*Figured on basis of 7-in. subgrade.

The sheet asphalt paving will consist of a 1½-in. binder course and a 2-in. wearing course. Two types of bituminous concrete pavement are covered by the specifications. Type A consists of two courses—a binder course and a 2-in. wearing surface. Type B will consist of a paint coat binder and a wearing surface.

Bids for the curbing and paving will be received until 10 a. m., March 24, by the Board of Affairs, Charleston, W. Va. G. S. Brown is city engineer.

Seven Concrete Bridges for Kansas Counties.

Nearly 1,300 cu. yds of concrete are required in two bridge lettings for Kansas counties now being advertised for bids. The work calls for the construction of five reinforced concrete bridges for Cloud County and two reinforced concrete bridges for Harvey County. Constructural features of these improvements are given in Table I.

TABLE I.—CLOUD COUNTY, KANSAS.

Bridge.	Span, ft.	Roadway, ft.	Height over all,§	Plain concrete, cu. yds.	Reinforced concrete, cu. yds.	Reinforcing steel, lbs.
Chavey*	24	18	12	59.6	32.1	5,293
Hinman†	64‡	18	23¼	51.1	254.2	25,667
Shrader†	20	18	24½	....	177.8	11,519
Murphy*	20	18	15½	113.8	28.9	3,613
Teasley*	24	18	15½	189	32.1	5,293
Reiger†	50	16	25	....	224.1	27,970
Kissoway	20	16	17	165.6	29.9	6,611

*Reinforced concrete superstructure and plain concrete substructure. †Reinforced concrete superstructure and substructure. ‡Two 32-ft. spans. §Bottom of foundation to top of roadway.

The Chavey bridge is to be erected in Aurora Township, 1 mile west of Aurora. The Hinman bridge will be erected over Wolf Creek in Buffalo Township, as a point about 2½ miles from Concordia. For this structure the excavation will be in loam and piling may be necessary to secure a satisfactory foundation. The Shrader bridge will be built over Oak Creek in Lincoln Township, about 3 miles southeast of Concordia. The Murphy bridge is in Shirley Township, about 2 miles south of Clyde. The Teesley bridge is in Solomon Township, about 5 miles north of Glasco. For these structures sand and gravel can be obtained from the Superior Sand & Gravel Co., Superior, Neb., and the Manhattan Sand Co., Manhattan, Kan. Suitable crushed rock can be had at Florence, Kan. C. J. Johnson, Irving, Kan., is the owner of the quarry. It, no doubt, will be possible to obtain satisfactory sand from the Republican River. Bids for the work in Cloud County will be received at the office of the County Clerk, Concordia, Kan., until noon, March 24.

For the two bridges in Harvey County crushed stone will have to be shipped in, but suitable sand probably can be obtained locally. The Reiger bridge will be constructed over Turkey Creek in Alta Township, about 10 miles from Burton. The Kissoway bridge will be erected over Kissoway Creek in Lakin Township, about 8 miles from Sedgwick. Bids on the Harvey County bridges will be received at the office of the County Clerk, Newton, Kan., until noon, March 22.

The seven bridges will be constructed under the plans and specifications of the State Engineer, Manhattan, Kan.

THE IOWA POST ROAD.

Bids Asked for 20.4 Miles of Highway in Dubuque County.

Gravel Surfacing—Reinforced Concrete Box Culverts.

A good sized gravel road contract in Dubuque County, Iowa, is now ready for bids. The work calls for the construction of the Iowa Post Road in this county; the road is known locally as the Hawkeye Highway. The improvement provides for grading and surfacing with gravel 20.4 miles of road from Dyersville to Dubuque, or as much of this as can be built for the approximate sum of $75,000. This is a unit bid job.

The main features of the work include 75 concrete box culverts, 4 ft. span and under; 132,500 cu. yds. unclassified excavation; 11,000 lin. ft. concrete or all wood guard rail, and 650 lin. ft. tile drain. The road is to be surfaced to a width of 15 ft. with chert gravel. The improvement is a good small shovel and industrial railroad proposition. The gravel also can be handled from deliveries by the Illinois Central R. R.

The concrete culvert construction is divided into four divisions as follows:

No.	Size.
Division 1 Dyersville to Farley.	
16	2 ft. by 2 ft.
4	3 ft. by 2 ft.
1	3 ft. by 3 ft.
1	4 ft. by 3 ft.
Division 2—Farley to Epworth	
12	2 ft. by 2 ft.
2	3 ft. bv 2 ft.
2	4 ft. by 3 ft.
Division 3 Epworth to Centralia.	
17	2 ft. by 2 ft.
1	4 ft. by 3 ft.
Division 4—Centralia to Dubuque.	
19	2 ft. by 2 ft.
1	3 ft. by 2 ft.
1	4 ft. by 3 ft.

The Iowa Post Road is to be constructed from a joint U. S. Government and County fund of $90,000, and the work will be in charge of Engineers of the U. S. Office of Public Roads. In addition to the improvements now being advertised, there will be let sometime during April bridge and viaduct work for the Post Road amounting to approximately $50,000. A large amount of road and bridge work is projected in Dubuque County for the present season and it is probable that at least $200,000 will be expended for these undertakings.

The work on the Iowa Post Road will be in charge of B. H. Burrell. U. S. Senior Highway Engineer, Office of Public Roads, his headquarters for this project being at Dubuque, Ia. Bids for the grading and surfacing will be received by the County Supervisors, John Inghram, County Auditor, Dubuque, Ia., until 2 p. m., March 31. Bids for the concrete culverts will be received on the same date.

The $750,000 Flood Protection Scheme of Indianapolis, Ind.

A large amount of construction work is contemplated for the present season by the city of Indianapolis, Ind. The Board of Public Works adopted plans and specifications last week for the first part of the $750,000 flood protection scheme. It also is probable that plans will be taken up again for the sewage disposal plant. This latter project will involve the expenditure of $1,500,000 to $2,000,000. The Legislature recently refused to pass a bill for the creation of a special sanitary district to construct these works. It is now proposed to carry out the undertaking by assessing the cost against the real estate owners.

The first work under the flood protection scheme will be done along the west branch of the White River from the Belt R. R. tracks on the south to 14th St. on the north. Plans for this were adopted on March 10, and a hearing on the condemnation of the necessary land will be held April 2. Bids for the construction work, it is stated, will be opened on April 23. The improvement is divided in 7 sections, and proposals will be received on one or all of them. The work will be paid for on the basis of 10 per cent by the owners of property directly benefited, 45 per cent by the city, and a like amount by the county.

The levee will be about 75 ft. wide and will be from 2 to 4 ft. above the 1913 high water mark. It will carry a 40-ft. road on the top and will have concrete facing at certain points. The river channel will have an average width of about 650 ft. It is planned to complete the work on the west side by Dec. 1. Plans are now being finished for a levee and street on the east side of the White River. In addition resolutions will be submitted soon to the Board of Public Works for the extension of bridges to give a greater waterway, for raising the Belt R. R. tracks to bring them above high water limits and for raising the tracks of the Big Four R. R. north of 10th St. Plans also will be submitted for weirs or dams for reducing the velocity of stream. B. J. T. Jeup is City Engineer of Indianapolis.

Annual Meeting of Illinois Section of the American Water Works Association.

The first annual meeting of the Illinois Section of the American Water Works Association was held at Champaign March 9-11. This was the seventh meeting of the former Illinois Water Supply Association which now constitutes the section named. The meetings under the new order of things promise to be even more fruitful of good results than in former years. The possibilities of state associations of water works men, when under competent and energetic leadership, have been well demonstrated in Illinois.

There was the usual program of short papers of practical nature. Many of these were valuable contributions to water works literature. The entertainment and inspection features of the meeting were especially enjoyable and instructive. The annual dinner, the complimentary concert by the University of Illinois Military Band and the review of the Regiment of student-citizen soldiers were notable features on the entertainment program. The regiment is composed of 2,300 underclassmen, officered by upper classmen. While not at all warlike the delegates admitted pride in this well drilled body composed largely of boys from Illinois homes.

On Thursday the delegates went by trolley to Danville where the supply and purification works of the Interstate Water Co. were inspected. A greatly appreciated complimentary luncheon was served to the visitors at the Plaza Hotel in Danville, the Water Company being host.

The delegates also visited two coal mines. At the first strip-mining was in progress. At the second, the visitors descended a shaft 180 ft. deep and rode by trolley a distance of 1½ miles to a point where a coal channeling machine was in operation. This was an exciting ride. One could understand the natural desire of the motorman to show the tenderfeet a burst of underground speed. The hoisting engineer also gave the visitors a couple of thrills. The 180 ft. of shaft were traversed, going and coming, in nothing flat. All eventually regained the surface in safety, strengthened in their allegiance to the water works business.

About 120 people registered at the convention. The Section will hold a one-day meeting in October of each year in addition to the usual annual spring meeting at Urbana. The place of meeting in the fall will be changed from time to time, in all probability, according to the location of new works offering educational possibilities to the membership. Mr. W. J. Spaulding of Springfield was elected chairman of the Section for the coming year. H. E. Keeler, Rookery Bldg., Chicago, was elected Treasurer, and Dr. Edward Bartow, Director of the Illinois Water Survey, Urbana, was appointed Secretary. Mr. F. C. Amsbary of Champaign was elected Trustee.

A $500,000 Road Contract in Lake County, Florida.

A $500,000 contract calling for the improvement of about 200 miles of highway is now being advertised for bids by the commissioners of Lake County, Florida. The approximate quantities involved in the work are as follows:

Roadway	1,091,046 lin. ft.
Excavation	329,630 cu. yds.
Pavement	1,147,610 sq. yds.
Concrete	301.62 cu. yds.
Square deformed steel	1,554 lbs.
R. C. Steel	5,146 lbs.
Terra cotta drains, 12 in. to 24 in.	885 lin. ft.
Pole line to be moved	1,552 ft.
Bridges to be raised	57

Bids will be received on the following types of surfacing: Sand-clay, shell, modified asphalt, waterbound macadam, macadam with Rocmac binder and oiled macadam. The material to be used will be determined after the bids are in. Bids for the construction of these improvements will be received until April 15 by the County Commissioners at the office of H. H. Duncan, County Clerk, Tavares, Fla. The J. B. McCrary Co., Atlanta, Ga., are the engineers.

A New Engineering Medal.—Leonard C. Wason, president of the Aberthaw Construction Company, Boston, who has just been elected President of the American Concrete Institute, has offered a new prize to be awarded annually by the Institute to the author of the best paper submitted to the Institute during the year. Competition is restricted to members, and the papers must be original in every respect and not previously published elsewhere. All papers submitted to the Institute for publication in the annual volume are eligible to this competition, but the Board has the privilege of withholding the medal any year in which no papers of sufficient merit are presented.

A 38 Mile Florida Road Letting.—Duval County, Florida, is now calling for bids on a good sized road letting. The work calls for the hand surfacing with vitrified brick, asphalt macadam or other suitable material, and curbing, the following roads:

Road.	Length, miles.	Width surfacing, ft.
Black Point extension	1.25	15
John Anderson	4.10	15
John Anderson	3.00	15
Atlantic Blvd.	.50	20
Atlantic Blvd.	2.4	15
Atlantic Blvd.	1.3	20
National Highway	14.3	15
Kings Road	4.0	15
Kings Road	3.4	15
Lem Turner Road	3.6	15
Lem Turner Road	.5	20
Evegreen Ave.	..	20
Talleyrand Ave.	..	20

Bids for the improvement of the above roads will be received by E. A. Ricker, Chairman County Commissioners, Jacksonville, Fla., until March 25.

NEWS LETTERS

Rust, Swift & Co. of St. Louis on March 10th were low bidders on the Government revetment and shore protection work on the Mississippi river in the neighborhood of St. Genevieve, Mo. Among the other bidders were Fruin & Colnon, McCann Bros. Const. Co., A. V. Fetter & Co., Kinser Constr. Co., J. W. McMurray Contracting Co. and the Miller Engineering Co.

The Board of Public Service will hold a public hearing at 2 p. m., March 16, on the request of the Terminal Railroad Association that it be permitted to lay tracks on part of the Ranken tract. The property crosses a number of city "streets" which, though unmade, have been platted. The plan of the terminal to lay tracks has been the subject of a long-standing controversy between the city and the railroad. If the request is granted, it is understood the terminal will use the tracks for storing cars.

Andy Koenig celebrated a birthday here last Wednesday. "He has a birthday every week" and a party of contractors and supply men who were visiting the city on that day presented Koenig with an elegant gold headed silk umbrella and a gold headed walking stick. The umbrella will see good service during our spring rains, and the cane is stored away for old age. Koenig is only 50 years old and does not think he will require a cane for at least fifty more, that is, if he continues feeling as good as he did at the cabaret show given in his behalf Wednesday night. Among those present and who made short talks (and some long ones) were J. W. McMurray of Kansas City, R. A. Sin Clare of the E. I. Du Pont de Nemours Powder Co., Chas. Nagel of La Grange, Mo.; Mark Ragsdale, representing A. V. Fetter & Co. of Quincy, Ill.; Roger Fabion of the J. W. McMurray Contracting Co., and a host of other good fellows. The entertainment lasted until the wee small hours the next morning and everybody left for home feeling happy even if they did lose out on some nice contracts the day before.

The Highway Improvement Committee of the East St. Louis Commercial Club appointed a subcommittee of three men to test out the sentiments of property owners relative to the proposed extension of Main street from Missouri avenue to St. Clair avenue. The committee, composed of Chief M. J. Tobin of the Fire Department, William Bensinger and Alderman Charles F. Short will begin its work immediately. Estimates as to the cost of the work will be furnished by City Engineer E. F. Harper. Mr. Bensinger announced that the merchants on Collinsville avenue, between St. Louis and St. Clair avenues, have pledged $6,000 toward completing the work. One of the largest items of cost will be the condemnation of a two story brick store at Main St. and Missouri Ave.

Big Riley of Clapp, Norstrom & Riley passed through here one day last week on his way back to Chicago from Hot Springs. Riley had about 15 minutes between trains, which he spent eating breakfast at the depot. Came pretty near overlooking to call us up.

C. H. Degenhardt, who has the contract for building a state aid road out of Alton as the first leg of a hard road between Alton and St. Louis, will start work next Monday at the Alton end of the line. The contract so far let will require the use of a million of the large block vitrified paving brick. The road will begin 3,024 ft. east of the corporation line of Alton and extend to East Alton. It will be started again south of Wood River. East Alton and Wood River being incorporated villages, will provide for the hard road through their limits, and Wood River has already started legal formalities to prepare for making an award of a contract.

W. F. Woodruff who finished his grading in Wisconsin last fall and has been laying up at Bedford, Ind., all winter, is ready to put his 7-team outfit on to any kind of grading.

Ed Harris, Neoga, Ill., wants work for a small team outfit.

T. J. Morris & Son have finished their work at Cape Girardeau, Mo. Are in the market for some more team work.

C. H. Walker expects to finish his bridge and trestle work on the K. R. & C. R. R. near Cressmont, Ky., in about 30 days. He will have a good first class bridge and piledriver outfit idle then.

Anderson Bros., 1010 Fourth Ave., Rockford, Ill., have a cracker jack 22-team outfit and 2 graders idle at that point.

Harrington Bros. were awarded the contract for grading a lot of property work near the corner of King's Highway and Arsenal Sts., St. Louis.

B. H. Smith, Concordia, Kan., want any kind of grading in the west. Smith has eight teams idle.

T. E. Luttzording writes us from Hillsboro, Texas, that he has 10 good railroad teams idle at that point that he can place on work immediately. Prefers the west or northwest.

The Alton Board of Trade has under consideration a plan to erect loading docks for Mississippi River barges at the foot of Ridge street. The Kansas City Shippers' Association, which has barges in operation between Kansas City and St. Louis would like to make Alton its terminal point, and probably will do so if docks are built.

J. E. Kughn & Sons have finished their work at Dows, Iowa, and are in the market for any kind of day or contract work. Prefer Iowa or South Dakota.

The L. J. Smith Construction Co. of Kansas City sold its factory and about 2½ acres of land to the Kansas City Tire & Rubber Co., a new company that is just being organized there for the manufacture of automobile tires and other rubber goods.

S. Dolman & Son, Topeka, Kan., were awarded the contract for grading, track laying and surfacing, 23 miles of the Bonner Springs Electric Line between Kansas City and Lawrence, Kan. They are ready to sublet this work in quantities to suit outfits.

The Illinois Traction System has surveyors at work preparing estimates for construction of an extension twenty-five miles in length, which will connect the Peoria-Springfield line with the Bloomington-Decatur line, extending between Lincoln and Wapella. There is a section of territory south of Bloomington which is not reached by any railroad.

The contract for water pipe to be laid from the city limits to the Industrial School at Bellefontain Farms, a distance of eight miles, was awarded on March 11th to the National Tube Company by Supply Commissioner Thomas. The company's bid for steel pipe was the lowest, $15,435.

The contract for installing a new system of plumbing in the St. Louis Federal building was awarded on March 11th by the Treasury Department to S. Faith & Co. of Philadelphia. The successful bid was $38,627. Several St. Louis concerns sought this contract, but the bids were too high. Work will commence at once.

A. B. KOENIG.

Bids Asked on $308,000 of Sewer Work At Indianapolis.

The city of Indianapolis, Ind.; is now calling for bids on two sewer contracts, the total estimated cost of which is over $300,000. One of these improvements is the College Ave. main sewer. This will be 37,824 ft. in length, and will be composed of the following:

Size.	Lin. ft.
7 ft. 6 in. circular	2,675
5 ft. 9 in. circular	2,660
5 ft. 3 in. circular	1,260
5 ft. circular	1,135
3 ft. circular	2,085
2 ft. 6 in. circular	.....
24-in. pipe, double strength	2,440
20-in. pipe, double strength	7,644
18-in. pipe	6,296
15-in. pipe	3,120
12-in. pipe	5,630
6-in. hose connections	38,340

94 manholes, oval.
16 manholes, circular.
17 inlets.
2 bellmonte junctions.

The excavation will be in gravel with 3 or 4 ft. of top soil; the total excavation will be about 113,000 cu. yds. The sewer will be built of vitrified pipe, concrete, brick or segmental block. The estimated cost is $218,000.

The other contract calls for the construction of a main drain in 38th St. and alley east of Cornell Ave., from Fall Creek to College Ave. The total length is 4,376 lin. ft. The sewer will be 8 ft. 6 in. in size and will be built of brick, vitrified block or concrete. The estimated cost is $90,000. The work will require about 40,000 cu. yds. excavation in gravel. Bids for the construction of the College Ave. and 38th St. main sewer will be received until March 31 by the Board of Public Works of Indianapolis, Ind. B. J. T. Jeup is City Engineer, and Charles A. Brown is Assistant Engineer in charge of sewers.

Sewer Construction at Minneapolis to Cost $980,000.

A tentative program for sewer construction in 1915 and 1916 has been laid out for the city of Minneapolis, Minn., that calls for an estimated expenditure of about $980,000. As proposed the program comprises the following work:

Vitrified Pipe.	Feet.
12-in	25,000
15-in	19,000
18-in	17,000
20-in	11,000
22-in	7,000
24-in	8,300
27-in	3,400
30-in	2,600
Total	93,300

Reinforced Concrete (built in place.)	Feet.
39-in	700
42-in	4,300
45-in	1,300
48-in	900
51-in	4,000
60-in	5,200
66-in	1,700
69-in	700
72-in	1,800
78-in	600
84-in	1,400
87-in	900
96-in	2,600
Total	26,100

This work will all be done by day labor. The contracts for material needed during the season of 1915 have already been let. C. Illstrup is Sewer Engineer of Minneapolis.

PERSONALS

Mr. H. E. Bilger, road engineer, Illinois State Highway Department, Springfield, Ill., was transferred on March 2 from the grade of Associate member to that of member in the American Society of Civil Engineers.

Mr. James Shakman, formerly assistant chief chemist of the Bureau of Streets Laboratory, Chicago, has joined the staff of Walter H. Flood, Consulting Chemical Engineer, 326 River St., Chicago, and has assumed the direction of the road materials laboratory which has recently been considerably enlarged.

Mr. Donald C. Wedgeworth, resident engineer on the New York State Barge Canal at Syracuse, has been transferred to Residency No. 2 with headquarters at Schenectady. Mr. Wedgeworth has been connected with the New York State Engineer's Department for the past 11 years. He is an associate member of American Society of Civil Engineers.

Mr. John B. Wickware has been appointed as superintendent of public works for Rutherford, N. J.; and will have full charge of design and construction of municipal improvements, sewers, paving, etc. Mr. Wickware has had 20 years of general civil engineering experience. He was engineer in charge of construction for various contractors on the New York State Barge Canal.

Mr. Charles F. Lacombe, until recently chief engineer of the Bureau of Gas and Electricity of the city of New York, announces that he has opened an office for consulting electrical engineering work at 30 Broad street, New York. He will make a specialty of electric lighting and power installations, the design and construction of street lighting systems, rate questions, etc. Mr. Lacombe has had fourteen years of experience in the engineering construction and executive operation of electric light and power enterprises. He served the city of New York for 12 years as chief engineer of the Bureau of Gas and Electricity. During that time he had direct supervision of the illumination of the streets and the lighting and power service to public buildings, the design and specifications for street lighting, public building lighting and for the city's gas and electric construction work, the rules and regulations governing the safety of private electrical institutions and the enforcement thereof, the inspection and operation of the gas and electric service and construction contracts and the certification of their performance, involving an annual expenditure of over five million dollars, much administrative work and rate adjustment.

Mr. W. C. Armstrong, who had charge of the design and construction of the Chicago passenger terminal of the Chicago & Northwestern Railway, has been appointed chief engineer in charge of construction of the Chicago, Milwaukee & St. Paul union depot at St. Paul. Mr. Armstrong is a graduate of Iowa State College, and entered railroad service in 1882 as draftsman for the Wisconsin, Iowa & Nebraska Railway, now the Chicago & Great Western. In 1884 he became resident engineer on the Burlington, Cedar Rapids & Northern, now part of the Rock Island. The following year he was employed on railroad surveys in South Dakota and county map work in Minnesota, and in 1887 he was resident engineer on the Soo line. After one year as resident engineer for the Great Northern Railway he was made engineer of track and bridges on the Pacific extension of that railway. He was with the Andrews Bridge Co. of Spokane for one year, and with the Toledo Bridge Co. of Toledo for three years. In 1899 he was appointed resident engineer for the Chicago & Northwestern, and was in charge of construction of the Boone County Railway and the Boone Viaduct. From 1902 to 1904 he was bridge engineer for that company, in 1905 superintendent of construction on the Missouri Pacific, and in 1906 bridge engineer for the Rock Island. In 1907 he returned to the Northwestern as terminal engineer in charge of design and construction of the passenger station at Chicago, which was completed in 1911. Since that time he has been engineer of bridges for that railway.

OBITUARIES

J. C. Rothrey, a prominent railway and electrical engineer in the employ of the Canadian Northern Railway, was killed by a fall from a train near Weston, Ont. Mr. Rothrey was engineer on construction of the Gorge Railway between Niagara Falls and Lewiston, and was afterward manager of that line. Later he was general manager of the International Railway System of Buffalo. He superintended construction of the International Bridge across the Niagara River and was for a time general manager of an electric railway in East Liverpool, Ohio. Seven years ago he joined the staff of Mackenzie & Mann in Toronto and has been superintendent of construction of electrical railways for that company ever since.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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Concerning the Permanency of Light Sectioned Concrete Highway Bridges.

Before the general establishment of state highway commissions it was difficult to secure adequate supervision of the design and construction of highway bridges. This lack of competent engineering supervision, together with a lack of definite knowledge as to future loads, resulted in numerous exceedingly light highway bridges. In steel spans the substructures generally were stronger than the superstructures, due to the use of stone and mass concrete piers and abutments, although insufficient attention to foundation and flood conditions often made this difference problematical. The present use of heavier loadings and better engineering supervision have resulted generally in more massive and better-balanced structures, and the question has now arisen in some states as to whether the bridges and culverts designed and constructed under present state highway commission specifications are too massive. It is argued by some that the expenditure required by such designs is greater than is warranted by the funds available and by the number of waterways to be bridged.

To justify the use of designs prepared by it the State Highway Commission of Iowa has recently made a detailed inspection, analysis and field study of concrete bridges and culverts in service in that state, the investigation covering 82 bridges and culverts. The first step in the investigation was an inspection and physical examination of each structure; measurements were made, foundations were partially dug out and exposed, photographs were taken, and a detailed record made of every evidence of failure either in design or in construction. Of the 82 lighter-sectioned bridges examined—all built under county control—60 have clearly developed defects, 16 are sufficiently defective to be unsafe for traffic, particularly during periods of continued high water, and 2 have collapsed completely.

The defective and unsafe condition of the spans considered is attributed by those in charge of the investigation as being due to the following causes: Insufficient foundation areas, or depths, or both, 39 cases; inadequate reinforcement, 16 cases; insufficient dimensions of sections, 7 cases; "thin-section" concrete members, placed in positions exposed to frost upheaval and stream erosion, 30 cases; inadequate wing-wall lengths, allowing stream erosion back of the filling, 8 cases; and inferior materials and workmanship, 8 cases.

Of the 82 structures examined 28 have had, and 17 more are in immediate need of, repairs or renewals. The causes to which this lack of permanency may be attributed are: "Thin-section" concrete members, placed in positions exposed to upheaval and erosion, 28 cases; insufficient foundation depths, 15 cases; and use of wing-walls of insufficient length to retain properly the approach filling (and which after construction have been lengthened by timber bulkheads or by rip rap), 23 cases.

To show that the light construction examined is neither safe nor permanent, and that adherence to the present state standard specifications will correct the main defects noted, the following data were compiled by the investigators: In 65 per cent of the defective spans the defects were due, entirely or in part, to insufficient foundation depths, or areas; in fact the foundations of a majority of the bridges examined did not extend more than 2 ft. below the bed of the stream. In contrast to this the state specifications require a minimum depth below the stream bed of 4 ft., and also specify the use of piling if there is uncertainty as to the character of the foundation material. Although the standard specifications limit the loading on clay soils to two tons per square foot, the pressures, as determined by careful analysis, on many of the structures examined reached eight tons per square foot. In about 27 per cent of the defective spans insufficient dimensions of sections under stress were a contributory cause of the defects. Analyses of the stresses produced in these bridges under ordinary load conditions disclosed unit stresses of from 40 to 80 per cent above those adopted by the state. As a result of this investigation it was concluded that the excess material required by the state standard specifications over that used in the lighter-sectioned types investigated was not only warranted but absolutely essential.

In analyzing the results of this investigation, too much significance should not be attached to the mere fact that high stresses were found in many of the sections, as a considerable number of the structures undoubtedly were designed for smaller loadings than are required by the present standard specifications. It is, however, pertinent to note that the assumed loadings were lower than those now in actual use, and that those in charge of the design of these structures failed to make adequate provisions even for the loadings now in use. As might have been expected, a large percentage of the defects and failures was due to insufficient foundations; and it is in the matter of foundation design that engineers have displayed the greatest weakness. The fact remains that foundation failures occur too frequently in our so-called permanent bridges. It is not improbable that engineers are tending toward the too extensive use of thin reinforced concrete sections in foundation design.

Methods of Forming Scroll Casings and Draft Tubes for Turbine Water Power Plants.

Few structures in concrete call for the molding of more complex shapes than do scroll cases and draft tubes for turbine installation. "Making snail shells" is the term applied by workmen to this task and it does not greatly exaggerate its difficulty. Complex curved surfaces have to be formed and formed with exactness. The molds for these surfaces must be true in shape and precise in size and they must be made so rigid as to keep to shape and size. This is expensive construction and because of it and of the fact that several like scrolls usually are to be molded economy urges that re-use of forms to as great an extent as practicable shall be sought.

Despite the obvious intricacy of scroll case and draft tube form construction literature gives surprisingly few examples worked out in any useful detail. It is for this reason that the detail drawings of turbine emplacement forms which are published in this issue are valuable. With the discriptive text these drawings are examples which can be copied from with certainty in laying out forms for other draft tube and scroll case work. The more important lesson to be gained, however, is that forms of this character are engineers' work. They must be designed and detailed as a machine or a strucural steel detail is designed by an engineer. And an engineer must direct their fabrication unless trained pattern makers are employed. The average carpenter is not skilled enough to interpret the designs.

Examination of the drawings for both scroll case and draft tube forms indicates two principle features. The first is the collapsibility of the ribs; the second is the assembling of the complete form by sections or units composed of several ribs with lagging attached. These provisions would be in any case necessary for handling and dismantling the forms, but they also enable re-use of the forms for succeeding turbine emplacements. In the forms illustrated and more clearly in the forms for the draft tubes, the ribs are individual units. Comparison is suggested with the draft tube form ribs illustrated in our issue of Feb. 17, 1915, p. 152; here a longitudinal frame or keel formed a center member to which rib quadrants were bolted to complete the skeleton of the draft tube mold. A gain in flexibility of the form for erection and removal is indicated by the keel construction.

It is curious that in all the many samples of turbine emplacement form work that engineering articles present one does not recall a case in which steel forms were employed. Doubtless there may be such cases and we shall be glad to have them brought to our attention, with discussion of their success. A description appears elsewhere in this issue of a turbine installation in which the scroll case was not molded in the concrete but was made of plate steel and was embedded in concrete. The merits of this construction compared with those of more ordinary construction, also any comparison of steel and wood forms and of wood forms of different designs, are largely speculative as far as the average engineer is concerned because of an almost total lack of published cost data.

Solution of the Section Labor Problem on the Long Island Railroad.

Section laborers on railways have for a number of years been required to work longer days and for a smaller daily wage than prevail in other employments. In addition the practice of the railways is to take on and lay off section men with the seasons and no man is certain of his job for any length of time beyond the busy months of spring and fall. The results of course were certain. Section foremen are limited in their choice to men discarded by employers paying higher wages or if a capable man is secured he remains no greater time than it takes him to find better employment, and always green men are being trained to the skilled work of track maintenance to the detriment of the quality of that work.

This statement here of a condition irritatingly familiar to railway maintenance officials is merely to preface an account of the remedial measures successfully taken by one railway company and which may be taken by other railways. In 1913 the Long Island R. R. inaugurated a *permanent section force*. The method followed is described in detail by Mr. Coleman King, supervisor, in the "Maintenance of Way Bulletin" for March, 1915. It is briefly indicated by Mr. King as follows:

> To meet this competition, we established on May 16, 191[illegible], our [illegible] section force, which [illegible] averages about [illegible] the entire system. The sections are divided into five classes; those of the first class covering important [illegible] men, and [illegible] one man, [illegible] allowed four [illegible] the force averages about 15 per cent less than we found to be necessary with the former seasonal

fluctuating force. Coincidentally, rates were increased to 17½ cts. per hour for laborers, and 18 cts. per hour for sub-foremen; sub-foremen being allowed on about 70 per cent of the sections. At the same time a material increase was made in the foremen's wages.

Coincidentally a plan was devised in the office for distributing the work of maintenance over the whole year. This task will materially vary on different railways and we will, therefore, let the reader particularly interested go to the original account for detailed information. Mr. King's statement of the success of his plan, however, merits quotation:

> So far we have found that the assurance of permanent work at a fair rate of wages has practically eliminated the shifting about of men and the necessity for breaking in green men, and we still have fully 95 per cent of the force we started with after the reorganization. I feel perfectly safe in saying that at the present time our section forces are comprised of the very best labor obtainable; they take an active personal interest in the work, and do everything possible to retain their places.

The experience of the Long Island R. R. is, it seems to us, distinctly instructive. First by systematizing section work and reorganizing the section forces 15 per cent fewer men were able to perform the work. Second by increasing the attractiveness of the employment more capable men were drawn to it. Both advantages were secured by means available to any railway company.

Estimating the Cost of Culverts and Other Small Structures in Road Building.

The contractor or engineer whose experience in the construction of roads in country districts has been limited, is prone to error in estimating the cost of culverts and other small structures. In the aggregate the sum of the cost of these features seldom exceeds ten per cent of the total cost of the job. But in point of effect upon the progress of other portions of the work and hence the cost of other work, error in estimating cost or arrangement of construction work may affect total costs very materially.

The two most important cost producing elements in building small structures are transportation of materials and the difficulty of working small and widely separated gangs. The former is affected by the condition of the roads—usually bad—and the frequent necessity of traversing a section of recently graded road or road in process of being graded, in the case of culvert construction. This results in decreasing the size of loads that may be carried and limiting the type of transportation to horse drawn vehicles. The latter element practically forces the employment of extra foremen or the use of highly paid and reliable workmen to secure effective work in the operation of small gangs.

The work that must of necessity be done by small gangs is varied and, as a rule, extends over the whole period required for the completion of the job. It includes the moving of fences, grubbing stumps, building temporary roads, digging trenches and laying pipe culverts in advance of grading operations, building concrete culverts, constructing temporary bridges, trimming and finishing, laying gutter, erecting guard rail and numerous other small jobs, usually at widely separated points.

In estimating the cost of such work it is therefore generally wise to become thoroughly familiar with the ground before figuring the probable cost. It is also advisable to estimate such work from the labor cost gang basis rather than attempt to use unit costs, although it must be admitted that the amount of work necessary in so doing is out of all proportion to the relative cost of the work. It is certainly convenient to estimate that concrete culverts will cost so much a cubic yard of concrete or guard rail so much a linear foot, but is it not wise to consider the number of culverts and their location and the number of different points at which guard rail is used? When these elements are considered the amount of labor must be computed or unit costs increased by estimate to secure a proper bid and which is the safer method of estimating?

Experienced contractors are familiar with the uncertainty of the cost of these small structures and their bids upon such features are generally quite high. A loss upon them, however, usually does not affect greatly the total cost of the work. But it is a matter of some satisfaction to remove the uncertainty as to the cost by more careful methods of estimating than it is the practice of some contractors to employ.

Rent for Street Occupation by Stock Piles.

In Philadelphia a contractor who piles building materials in the street must pay a monthly rent of 25 cts. for the space occupied. This rent is not adequate recompense for the obstruction of several hundred square feet of street nor is it enough to discourage almost as free occupation of the roadway by brick piles and mortar boards as would prevail were nothing charged for the privilege. Why not then give the privilege or else charge a reasonable rent? Perhaps the purpose of the nominal rent is to necessitate the formal recording of the act of occupation by the builder and thus appraise the street officials of the need of watchfulness and restriction. There is sound reason in this, but what we started to note here is another thing. The Bureau of Highways of Philadelphia, which needs money for its work of maintaining streets, proposes that the rent be increased from 25 cts. to $5 per month and that the rental be appropriated to the street department funds. The annual rental that would result from this increase is estimated at $40,000. This is not a great sum but it would go far toward relieving the handicap of too small a supervising force of which the Bureau complains. In this connection it is interesting to note that in this Bureau engineering and overhead charges together amount to only 4.8 per cent of the total expenditures. This is a remarkably small figure as such charges run in municipal and state work and seems to lend justice to the claim that the supervising force of the Bureau is undermanned.

POWER PLANTS

Construction Plant and Methods for Concrete Work on the Lock Twelve Dam, Coosa River, Alabama.

Dam construction is largely a problem of plant equipment and arrangement for handling rapidly a large volume of materials and in case of included power house, also a problem of special form work for wheel encasements, penstocks and draft tubes. In an elaborate paper by E. L. Sayers and A. C. Polk (Proc. Am. Soc. C. E., Vol. XL, p. 2189) these features are considered in detail for Lock Twelve Dam of the Alabama Traction, Light & Power Co., and from this paper such data as relate exclusively to the concrete construction are abstracted as follows:

GENERAL DESCRIPTION.

The dam on Coosa River, known as Lock 12 Dam, is about 11 miles northeast of Clanton, Chilton County, Alabama. The spillway forming the principal part of the dam has a net crest length of 780 ft., divided into 26 sections, each 30 ft. long, separated by concrete piers, 6 ft. long on the axis of the dam. One the crest of each section of spillway there is placed between piers a gate, 30 ft. long and 14 ft. high, of a modified Stoney type. The height of the dam from the average elevation of the original river bed to the elevation of the flow line of the reservoir is 77 ft. The foundations of the power house are built transversely to the axis of the river and form an integral part of the dam. The length of spillway, power house, and abutments, over all, is 1,530 ft. 5½ ins. The power house substructure is 303 ft. 4 ins. long, 136 ft. 5 ins. wide, and contains provision for six units. Four units constitute the present installation, and the superstructure is built with a temporary wall at the river end so that it can be extended to cover all six. In all, there are approximately 190,000 cu. yds. of concrete in the power house foundations and the dam. The first concrete was placed on April 12, 1913; it was all placed by Feb. 26, 1914; and commercial power was turned out for the first time on April 12, 1914, just one year, to the day, from the date of placing the first concrete.

CONSTRUCTION PLANT.

Railroad Yards and Tracks.—Yards and tracks for the storage and rapid handling of materials were provided; and a line was built down into the river bottom, below the dam, whereby trains and engines could get down on the cofferdam; this was known as the "Low-Level Line." There were two storage yards for sand and gravel where loading and unloading operations in no way interfered with regular train and switching movements. A long side track served the main cement warehouse, oil house, and general storehouse, so that cars were unloaded directly into them. The shops were also served with another siding, but the arrangement used was a poor one. The main line, known after it left the yards on its way to the dam as the "High Level Line," served the mixer, cement warehouse, concrete material bins, and compressor plant, materials being unloaded directly to these various places from the cars. Figure 1 is a map showing this detailed track layout.

Cableways.—Two traveling cableways spanned the river parallel to and immediately over the face of the dam. Together, the two cableways had a range of about 150 ft. up and down stream. The towers were 95 ft. above the rail, their track elevation being about 440. The length of span, was 1,647 ft. The towers traveled on standard gage tracks and on standard M. C. B. car wheels and axles. The main cables were 2¼ ins. in diameter and of patent, lock laid, flat, steel strands on the outer covering. The cableways were also equipped with one button line, having eight buttons on it, one endless line, and one hoist line. The button and hoist lines were ¾-in., 6/25-strand, Hercules, wire ropes. The endless line was a ¾-in., 6/25-strand, flat, wire rope. The button line was 1,700 ft. long, the hoist line, 2,100 ft., and the endless line, 2,600 ft. long. The cableways were operated by 12¼x15-in. engines, driven by steam, from 80-hp. locomotive type boilers, all mounted on the trucks of the towers. The cableways had a rated capacity of 10 tons, and were operated under a sag of 80 ft. with a load of 6 tons. In the early stages of the operation of the cableways, a good deal of trouble was experienced with carriers. The original carriers seemed to be too heavy, frequently breaking each other when they struck. Lighter carriers were made, and much of the trouble was eliminated. Trouble was also caused by the breaking of two strands in No. 2 cable. The first breaks were welded by the oxy-acetylene process. The weld did not prove satisfactory, and they broke again; this cable was used for the remainder of the job with these strands cut out. The buttons used on the button lines were of an obsolete type, and were not satisfactory; when one of them broke or slipped along the cable, it was necessary, in order to put on a new one, to lower the cable, cut out a section, and replace it, all of which was expensive and caused much delay. There is now manufactured a cast-steel button, made in two parts, which does away with the necessity for lowering the cable. A button of this type can be put on in an hour, and is a great improvement over the old one. Extra hoist, button, and endless lines were kept in readiness at the head towers, so that, in case of a breakdown at any time, they could be quickly and rapidly installed. The cableways handled practically 60 per cent of the concrete, and were run both day and night. They also handled practically all the excavation in the early stages of the work. They were used for moving and erecting all derricks, etc., handling form lumber, iron and materials of a like character, and were found to be exceedingly useful for the latter purpose.

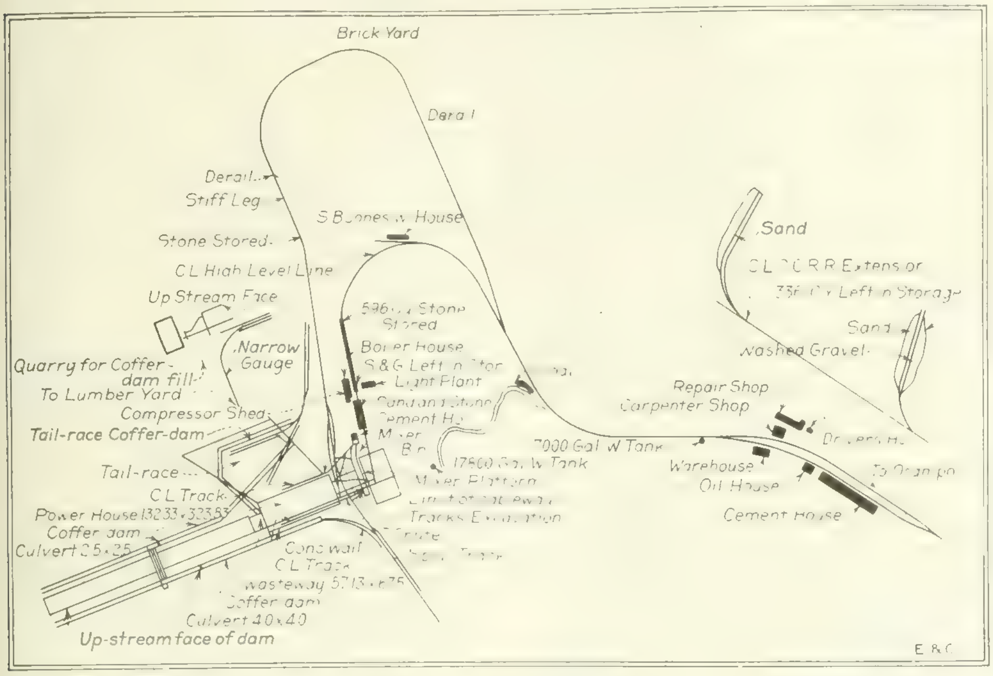


Fig. 1. Plant Layout for Lock Twelve Dam, Coosa River, Alabama.

Derricks.—All derricks used at the dam for excavating and for placing concrete were of 5-ton capacity, of the wooden, traveling stiff-leg type, with 37 to 40-ft. masts and 55 to 65-ft. booms. These derricks traveled on the upstream and down-stream cofferdams, parallel to the line of the dam, and on the bottom in the tail-race and draft-tube excavation of the power house. Later, when the concrete reached elevation 380 in the power house, three of these derricks were set up on high bents and were stationary. All the derricks were equipped with ⅝-in., 6/19-strand, Hercules, steel-wire rope hoist and boom lines, and with 14-in. derrick irons and 12-ft. bull-wheels. Double blocks were used on the booms and single blocks on the hoist lines, and were operated by 7x10-in. engines, with swinging gears, driven by air. The traveling feature of these derricks was an excellent one, as their increased radius of action was most advantageous. In this case the back trucks of these derricks traveled on the top of the cofferdam, and the front trucks on a trestle resting on the bottom inside. Three of them were able to cover a length of 475 ft. of the dam, on the upstream face. These derricks handled excavation in skips into cars run out on the upstream coffer, and took concrete from the cableways, placing it in the forms, the cableways depositing a loaded bucket in a certain place and removing the empty bucket, the derrick then taking the bucket and dumping it in any portion of the form desired. They also took concrete from flat cars run out on the upstream cofferdam.

Mixer Plant.—The mixer plant was about 200 ft. south of the cableways, and discharged concrete to cars standing at elevation 425. The plant consisted of two model 64, 84-cu. ft. mixers, owned by the Powers Co., and driven by an 18x24-in., horizontal, single cylinder engine, rented from the contractor. This engine was run by steam supplied from the compressor plant, about 100 ft. away. These mixers had a capacity of 20 batches per hour, their combined capacity being 3,200 cu. yds. Materials for concrete came in in hopper-bottom cars, and were dumped through a trestle into a bin having a capacity of 800 cu. yds. They were removed from this bin by a belt conveyor to a bucket elevator, and deposited in smaller bins over each mixer, from which they were drawn to the measuring hoppers. The belt conveyor and bucket elevator were driven by a 10x16-in. horizontal, single cylinder, engine, also run by steam supplied from the compressor plant. The drive on both the mixers and elevators was with belts, to line shafts, and friction clutches. One of the drums of the mixers wore through comparatively quickly, due to the exceedingly tough and hard quality of the stone. This drum mixed approximately 70,000 cu. yds. of concrete. These drums were of ¼-in. metal, and the engineers believe this to be somewhat too thin for this size. They suggest that a ⅜-in. shell would be preferable. Four sets of blades and one drum were worn out on one mixer, and three and one-half sets of blades on the other, in course of the job. Two elevators were installed during the progress of the work. The first was a No. 6, 18-in. bucket, stone elevator, 67-ft. centers, on the main pulleys. It did not have sufficient capacity to supply 1,000 cu. yds. per 10-hour day to the mixers, as required, and was taken out in August and replaced with a No. 8, 30-in. bucket elevator. A 32-in., 6-ply belt, 147 ft. long, was used, and had 98 30x17x10-in. steel buckets. After the installation of the larger elevator, there was no more trouble.

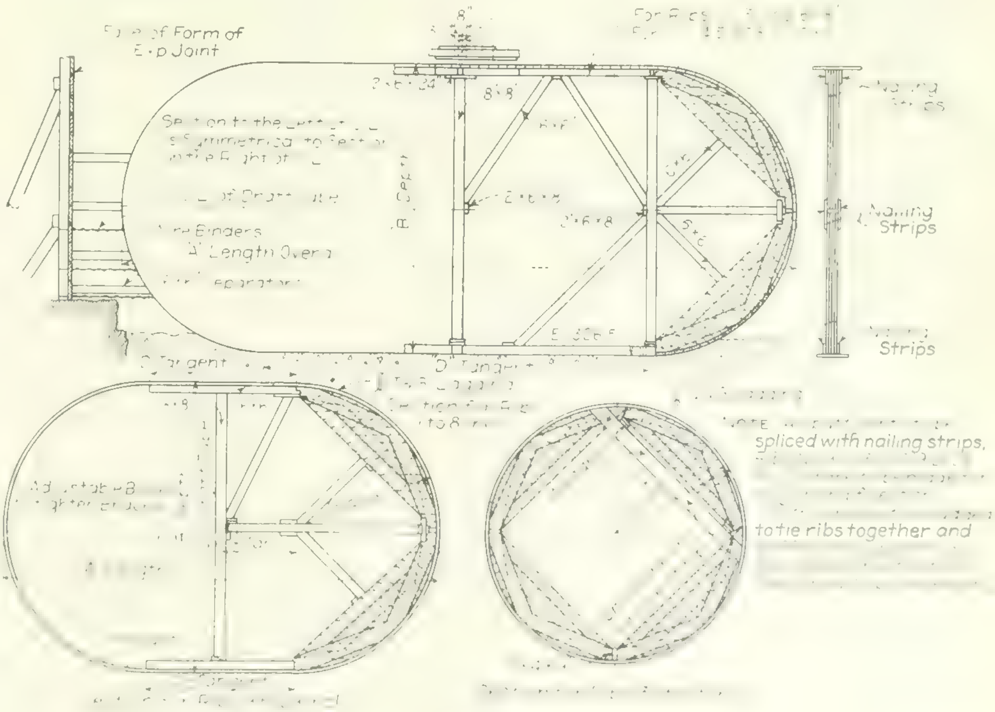


Fig. 2. Typical Ribs of Draft Tube Forms.

Water was supplied to the mixers through a 2-in. line from the main storage tank at the dam. Two small iron tanks with the necessary control valves, gage glasses, etc., were equipped and set up overhead in the mixer room, and all the water drawn directly from these to the mixers.

As soon as the cement was emptied into the hoppers, two laborers assigned to the duty gathered the sacks, shook them off to one side, packed them in bundles of 50, and stored them in the mixer cement house until from 20,000 to 30,000 sacks had accumulated, when a carload was shipped to the mills. The sweepings were sacked and used with the other cement.

Compressor Plant.—Practically all derricks, hoists, small pumps, air drills, small wood-boring tools, etc., were operated by air at a pressure of 85 lbs., furnished by a central compressor plant which was near the mixing plant. The boilers of this plant also furnished steam for driving the mixing plant. Two 24x30-in. straight line air compressors, each with a capacity of 1,225 cu. ft. per minute, furnished all the air. These machines were leased with other equipment from the contractor. The compressor and the mixer plant were supplied with steam by four 125-hp. horizontal, locomotive type boilers, leased from the contractor. The compressors delivered air at 85 lbs. pressure through a 6-in. main to a storage tank, 4 ft. 9 ins. in diameter, 12 ft. long, and of ⅝-in. metal, located outside the building. A system of pipes was arranged to spray water constantly over this tank to keep it cool, and a special grade of oil was used in the compressors on account of the likelihood of explosion in the storage tank. The air was distributed to the principal points of use through a 6-in. main.

Machine and Carpenter Shop.—The machine, carpenter, and blacksmith shops were all in one long building in the yards near the main storehouse. One line shaft, 84 ft. long, ran through the length of the building, and all machine tools were driven from it. The engine driving this line shaft was an 11x14-in. horizontal, single-cylinder engine owned by the Alabama Power Co. It was supplied with steam by a 30-h.p. vertical boiler, leased from the contractor. The engine and boiler room was in the center and at the rear of the shops. The machine shop contained the following tools: One 30-in. radial drill press; one 30-in. shaper; one 18-in. x 10-ft. lathe; one 1½-in. bolt threading machine; one No. 94 Forbes, 2½ to 6-in. pipe cutting and threading machine; one 16-in. x 5-ft. lathe; one 30-in. diameter by 5-in. face power grindstone, and one No. 4 Vulcan emery grinder. The blacksmith shop contained the following: One No. 2 Champion blower for forges; three blacksmith forges, home-made; three anvils, from 250 to 300 lbs. The carpenter shop contained: One No. 8 variety rip-saw and joiner; one band saw; one No. 402 bench grinder; one No. 8 planer and matcher. This planer was very useful, and surfaced all form lumber; if the saw mill had been operated by the company, however, the planer should have been there.

There should have been added to the machine shop a power hack-saw, a set of shears large enough to cut rounds up to 1 in. in diameter and flats up to 1x3 ins., and a small steam-power hammer on a job where there are a number of locomotives and cars to be taken care of. The shops, as located, did not have sufficient floor and working space, and should have been separated from each other. Both should have been closer to the dam, and served by independent spurs from the railroad, so that cars of lumber could have been delivered to the platforms and yards direct. The laying-out floor of the carpenter shop should have been large enough to build one complete scroll case form on it, which would have taken a platform 75 ft. square. Also, there should have been a second laying-out floor, at least 50x100 ft., for ribs and other work of that kind. The machine shop, if possible, should have been as close to the work as convenient for all purposes, and should have at least two tracks for its own exclusive use; one for bringing machinery, etc., to be repaired at the shop, the other to serve as a general rip yard track. Where a railroad is operated and engines are taken care of, a pit for dropping wheels should be provided on one of these tracks.

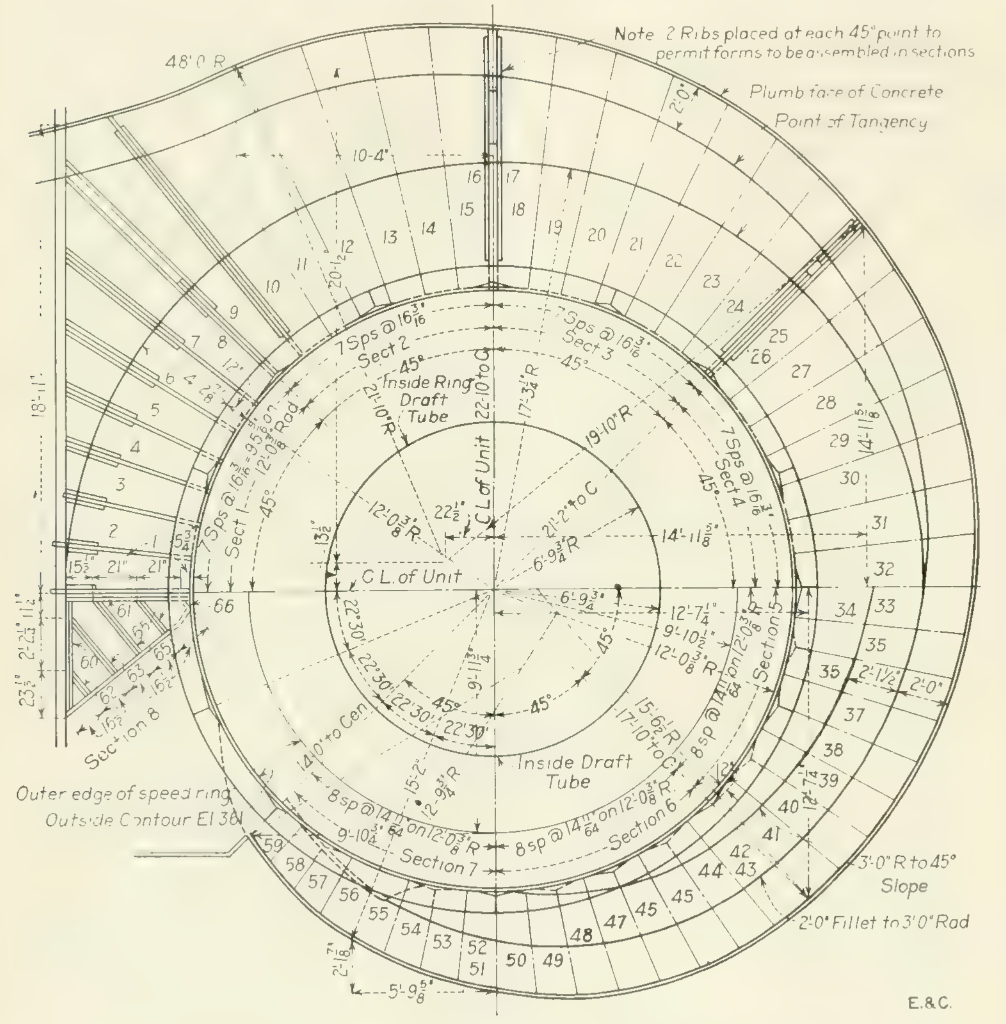


Fig. 3. Rib Layout for Scroll Casing Form.

TABLE I.—DETAILED DIMENSIONS FOR RIBS OF SCROLL CASING FORMS.

Rib No.	A Ft.	A Ins.	B Ft.	B Ins.	C Ft.	C Ins.	D Ft.	D Ins.
10.....	2	2½	5	4¼	0	6	12	9⅝*
11.....	2	1	1	7½	0	6	11	11⅜*
12.....	2	0	4	4	0	6	11	6⅞
13.....	2	0	4	2	0	6	11	4⅞
14....	2	0	4	0	0	6	11	2⅞
15.....	2	0	3	9½	0	6	11	0⅜
16....	2	0	3	7	0	6	10	9⅞
17....	2	0	3	7	0	6	10	9⅞
18....	2	0	3	4½	0	6	10	7⅛
19....	2	0	3	1¼	0	6	10	4⅛
20....	2	0	2	10¼	0	6	10	1⅛
21....	2	0	2	7¼	0	6	9	10⅛
22....	2	0	2	4¼	0	6	9	7⅛
23....	2	0	2	1¼	0	6	9	4⅛
24.....	2	0	1	10½	0	6	9	1⅜
25....	2	0	1	10½	0	6	9	1⅜
26.....	2	0	1	7¾	0	6	8	10⅝
27.....	2	0	1	1¾	0	6	8	7⅝
28....	2	0	1	1½	0	6	8	4⅜
29....	2	0	0	10¼	0	5⅛	8	1⅛
30.....	2	0	0	6¾	0	3⅜	7	9⅝
31....	2	0	0	3¾	0	1⅞	7	6⅝
32.....	2	0	0	0¾	0	0⅜	7	3⅝

Rib No.	a Ft.	a Ins.	b Ft.	b Ins.	c Ft.	c Ins.
33....	2	0	5	3⅝	4	0
34.....	2	0	5	0¾	3	9½
35.....	2	0	4	10	3	7½
36....	2	0	4	7¾	3	5¼
37.....	2	0	4	5½	3	3¼
38.....	2	0	4	3	3	1
39.....	2	0	4	1	2	11
40.....	2	0	3	11¼	2	8¾
41.....	2	0	3	9⅝	2	6⅜
42.....	2	0	3	9⅝	2	6⅜
43....	2	0	3	8	2	4
44.....	2	0	3	6	2	2
45.....	2	0	3	3½	1	11¾
46	2	0	3	1¼	1	9¾
47.....	2	0	2	10½	1	7¼
48.....	2	0	2	8	1	4½
49.....	2	0	2	5	1	1¾
50.....	2	0	2	1⅝	0	10½
51.....	2	0	2	1⅝	0	10½
52.....	2	0	1	11	0	7½
53.....	2	0	1	8	0	4½
54.....	2	0	1	4¾	0	1½
55.....	2	0	1	1½	0	1¾
56.....	2	0	0	10½	0	5
57.....	2	0	0	7¼	0	8
58.....	2	0	0	3½	0	11¾
59.....	1	11½	0	0	1	3¾

*R. generates ellipse.

Locomotive Cranes.—Two 10-ton locomotive cranes were used in all features of the work. They did the work well, but the type used had only four wheels, which was hard on the track. Two 1½-yd. clam-shell buckets were furnished with these cranes, and were used for unloading, storing, and reloading from storage all sand and gravel, and for coaling engines, etc. They were also used to assist in the disposal of excavation from the dam and tailrace, handling loaded skips. They were also used in unloading and erecting the contractor's plant and in reloading it when the work was completed. They were found exceedingly useful all through the work, but were not quite big enough for all purposes. After the work was started a larger crane was purchased, having a 50-ft. fixed boom and a 30-ft. trussed extension. This crane had a capacity of from 20 to 30 tons at 12 ft. radius, and was used at first for stripping at the quarry and loading cyclopean stone. Later it was used in erecting the steel framework of the powerhouse and handling the heavy castings and machinery going into it.

Quarry Plant and Layout.—In general, the plant consisted of a crushing outfit of two McCully crushers, with necessary elevators for storing in a large storage bin, and a compressor plant for the operation of derricks, drills, pumps, etc.

STORAGE AND CARE OF MATERIALS.

Two yards were provided for the storage of sand and gravel, and two were served by spurs leading off the main line of the railroad west of the yards, as shown on Fig. 1. Each spur branched into a double track after leaving the main line, so that a locomotive crane operating on one track could unload a string of cars on the other without having them switched. Structural steel was also unloaded and stored in one of these yards. In addition, 1,600 cu. yds. of sand were dumped through a high trestle next to the compressor plant and about 300 ft. from the mixer bins. Run-of-pit gravel (containing about 55 per cent sand) from Elmore was stored in the same piles with the sand. Washed gravel was stored in separate piles. At the quarry a storage of 8,000 cu. yds. of crushed stone was accumulated during the latter part of the job, when the concreting slacked up at the dam. This stone was stored beside the main line of the quarry branch, being dumped from 7-yd. cars over the side of a 10-ft. embankment. Storing this material at that place permitted the quarry to shut down, thus getting rid of a large overhead expense some time before the concreting of the dam was finished. This material was afterward loaded by a locomotive crane operating a 1½-yd. clam-shell bucket. A maximum quantity of 8,400 cu. yds. of sand was in storage on Dec. 14, 1914, and approximately 2,000 cu. yds. of Elmore gravel, and 2,800 cu. yds. of washed gravel. These quantities of materials were put into storage primarily in order to avoid hauling over the railroad any more material than was absolutely necessary after Jan. 1, 1914; the rainy season generally starting about then and giving a great deal of trouble from soft track, derailments, etc.

Cement Storage.—Cement was stored in two warehouses, the main one being in the yard, and having a capacity of 15,000 bbls. This building was absolutely damp-proof, and the cement stored there was well preserved. The other warehouse, accommodating about 2,000 bbls., was built at the mixers. This storage fluctuated considerably, as it was used simply to insure a supply of cement at the mixers at all times. Most of the cement used at the mixers was unloaded there directly from cars and was not kept in storage.

Sand.—So much loam and foreign matter was contained in certain sections of the sand pit that it became necessary to place an inspector there. He sampled the sand from fixed positions in the cars and made the ordinary rough test of mixing it with water in large test tubes and allowing the material to settle after being thoroughly shaken up. The coarse sand settling to the bottom was measured, and the percentage of clay or loam resting on its surface was determined. Cars containing more than an average of 10 per cent of clay or loam, as determined by this method, were not accepted. This percentage was greater than is ordinarily allowed, but there were times when no cleaner sand could be obtained, and many carloads were rejected. The concrete obtained with the sand was very dense and of excellent quality. A very close watch was also kept on foreign crushed stone, as some of it was dirty; if it was bad, it was rejected, by an inspector at Ocampo, before being brought to the dam. Watch was also kept and inspection made of incoming materials at the dam. The engineers in charge on the dam made regular trips during their respective shifts to the bins and the mixers, and kept close watch on the character of the materials running. A good deal of trouble was caused by using washed sand from foreign pits by itself; being very coarse, it would not hold the cement or water, and would not dump out of the buckets, thus causing considerable delay at times. The principal remedy was to dump cars of fine sand containing some loam alternately with the coarse sand, mixing it as much as possible in this manner. About 30 per cent of this coarse sand was retained by a ⅛-in. screen. A series of tests was run on the Elmore gravel, and also on the washed gravel, to determine its fineness; 50 per cent of the washed gravel would pass a ½-in. screen, and 55 per cent of the Elmore run-of-pit gravel would pass a ⅛-in. screen. The quantities of the various materials were determined both by measurement and by weight. All materials coming through Ocampo were weighed on a standard track scale installed by the Power Co. One hundred cars of material of each class were weighed and also measured, and the weight per cubic yard was thus determined. This factor was then used on all subsequent receipts. All quarry-crushed stone was measured in cars at the quarry by the inspector. All cyclopean stone was measured on cars by the yard clerk.

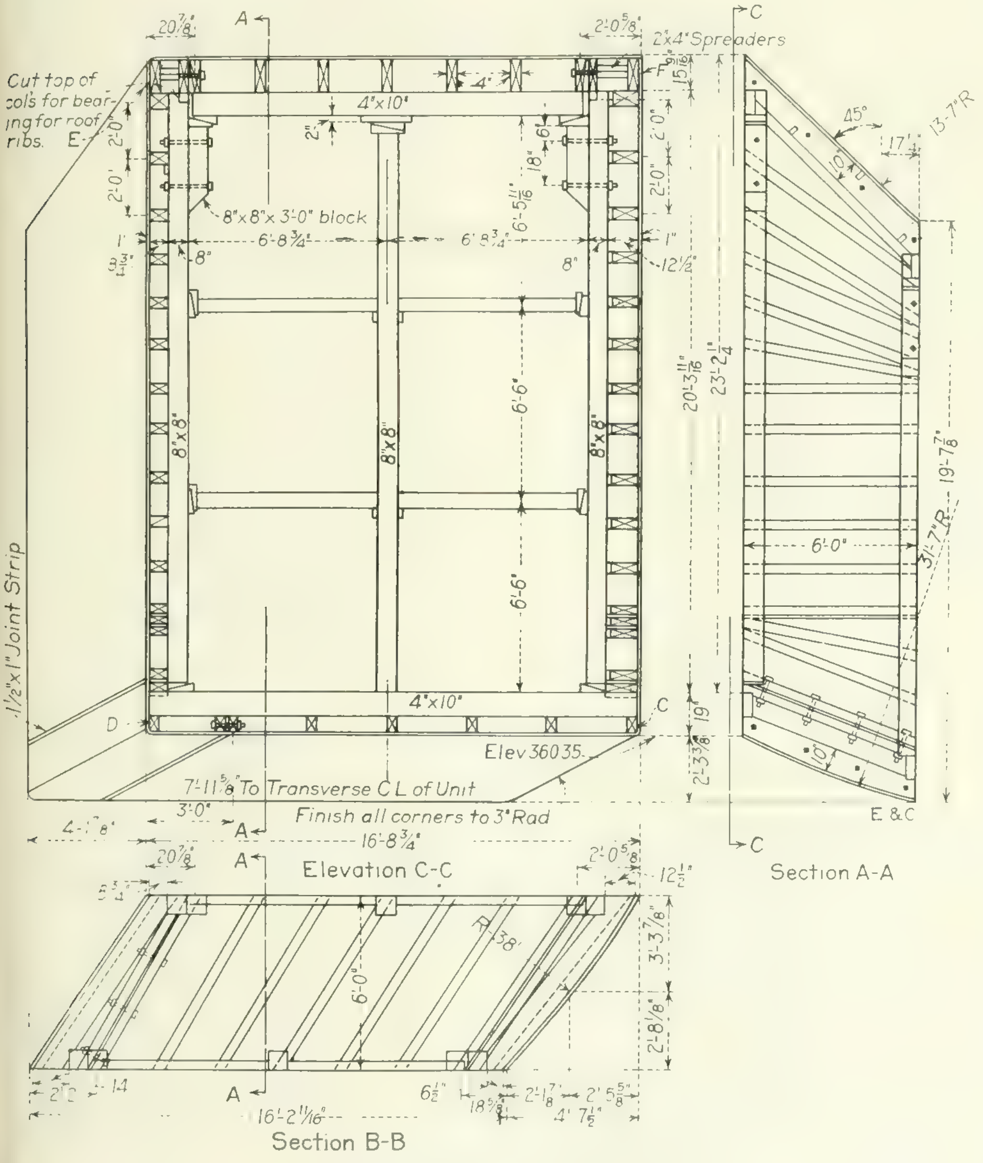


Fig. 4. Typical Rib for Penstock Form.

METHODS OF CONSTRUCTION.

Forms for Dam.—The forms used on the vertical faces of the dam were of the cantilever type, built in sections, 12 ft. long and 6 ft. high, with upright posts extending 6 ft. below the bottom of the sheeting. All the sheeting was sized and dressed to 1¾ ins. in thickness, and all vertical posts were made of two 4 x 8-in. timbers nailed together, with 1-in. blocks between them at the top, middle, and bottom. The waling pieces were 4 x 8-ins., or 6 x 8-ins. laid flat. These forms were built complete and raised in one piece, from one lift to another, by a 3-ton chain block hung from an A-frame, guyed back with form wire to hook-bolts in the concrete. This particular kind of form was not used throughout the job, for, as the work progressed and carpenters became rather scarce, sections of this type were abandoned, and 3 x 6-ft. panels were made in the carpenter shop and simply tacked to the posts. This type was practically the same as the first and was handled more quickly and easily than the forms of heavier section. The following method was used to hold the forms in place: When a form was completed, ¾-in. bolts, 22 ins. long, with an ogee washer on one end, were placed in them, 10 ins. below the top, the bolts having a 10-in. hold in the concrete when it was poured around them. Also, when the pour in the form was completed, and while the concrete was still soft, ¾-in. bolts, 12 ins. long, with a hook on one end, were set in the concrete opposite each post and about 6 ft. back from the face of the form. When a section form or panel was raised, it was lifted until the bottom of the sheeting was above the bolts set 10 ins. below the top of the previous pour of concrete. The posts were fitted on these bolts which held the form in place, passing through the slot between the two 4 x 8-in. posts. A waling piece at the top of each section was used to wire the form back to the hook-bolts placed in the concrete. Wedges were placed at the bottom of the post to line up the form. The panel forms were handled in the same manner, the loose posts being placed on the bolts previously set in the concrete, and the panels dropped into place behind them and tacked to the posts. As the speed of filling the forms increased, two walings were used instead of one. All expansion joint forms were held in this same way. For the curved section of the dam, on the downstream face, ribs were cut to the proper radius in the form shop and brought down to the job where sheeting was nailed on them in place at the dam. The ribs for all curved forms were made of two 2 x 8-in. timbers nailed together, with a 1-in. spacing block between them, leaving a 1-in. slot to catch the anchor bolts, in the same manner as the vertical forms. In some of the big blocks on the dam, where the concrete came up slowly on the forms, two 2 x 8-in. pieces were used in place of the two 4 x 8-in. timbers, and proved satisfactory. As a general rule, these forms worked well and were fairly economical of timber. However, it is not the fastest method; after a form is poured, sufficient time has to be allowed for the concrete to set properly and for the bolts to take hold. More rapid work could be done with a form of the same general type, but built up continuously, releasing the bottom sections as the opportunity arose. In building the forms continuously, one could be raised as soon as the carpenters could walk on the concrete, and the next pour could be made from 12 to 24 hours sooner than with the type used. The latter, however, would take considerably more timber, but the speed would be increased, and in a country where timber is very cheap and speed a big consideration, the continuous type might pay.

Forms for Power-House.—All straight and vertical wall forms in the power-house were of the same type, and were handled in exactly the same manner as the dam forms. All special or curved forms, such as for draft-tubes, scroll casings, and penstocks, were made in the form shop according to detailed drawings furnished by the company's engineers. The type of scroll casing used was more or less of an innovation, and there was considerable discussion at the beginning of the work as to the practicability of moulding such a complicated opening. The form work, as can be readily seen from Figs. 2, 3 and 4, was highly complicated, and, even when carefully detailed, was difficult of execution in the field, for several reasons: First, the average carpenter foreman is out of his depth on a complicated drawing of this kind; secondly, the setting and lining up of a large form of this character is difficult of execution; thirdly, unless the laying out of the forms is done carefully, they are hard to get out. In the case at Lock 12, the engineers made all the calculations and furnished a sufficient number of detailed drawings to enable the work to be laid out and assembled in the form shop. A competent engineer assisted the carpenter foreman in reading these drawings properly, and layout the various parts of the form. The greatest care was exercised in setting up the forms and holding them in place. The work was handled in this manner with no great difficulty, and the final results were excellent.

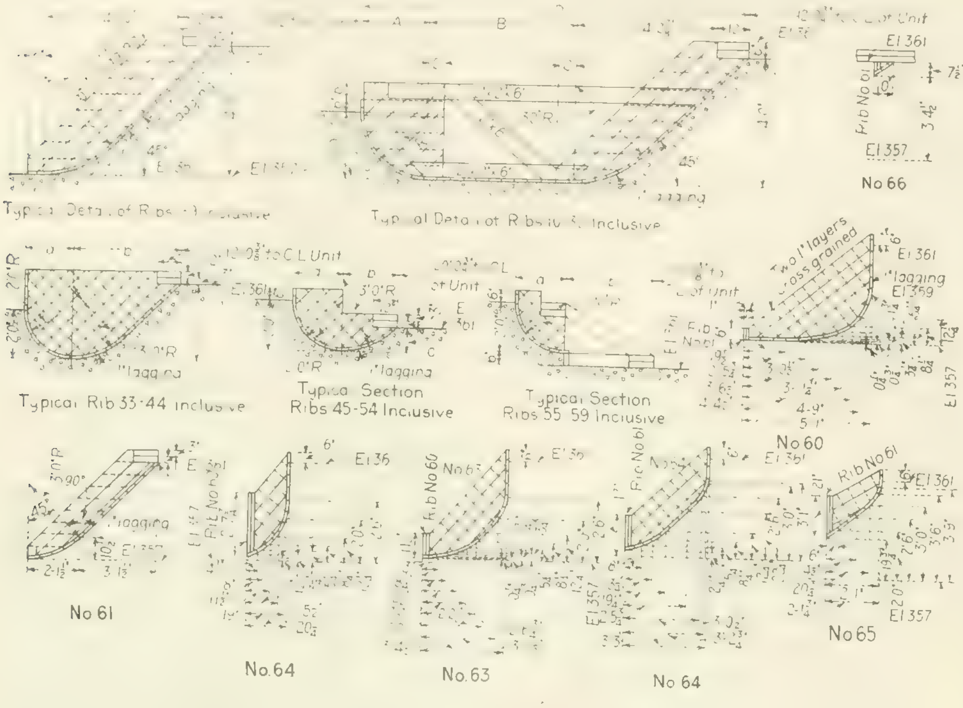
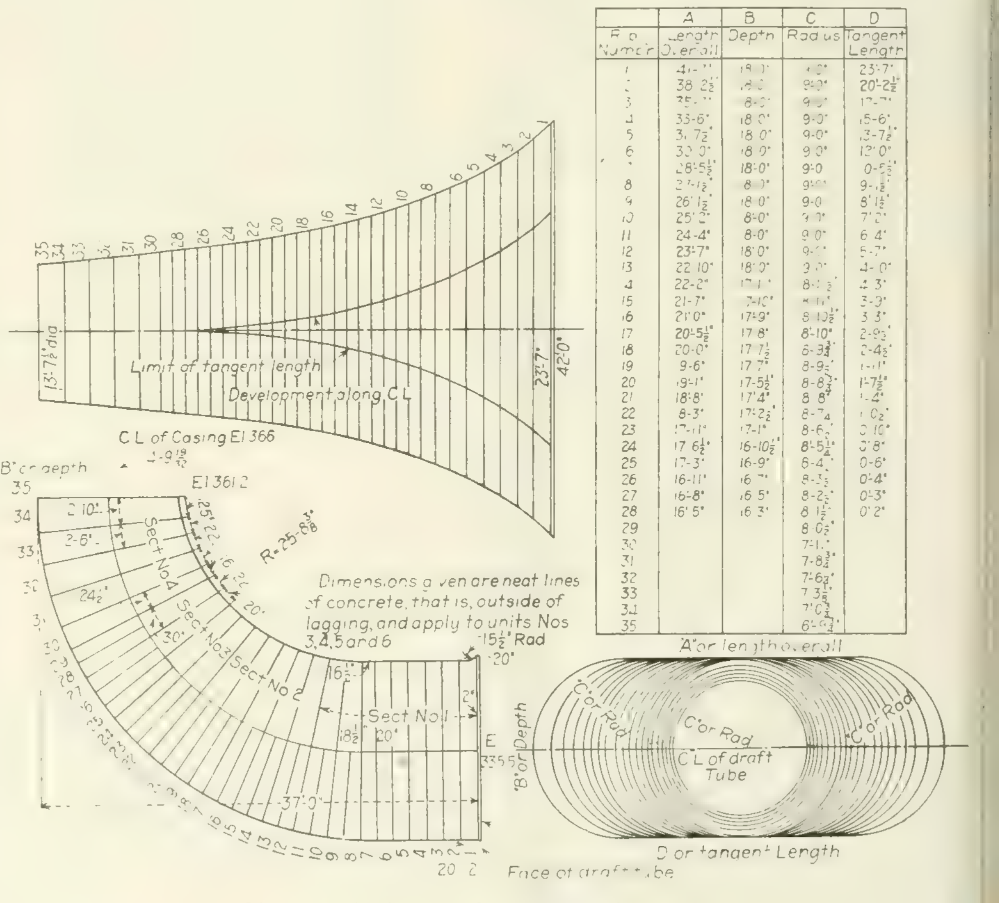

Typical Detail of Ribs 1-3 Inclusive
Typical Detail of Ribs 1-32 Inclusive
No 66
El 361
El 357
Typical Rib 33-44 Inclusive
Typical Section Ribs 45-54 Inclusive
Typical Section Ribs 55-59 Inclusive
No 60
No 61
No 64
No.63
No 64
No 65
lagging
El 357

Fig. 5. Typical Ribs for Scroll Casing Forms.

In detail, these complicated forms were built as follows: All the ribs of the scroll casings (Figs. 3 and 5) were made according to the drawings furnished, and were then set up in the shop in their proper positions, as laid out, and sheeted with 1-in. material. The detailed dimensions for the ribs are given in Table I. On the curved portions, 1 x 1-in. lagging was used, in order that it might bend easily and conform to its intended shape. The whole scroll casing was built in eight sections in order to facilitate handling and erecting, each section being complete in itself. For the draft-tubes (Figs. 2 and 6), all the ribs were made and fitted together on the form-shop floor; they were then taken down and hauled to the dam and re-assembled on a platform from which a derrick could lift and place them. A concrete cradle, containing a number of anchor-bolts, had previously been built, conforming exactly to the curve of the bottom of the draft-tube, and these ribs were placed on a 1-in. board resting on this cradle. Tongued and grooved 1-in. sheathing was nailed to the ribs after they had been properly lined and braced. The tops of the draft-tube forms were covered with 2 x 7-in. planks which extended out and helped support and keep in place the bottom section of the scroll case above. When a scroll case was first put in place, it was blocked up on wooden posts to exact line and grade and then small 1 x 3-ft. concrete piers were poured up under the joints and the middle of each section. These piers also contained anchor-bolts, and after the concrete of the piers had set, the forms were bolted tightly to them. They were also wired down to hook-bolts set in the concrete below, to keep the form from floating. Penstock forms, Fig. 4, were made in sections, 6 ft. long, in the carpenter shop; they were then knocked down and transported on cars to the dam, where they were re-assembled on a platform adjoining a derrick which could pick them up and place them. A double cradle with anchor-bolts in it was prepared beforehand, in the same manner as the cradle for the draft-tubes. Types of drawings from which these forms were built are Figs. 2, 4 and 5.

The system of building complicated curved forms on a large laying-out floor, and also all curved ribs for other forms at the carpenter shop, is recommended on similar work. The shop, however, as previously noted, should be much closer to the job than it was on this work. The concrete-cradle method of setting these large forms is recommended as the best and most accurate.

Concrete.—As many different classes of material were used in the work, the coarse-aggregate bin, having a capacity of 800 cu. yds., was roughly divided into two sections; all crushed stone was dumped in one end of the bin and all washed gravel and Elmore gravel, consisting of 55 per cent gravel and 45 per cent sand, were dumped in the other end. The sand section of the bin was separated from the coarse-aggregate section by a partition. The crushed stone and gravel were drawn to the conveyor belt at the same time, in about equal proportions, and were elevated into the coarse-aggregate hoppers above the mixers. The sand was drawn by itself and ran into a separate bin, also above the mixers. There was a charging hopper just above the mixers, and all materials were drawn from the bins above into this hopper, where they were properly proportioned. The mixing of the concrete was watched by an inspector on duty at all times at the mixer plant, and he was constantly in touch with the chief inspector on the dam, who also with his assistants kept close watch on the concrete coming to the dam. Three mixtures were used: 1:3:6 in the main body of the dam and the heavy sections of the power-house; 1:2½:5 in the cut-off trench and bottom 2 ft. of the foundation of the dam; and 1:2:4 around the scroll casings, penstocks, and all reinforcing in the power-house. The greater percentage of crushed stone came from Zion Quarry developed for this work, the remainder being brought from outside quarries and shipped to the dam by rail. In addition to the crushed stone, 31,034 cu. yds. of gravel were used, principally around the complicated curved forms in the power-house and in filling the stream-control openings. In general, as shown by the analyses of a great many different mixtures used in the work, there was about 10 to 15 per cent too much fine aggregate used. In view of the results obtained, however, this was not a bad feature. There were no honeycombed walls in either the dam or the power-house, and only a few seepage spots appeared in any places except at the vertical expansion



	A	B	C	D
Rib Number	Length Overall	Depth	Radius	Tangent Length
1	41-7"	18-0"	9-0"	23-7"
2	38-2½"	18-0"	9-0"	20-2½"
3	35-7"	18-0"	9-0"	17-7"
4	33-6"	18-0"	9-0"	15-6"
5	31-7½"	18-0"	9-0"	13-7½"
6	30-0"	18-0"	9-0"	12-0"
7	28-5½"	18-0"	9-0	10-5½"
8	27-1½"	18-0"	9-0"	9-1½"
9	26-1½"	18-0"	9-0	8-1½"
10	25-2"	18-0"	9-0"	7-2"
11	24-4"	18-0"	9-0"	6-4"
12	23-7"	18-0"	9-0"	5-7"
13	22-10"	18-0"	9-0"	4-10"
14	22-2"	17-11"	8-11½"	4-3"
15	21-7"	17-10"	8-11"	3-9"
16	21-0"	17-9"	8-10½"	3-3"
17	20-5½"	17-8"	8-10"	2-9½"
18	20-0"	17-7½"	8-9¾"	2-4½"
19	19-6"	17-7"	8-9¼"	1-11"
20	19-1"	17-5½"	8-8¾"	1-7½"
21	18-8"	17-4"	8-8"	1-4"
22	18-3"	17-2½"	8-7¼"	1-0½"
23	17-11"	17-1"	8-6½"	0-10"
24	17-6½"	16-10½"	8-5¼"	0-8"
25	17-3"	16-9"	8-4½"	0-6"
26	16-11"	16-7"	8-3½"	0-4"
27	16-8"	16-5"	8-2½"	0-3"
28	16-5"	16-3"	8-1½"	0-2"
29			8-0½"	
30			7-11"	
31			7-8¾"	
32			7-6½"	
33			7-3⅛"	
34			7-0¾"	
35			6-9¾"	

Fig. 6. Rib Layout for Draft Tube Forms.

joints, the showing in this respect being excellent. When broken off in large chunks, the concrete was dense and had a uniform texture; and when the forms were removed, the outside appearance of all walls was good, no finishing being necessary except in spots where pieces had been broken out by bolts, etc.

Expansion Joints.—At first, expansion joints were placed 100 ft. apart, and after two of them had been started, the distance was cut down to 72 ft. The 108-ft. block proved a little too large to complete satisfactorily as the concrete at once end set before it did at the other. All joints were very effective, as far as could be noted at the end of one winter, and no cracks of any kind developed in the dam.

Handling and Placing the Concrete.—The concrete was dumped from the mixers into 2½-yd. buckets on small cars, or directly into chutes. The cars were hauled by mules to the cableways, two cars being used for each mixer. There were four tracks under the cableways, drawing closely to each other in pairs at the mixers. The buckets were picked up by the cableways and placed at the points needed. No. 1 mixer also dumped directly into a chute. Chutes were used wherever possible to deliver concrete to buckets traveling on small cars operated with a hoisting engine. A large portion of the power-house concrete was passed through chutes, and the system when properly laid out is most effective. The chutes delivered the concrete to buckets on cars which were taken to the dam, via the Low-Level Line and the upstream coffer, by a dinky locomotive. This method was as effective and rapid as any used on the job. A great deal of the concrete was dumped directly from the cableway, and this method was fairly rapid. However, the maximum 10-hour run with cableways was seldom more than 400 cu. yds. The engineers believe that cars and derricks, where it is possible to use them, are more efficient and rapid than cableways. Where narrow forms are to be concreted, the cableway is exceedingly slow and should not be used if any other method can be found. Cyclopean stones were delivered directly to the derricks on the cofferdam, and, between buckets of concrete, were set by the derricks. Each stone was carefully washed and cleaned, and, after it was placed, it was carefully shaken with a bar and bedded. In the dam the percentage of cyclopean stone was small. The horizontal joints between pours were always left bedded with as many cyclopean stones as possible, in order to get a thorough bond with the next layer. A total of 6,482 cu. yds. of cyclopean stone was placed in the dam, or 5.1 per cent. In the power-house foundations there were 1,188 cu. yds.

There were two types of chutes on the work. The first was made of No. 12 gage metal and was 10 ins. in diameter. It was of the semicircular type, and was served by a special bottom-dumping car at the mixers. The mixer dumped into the car, and the car was pushed by hand over a hopper to the chute, and dumped into it. This chute was not a success, the main objection being that it was too small. It clogged frequently, and took too many men strung out along it to operate it and keep it clear. The metal was too light and wore out too quickly. The size and type are not recommended for similar work. This chute was abandoned, and a home-made one was built, which gave satisfaction. It consisted of a trough, built in 6 to 8-ft. lengths, with sides about 18-ins. high, and well braced; ⅛-in. sheet iron was rolled in 8-ft. lengths to a half circle, 14 ins. in diameter, and fastened into the bottom of the trough, giving a chute with high sides and a rounded bottom. It was of sufficient size, discharged on slopes of 18° rapidly and without clogging, provided the concrete was wet enough to flow, cost about two-thirds of the price of the first chute, and its life was nearly twice as long. It is to be noted that concrete discharged down a 75 to 100-ft. chute was as good as that which fell only a few feet from the mixer to the bucket, and on dumping the two sides in the forms no difference was discerned.

After leaving the mixer platform, the concrete was delivered to a derrick, via some one of the routes mentioned, and by it placed in the form. An inspector in the form saw that the concrete was brought up uniformly throughout, no racking being allowed. When it was seen that the form could not be completed in one pour, a temporary saw-tooth bulkhead was put in to prevent thin-edged layers. The inspector saw that all concrete was well worked after being dumped; when it lacked sand, it was worked with shovels and tamped until the mortar had worked its way all through it. All faces against forms were carefully spaded. Two bars were used in bedding the cyclopean stone in the soft concrete. Before making a new pour on the surfaces of old concrete, they were thoroughly cleaned in the following manner: Two gangs of from 12 to 14 men with foremen, when the work was at its height, were kept cleaning forms only. Whenever possible, the surfaces of the old concrete were cleaned about 12 hours after pouring, while they were still green, all scum mortar and "laitance" remaining on top were carefully picked or shoveled off, and the surface was washed until it was absolutely bright and clean. Great stress was put on this particular feature. Concrete was not allowed to be placed in any form until it was cleaned to the satisfaction of the engineer. After the work got under way, and the amount of cleaning insisted on was fully comprehended by the contractor's superintendent, there was little trouble. Also, after a form had been properly washed and cleaned, a 1:2 mortar was dumped in and swept over the surface with a wire broom just before the concrete was dumped. Leaks through horizontal joints have not appeared in any portion of the dam or power-house, and the engineers attribute this to the care exercised in cleaning and working the surfaces of old concrete as described.

Safety Factors for Overturning and Sliding in Dam Design.

TO THE EDITORS: For use in a book on the Design of Dams, I am trying to reach as many engineers as possible for an expression of opinion as to the proper safety factors to allow in the design of masonry dams for overturning and for sliding as based on frictional resistance alone.

I realize, of course, that such a statement might be much qualified, but there certainly could be such a minimum value under perfect conditions for remote or unimportant structures and a conservative value for important structures or those, the failure of which would be a catastrophe.

Will you publish this letter in the hope that replies may be elicited from others than those directly reached by the writer?

Yours very truly,
Southern Power Company,
C. A. MEES,
Designing Engineer.

Charlotte, N. C., March 8, 1915.

SEWERAGE AND SANITATION

Design, Cost and Operation of New Sewage Treatment Plant at the State Hospital, Warren, Pa.

Contributed by P. E. Mebus and F. R. Berlin,
Assistant Engineers with Albright & Mebus,
Philadelphia, Pa.

The State Hospital for the Insane of the Northwestern District of the State of Pennsylvania is located in Warren County, about three miles north of the Borough of Warren. The hospital buildings are located on gently sloping land in the valley of the Conewango Creek, a tributary of the Allegheny River. The entire area of the hospital grounds is about 800 acres, principally farm lands. The present population is about 1,800 persons, of which nearly 300 are employes. The principal buildings consist of the main wards, baths, annex buildings, convalescent's buildings, superintendent's, steward's and employe's residences, power house and farm buildings. The daily average sewage flow is about 270,000 gals., or approximately 150 gals. per capita per day, which is just about an average figure for institutions of this character.

An Act of Assembly dated July 26, 1897 required the hospital authorities to build a "precipitation plant to prevent the sewage being cast on the waters of the Conewango Creek." Fortunately nothing was ever done to carry out the provisions of this Act. In late years, however, it has been the policy of the State Board of Health to insist on the installation of sewage plants at all state or semi-state institutions, so that all sewage from such should cause no pollution of streams.

Another Act of Assembly dated June 13, 1911 required the hospital to build a complete sewage treatment plant and a sanitary sewer system and made an appropriation therefor of $40,000. Plans were at once prepared, submitted to the State Board of Health, and approved by the Commissioner on February 20, 1912. Work was begun during May, 1912, but on account of the difficulty of obtaining labor during the summer of 1912, its final completion was delayed until the summer of 1914. The extreme winter weather in this climate also precluded any construction work between November and May, which partly accounts for the delayed date of completion.

Sewer System.—The original sewer system was built on the combined plan and discharged directly into the aforementioned creek. All of the later extensions, however, were built on the separate plan. As a matter of economy in building and operating the sewage plant, it was decided entirely to separate the sewage from the storm water. This necessitated a new sewer system for nearly all of the house drainage, leaving the former system for the storm water. The new system consists of 1¾ miles of 8 in. and 10 in. vitrified pipe sewers draining to the collecting well of the pumping station, which is located on the lower ground to the south of the main building. No extraordinary difficulties were encountered in construction of the sewers, although in several cases they were built through the foundations of buildings.

SEWAGE PUMPING STATION.

Only two sites for a treatment plant were available, one on an island in the creek to the east of the main building, and the other, in the open fields to the west of the farm buildings. The main highway runs along the west bank of the creek about 100 ft. west of the above mentioned island. This condition, together with the possibility of flooding during high water and the inherent damages to the plant, made it obviously inadvisable to place it at this location.

The other site, necessarily chosen, is on the higher ground, near the piggery and about 1,200 ft. west of the main buildings, and hence it was necessary to lift the sewage about 40 ft.

The substructure of the pump house is built of reinforced concrete, 1:2½:5 mix, and consists of two compartments, a 5,000 gal. collecting well and a pump well. The substructure is shown in plan and section in Fig. 1. Located adjacent to the former is a screen and rag chamber in which there is an inclined screen with ¾-in. openings, through which the crude sewage must pass before entering the collecting well. The pump well contains two 5-in. "Buffalo" vertical centrifugal pumps with open impellors. Their capacity is 500 gals. per minute, each, when discharging against a total head of nearly 50 ft. The suction and force mains, the central valves and the float switches are also located in this well. The advantages of this arrangement are obvious, especially in the matter of making repairs to the pumps. The superstructure is built of brick masonry, the architectural treatment of which is in conformity with other buildings of the hospital group. The building houses two 30 hp. vertical type motors (110 volts, D. C.), a switchboard, crane, lockers, natural gas heater, work bench, etc. The starting and stopping of the motors is controlled by the rise and fall of the sewage in the collecting well. This is done by means of floats, float switches and Cutler-Hammer control apparatus. At a determined level one unit is thrown in service and should the sewage rise still higher, the other unit is also thrown in. The motors are thrown out when the sewage falls to a determined level in the same manner. The switchboard is wired to permit either pump starting on the "first level" so that there is rotation of work. Space has been allotted for installing a third unit when needed. The force main is 10 in. cast iron bell and spigot pipe, Class A (A. W. W. A.), and is about 3,900 ft. long. For about one-half its length it was laid on concrete posts along the sanitary sewer, thereby avoiding the expense of an additional trench. It ends in the 18 in. wide influent channel of the Imhoff tank.

THE TREATMENT PLANT.

The plant, see Fig. 2, consists of six units, as follows: 1. Imhoff tank. 2. Dosing chamber. 3. Percolating filter. 4. Chemical house. 5. Secondary tank. 6. Sand filters for sludge.

Imhoff Tank.—The first plans showed a circular Imhoff tank of the radial flow type, but acting on the advice of Dr. Imhoff, the design was changed to one of the horizontal flow type. This tank is built of reinforced concrete, 1:2:4 mix, the sedimentation compartment overhanging the sludge compartment. The latter consists of a 16 ft. diameter cylinder superimposed on an inverted cone of equal diameter and a depth of 5 ft., from the apex of which the sludge is withdrawn by a differential head of about 10 ft. The sedimentation compartment is rectangular in plan, being 16 ft. x 35½ ft., and has a capacity of 45,000 gals. The average velocity therein is about .05 ft. per second. The "detention period," based on the pump discharge, is about 1½ hours, while the sludge capacity is sufficient for about five months' storage. The overhanging type of tank was considered better adapted to the conditions and more economical than either a circular or a rectangular tank of uniform cross section, because of the fact that the sewage is so considerably diluted, or in other words, for a given population the ratio of the required sedimentation capacity to required sludge capacity is practically double that found in ordinary practice. The tank is provided with the usual side vents and also a central vent of 8 sq. ft. rectangular area. The main tank walls are 18 ins. thick and extend 18 ins. above the level of the sewage, while the stack walls are 4 ins. thick and extend 3½ ft. above the water level. The diaphram walls are 4 ins. thick and are supported by two intermediate ribs built of 6 x 4 x ¾ in. angles enclosed in concrete. To the rib angles other angles are riveted at right angles and in such a manner that one end rests in the main tank and the other in a transverse concrete beam under the central diaphragm. The reinforcements in the stack walls and diaphragm walls consist of ¼-in. square bars spaced at 4-in. centers, both directions. The sewage is distributed over a weir at one end of the tank and collected at the other end by three weirs protected by concrete scum boards. This arrangement assures a nearly even distribution of sewage over the entire cross section of the tank.

Dosing Chamber.—Built adjacent to and in the intervening space between the Imhoff tank and the chemical house is the dosing chamber, the reason for which will appear later. The tank is rectangular in plan and of the taper type which gives a somewhat better distribution of sewage on the percolating filter. The sewage is discharged by a 12 in. Miller syphon, fitted for heads varying from 3½ to 4½ ft. Each discharge is about 1,200 gals.

Percolating Filter.—The percolating filter is 99 ft. 5 ins. x 95 ft. in plan and has a superficial area of 0.22 ± acres. The present rate of operation is, therefore, 1,300,000 gals. a day. The average depth of the filter media is 7¼ ft. and consists of 2 in. to 3½ in. size Buffalo limestone. The distributing system consists of cast iron bell and spigot pipe supported by square concrete posts running to the floor. The sizes of the feed pipes vary from 16 to 6 ins. internal diameter. The riser pipes are 3 in. wrought iron and are set in the cast iron tees placed along the lateral feed pipes 12 ft. 6 ins. on centers. Reading type nozzles are used to spray the sewage on the surface of the bed. There are altogether 72 nozzles, 9 of which spray half circles. The underdrainage consists of 10 in. semi-circular cement tiles laid on a 6 in. concrete floor sloping toward the main collecting channel which runs along the entire southerly side of the filter.

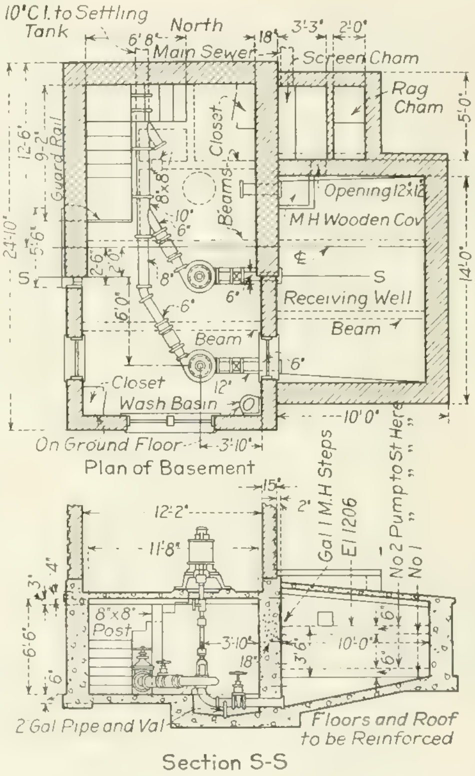


Fig. 1. Plan and Section of Sewage Pumping Station Substructure and Machinery at State Hospital, Warren, Pa.

Chemical House.—This channel passes through the chemical house wall and forms the mixing channel in which the hypochlorite of lime is mixed with the effluent of the percolating filter. From here the same channel carries it to the secondary tank which adjoins the chemical house to the north. In addition to the mixing channel, this building houses three reinforced concrete tanks, one of which is used for mixing the dry powder with water and the other two for storing the resulting solutions preliminary to adding them to the sewage. There are also two smaller concrete tanks called, respectively, the "measuring" and the "orifice" tanks. The orifice tank rests directly on the floor of the house with the measuring tank located immediately above it, so that the hypo solution flows by gravity from the latter to the former. The measuring tank is in turn located below the solution tanks and connected thereto by 1 in. wrought iron piping. The operation of adding the hypo solution will be described later on.

Secondary Settling Tank.—The secondary tank is merely a plain sedimentation tank with a sloping floor so that the sludge may be drained to the low end. It provides a detention period of about ¾ hour. The details and operation are similar to the Imhoff tank.

Sand Filters for Sludge.—Two sand filters, each 30 x 60 ft. in plan, are provided for drying the sludge and are located about 200 ft. east of the plant. The sludge from both tanks is carried thereto by an 8 in. vitrified pipe sewer. This sewer also serves as a by-pass line, suitable connections having been made for this purpose. If necessary to by-pass the plant, therefore, the sewage will at least have the benefit of a straining action. This accounts for the extra large area of these beds not all of which is needed for sludge drying. A concrete trough provided with suitable outlets distributes the sludge to each bed and incidently provides a division wall between the beds. The filtering media consists of 2 ft. of graded gravel underdrained by a system of 4 and 6 in. vitrified pipes laid with open joints in a bed of 1 to 1½ in. gravel. The drainage discharges into the 10 in. vitrified pipe sewer which carries the effluent of the plant. This final effluent is discharged into the aforementioned main storm water sewer which, in turn, carries it to the Conewango Creek.

Cost of Plant and Sewer System.—Table I gives a complete summary of the various items, quantities and contract prices for the entire system.

OPERATION.

The entire plant has been in operation for nearly five months under the supervision of the consulting engineers. Mr. E. E. Ludwick, the resident engineer, has had immediate charge of the plant up to this time. The results obtained during this short period have very fully met all the expectations of the designers and the requirements of the State Board of Health. All the vents of the Imhoff tank at first showed a decided tendency to scum, but by the daily use of a stream of water from a ¾-in. hose, this scum formation has been completely broken up and the surface is kept clean. This shows that by giving such matters the proper attention, the operating difficulties may be reduced to a minimum. The slopes of the diaphragm walls (proclivity 1.2 on 1) are steep enough to prevent sludge from adhering thereto. The sludge has not yet "ripened" and only small quantities have been withdrawn to date. No trouble is anticipated however from this source. The percolating filter is uncovered and despite the fact that during the past winter it has operated at temperatures as low as —28° F. it has been and still is in splendid condition and there are no evidences of pooled areas. The effluent is clear, colorless and apparently well nitrified. It has been found to be stable with methylene blue for the required five days. No odors are noticeable at either the pump house or the disposal plant, which is undoubtedly due to the fact that the sewage is kept fresh and passed through the plant as rapidly as practicable.

The device for adding the hypo solution to the filter effluent in proportion to the flow is rather unique. It is shown in Fig. 3. It consists essentially of a log float located in the dosing chamber, a "walking beam," and the aforementioned measuring and orifice boxes. The "walking beam" is fastened in the chemical house wall and wire ropes lead from each end of it, the one to the log float in the dosing chamber, and the other to the stem of the outlet plug of the measuring box. This is the reason for locating the chemical house immediately adjacent to the dosing chamber. The Imhoff tank effluent channel is extended into the dosing chamber and forms a necessary adjunct to the device. Its operation is as follows: We will suppose the dosing chamber empty; the nozzles have then finished spraying; the flow in the collecting channel is rapidly diminishing; and the log float is lying in the bottom of the chamber. To the end of the Imhoff effluent channel there is attached a wooden gate pivoted to swing in an oblique direction and also attached to the log float in a way that when the float lies on the syphon chamber floor the gate is held tightly against the end of the channel so that the effluent is

TABLE I. ITEMS, QUANTITIES AND UNIT CONTRACT PRICES FOR SEWAGE COLLECTION AND DISPOSAL WORKS AT STATE HOSPITAL, WARREN, PA.

Item.	Unit price.	Quantity.
8-in. vitrified pipe sewer, depth under 6 ft.	$ 0.45 per ft.	[illegible] ft.
8-in. vitrified pipe sewer, depth 6 ft. to 8 ft.	0.55 per ft.	2,638.4 ft
8-in. vitrified pipe sewer, depth 8 ft. to 10 ft.	0.70 per ft.	1,876.98 ft.
8-in. vitrified pipe sewer, depth 10 ft. to 12 ft.	0.85 per ft.	726.5 ft.
8-in. vitrified pipe sewer, depth 12 ft. to 14 ft.	1.20 per ft.	112.0 ft.
10-in. vitrified pipe sewer, depth under 6 ft.	0.51 per ft.	379.5 ft.
10-in. vitrified pipe sewer, depth 6 ft. to 8 ft.	0.60 per ft.	202.6 ft.
10-in. vitrified pipe sewer, depth 8 ft. to 10 ft.	0.75 per ft.	473.4 ft.
10-in. vitrified pipe sewer, depth 10 ft. to 12 ft.	0.90 per ft.	204.5 ft.
10-in. vitrified pipe sewer, depth 12 ft. to 14 ft.	1.25 per ft.	635.1 ft.
12-in. vitrified pipe sewer (depth varies)	1.10 per ft.	171.5 ft,
8-in. Y's or T's	0.40 each	38
10-in. Y's or T's	0.50 each	7
12-in. Y's or T's	0.55 each	2
Deep cut laterals	2.50 each	2
Subs. 8-in. c. i. p. for 8-in. vitrified pipe	0.80 per ft.	226.09 ft.
4-ft. diam. M. H. 6 ft. deep or under	36.00 each	31
4-ft. diam. M. H. extra depth (feet)	6.25 per ft.	85.12 ft.
3½-ft. diam. M. H. 6 ft. deep or under	32.00 each	9
3½-ft. diam. M. H. extra depth (feet)	4.60 per ft.	19.12 ft.
Drop connections (vertical feet)	0.80 per ft.	28.84 ft.
Flush tanks	29.50 each	3
Rock excavation	1.75 cu. yd.	2 cu. yds.
8-in. vitrified pipe sewer in concrete (to top of pipe)	0.45 per ft.	43.5 ft.
10-in. vitrified pipe sewer in concrete (to top of pipe)	0.45 per ft.	6 ft.
Earth excavation (cu. yds.)	0.53 cu. yd.	2,512.45 cu. yds.
Concrete—mix 1:2½:5	6.15 cu. yd.	72.33 cu. yds.
Pump house (superstructure)	$1,015.00	1
Complete pumping units and switchboard	900.00 each	2
Suction and discharge piping in pump well	220.00	Lump.
10-in. C. I. force main complete	$ 1.60 per ft.	3,911.83 ft.
Grading	0.25 cu. yd.	148 cu. yds.
Concrete—mix 1:2:4	8.30 cu. yd.	333.65 cu. yds.
Concrete—mix 1:2:3	14.00 cu. yd.	17.46 cu. yds.
Concrete—mix 1:3:6	5.10 cu. yd.	292.90 cu. yds.
Reinforcing steel	0.032 per lb.	23,807.1 lbs.
10-in. underdrains for perc. filter	0.12 each	8,843 pcs.
Concrete block retaining wall for perc. filter	7.00 cu. yd.	102.94 cu. yds.
Filter media	2.57 cu. yd.	2,533.54 cu. yds.
6-in. C. I. P.	0.90 per ft.	12.33 ft.
8-in. C. I. P.	1.04 per ft.	690.5 ft.
16-in. C. I. P.	4.65 per ft.	60.13 ft.
16-in. by 16-in. by 12-in. C. I. 3-way branch	25.70 each	8
16-in. by 16-in. by 12-in. by 6-in. C. I. 4-way branch	32.50 each	1
6-in. ¼ bend	5.00 each	1
8-in. by 8-in. by 3-in. tees	6.60 each	72
8-in. plugs	1.60 each	9
16-in. plugs	7.50 each	1
8-in. by 8-in. Y	13.00 each	1
16-in. L. R. ⅛ bends	14.25 each	2
8-in. blank flange	3.00 each	1
12-in. by 8-in. C. I. reducers	7.60 each	9
16-in. gate valves	60.00 each	1
8-in. gate valves	18.50 each	10
Valve boxes for 8-in. valves	3.75 each	10
Valve keys	1.40 each	1
8-in. sluice gates	24.50	1
10-in. sluice gates	26.50	2
6-in. sluice gates	24.00	1
Riser pipes and nozzles	5.25 each	72
12-in. Miller syphon	217.00	1
6-in. v. p. underdrains (sludge bed)	0.15 ft.	560 ft.
Filter media (sludge bed)	1.10 cu. yd.	15
Chemical house (entire, except concrete tanks)	877.00 each	1

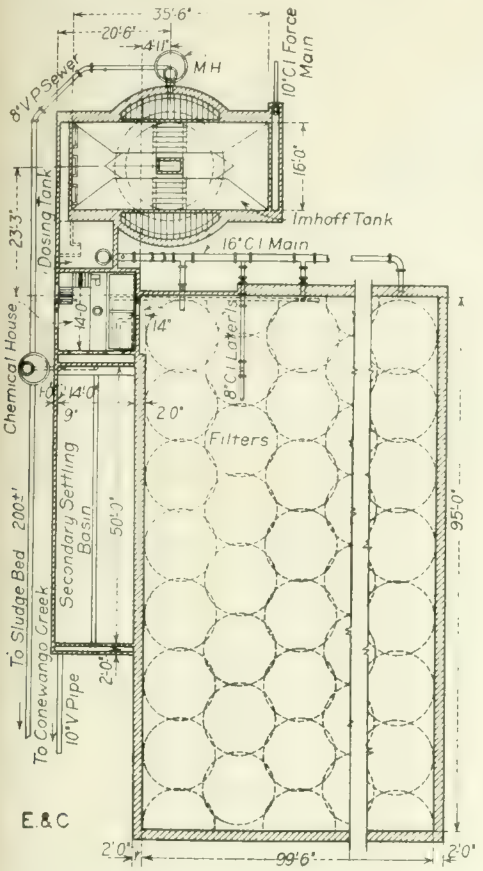


Fig. 2. Part Plan of Sewage Treatment Works at State Hospital, Warren, Pa.

dammed up therein. This position is maintained until said channel is filled to the height of a weir when it overflows and the dosing chamber begins to fill. This causes the log float to rise and upon rising releases the gate which opens and allows the discharge to take place properly from the end of the channel. During this time the measuring and orifice boxes have emptied their contents into the mixing channel. The flow of hypo solution into the measuring tank is controlled by a glass float and float valve. A chain attached to the glass float and to the wire rope leading to the "walking beam" holds the float in a position which keeps the control valve closed and no solution is wasted. When the log float rises the brass plug is forced to its seat by a spring, thereby closing the measuring tank outlet. This allows the glass float to drop, thereby opening the control valve and permitting the tank to fill. When full it is automatically shut off by the glass float, and we have a measured quantity of solution stored in the box. Again, during this time the dosing chamber has been filled, the syphon begins discharging and the nozzles 'spraying. As the water reaches a predetermined height, the log float pulls on the wire rope, which, in turn, pulls the plug from its seat and the solution flows into the orifice box below and is immediately added to the filter effluent which is now flowing in the channel. As the flow in the channel decreases, the flow from the orifice also decreases, due to lowering of the head so that the hypo solution is added almost directly in proportion to the flow. The next cycle has meanwhile begun and continues as long as the sewage flows. Should the sewage flow cease entirely, there would be no solution added at all. This, then, is a double acting device adding the hypo solution in nearly a direct ratio to the sewage flow and effecting an economy in not allowing any solution to flow to waste. The strength of the solution is so computed that the filled measuring box taken together with the syphon discharge results in adding available chlorine at the rate of 1½ parts per million to the filter effluent. This quantity is sufficient to meet all the necessary requirements.

Table II gives the weekly results of analyses for 1915 as reported by the State Board of Health. It also gives analyses showing the condition of the creek above the sewer outlet, all of which is self explanatory.

TABLE II.—REPORTS OF BACTERIOLOGICAL ANALYSIS OF SEWAGE FROM DISPOSAL PLANT, STATE HOSPITAL, WARREN, PA.

	Raw sewage.		Imhoff tank eff.		Filter effluent.		Final effluent.	
	Total bac.	B. coli.	Total bac.	B. coli.	Total bac.	B. coli.	Total bac.	B. coli.
January 7.	1458000	162000	594000	144000	78000	6400	72	0
January 14.	1134000	147000	567000	133000	96000	8640	38	0
January 21.	594000	78000	918000	120000	270000	4800	9	0
January 28.	756000	90000	594000	216000	108000	1980	48	0
February 4.	594000	216000	324000	1800	66000	1200	18	0

CREEK WATER (above sewer outlet).

Date.	Total bacteria.	B. coli.
December 10	960	420
December 17	1320	420
January 7	840	8
January 11	248	33
January 21	208	42
January 28	600	96
February 4	660	12

Note.—Pollution of creek water is due to the sewage discharged into it by the City of Jamestown, N. Y., about 20 miles distant.

ENGINEERS AND CONTRACTORS.

The entire system was designed and constructed under the supervision of Albright & Mebus, Consulting Engineers, of Philadelphia, Pa. The construction work was efficiently carried out under the personal supervision of

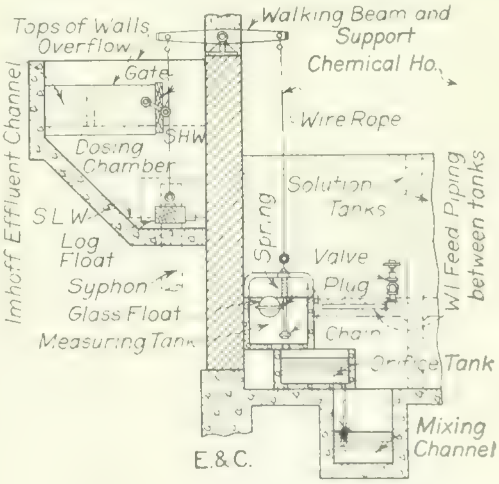


Fig. 3. Diagrammatic Section Illustrating Operation of Automatic "Hypo" Feed Apparatus in Sewage Treatment Plant at State Hospital, Warren, Pa.

(Dosing and measuring [illegible] tank feeding solution to effluent.)

Mr. P. L. Scholl, of the firm of P. L. Scholl & Co., Contractors, of Reading, Pa.

Extra work at cost plus 10 per cent amounted to $734.68. The total contract cost was $37,855.90.

Surprising Results Disclosed by Sanitary Survey of Vincennes, Ind.

During the summer of 1914 the Water Laboratory of the Indiana State Board of Health conducted a sanitary survey of the city of Vincennes. This representative Indiana city has a population of about 17,000, and is the oldest town in the State. In this survey, here described from information given by J. C. Diggs, Water Chemist of the Board, in a paper before the Indiana Sanitary and Water Supply Association, every private well in the city was examined chemically and bacterially, every back yard and every privy vault was inspected and classified, and data were obtained from every household regarding the health conditions during the past year. Special attention was paid to the study of typhoid fever.

The percentage of the population depending on shallow well supplies is here greater than in any city of similar size in the State, although filtered public supply is available. The city has a most complete public sewerage system of recent construction, but as yet only a small percentage of the population uses it. There is an out-of-door toilet at nearly every house. The city lies on flat formations of sand and gravel.

Field parties consisted of three men; one man called at each house for certain data. These data consisted of the name and address of the resident, owner of the property, source of water supply, means of sewage disposal, sanitary condition and appearance of the back yard and the health condition of the family. These data were collected on a specially printed card, on the reverse side of which was later placed the analysis of the sample of water collected at the home. A second man made the inspection of the privy vault and sketched a rough map showing the location of the houses, wells and privies of each block. The third man collected the sample of water from the well. Inspections were made each morning until 40 samples of water had been collected.

TABLE I. — RESULTS OBTAINED IN SANITARY SURVEY OF VINCENNES, IND., 1914.

Sections.	Residences.	Privies.	Cesspools.	Total wells.	Good wells.	Bad wells.	Per cent bad
A	1,324	1,175	71	1,077	909	168	15
B	909	824	53	717	508	209	29
C	664	335	41	380	307	73	19
D	1,092	895	22	826	534	292	34
Total ..	3,989	3,229	187	3,000	2,258	742	24.7

Table I shows there are 3,989 residences in the city of Vincennes, 3,229 privies and 187 cesspools. Six hundred and eleven of the privy vaults were in such a bad condition on account of improper construction, need of repair or filthiness that orders were issued from the office of the City Board of Health that proper improvement be made.

In all, 3,000 wells used for drinking water were examined. These wells were divided into two classes—polluted and satisfactory. Whenever a well showed by a chemical examination that it was receiving a considerable amount of pollution—indicated by abnormal nitrate, nitrite and chlorine factors, or that it was contaminated with sewage organisms, together with unfavorable surroundings, the well was classed as polluted. Of the total number examined, 722 wells were deemed to be contaminated.

Fully 90 per cent of the wells are shallow. Generally speaking it was found that in spite of the very numerous outhouses, cesspools and manure piles the pollution from them did not travel far, on account of the purifying action of the sand and gravel soil. In practically all cases of abnormal chemical factors the pollution could be traced to a nearby deep, leaching, privy vault or cesspool. Wells were thus affected at considerable distances. Practically all cesspools were constructed with pervious bottoms to minimize the number of cleanings necessary.

Vincennes is not an abnormally unhealthy city, due to the underlying sand and gravel. This formation originally furnished a good water supply and now serves as a means of sewage disposal; it should not be used for both purposes. Probably many of the polluted wells have not yet caused serious illness, but at almost any time the purifying process of the soil may be carried out less efficiently and the sewage organisms will then pass into the wells.

BRIDGES

The Design of Concrete Highway Bridges With Special Reference to Standardization.

The following data apply to the various factors influencing the design of reinforced concrete bridges. Some of the factors discussed are not given sufficient attention by engineers, and a study of the data presented should prove of distinct value. Many of the illustrations are drawn from the established practice of the Iowa Highway Commission. The data were abstracted from a paper by C. B. McCullough, designing engineer, Iowa Highway Commission, presented at the 11th annual convention of the American Concrete Institute at Philadelphia.

STREAM BEHAVIOR AND ITS EFFECT ON DESIGN.

No bridge structure can ever be safely and economically designed, nor should the preparation of such a design ever be attempted, without an accurate and adequate knowledge of the behavior at all times and under all conditions of the waterway over which it is desired to place the bridge. In treating the subject of bridge design, therefore, a study of stream conditions logically assumes first place in point of time, and it may be so placed in order of importance, particularly if the construction is of concrete, inasmuch as this material when once misplaced can be corrected only at a tremendous expenditure. Moreover, if the expedient of wrecking and rebuilding must be resorted to the labor costs are always excessive and practically none of the material can be salvaged.

The geologist has classified the three stages of stream development as: the stage of youth; the stage of maturity; and the stage of old age. The first stage begins with the formation of the first gulley on the hillside and continues until the stream has established for itself a grade or base level. Throughout this period the stream is eroding its channel, but it has done no work as yet on its flood plane. In the younger streams in this stage the waterways are carried in comparatively shallow channels, and the headroom available in bridging consequently is low. The end of this stage, however, finds the stream channels considerably deeper.

The second stage of stream development witnesses the cutting and formation of the flood plane but no further erosion of the channel. The general gradient now being more uniform, as the general valley or flood plane is widened, the stream enters the "meandering" stage, and the danger of a channel change is increased. The water at ordinary stages is now carried in deeply cut ravines and headroom is, in general, no longer limited.

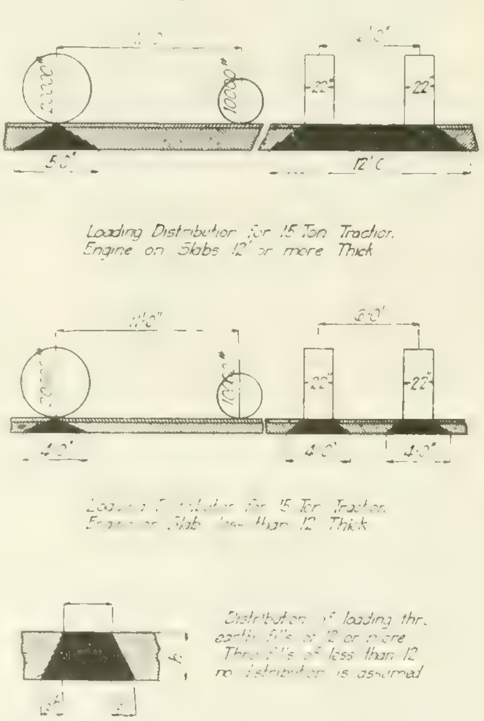

5'0"
12'0"
10000
22"
22"
Loading Distribution for 15 Ton Traction Engine on Slabs 12" or more Thick
11'0"
6'0"
22"
22"
4'0"
4'0"
4'0"
Loading Distribution for 15 Ton Traction Engine on Slab less than 12" Thick
Distribution of loading thr. earth fills of 12" or more
Thru fills of less than 12" no distribution is assumed

Fig. 1. Iowa Highway Commission Standard Loading Distribution for 15-Ton Traction Engine.

The third stage of development witnesses a complete erosion of the flood plane and valley. The streams in this stage are in general filling rather than cutting, and are even more unstable or meandering than in the second stage.

The first stage stream is found in the newer drift areas of the glaciated region which occupies the northern part of the United States and in the mountainous regions of the unglaciated area. The second and third stages are encountered in the older glacial drift areas and in the unglaciated lowlands. The topography accompanying these latter stages of development being older, a more complete weathering and breaking down of the surface materials has taken place, and in general concrete materials are encountered less frequently than in the former areas.

The stage of stream development has a close bearing on that most important consideration of design, the selection of type, thus for the first-stage stream the low available headroom often renders the selection of the through girder or flat slab type of construction imperative, while the low pier heights may throw economy on the side of the short multiple span construction. A plentiful deposit of glacial gravel near the bridge is not unusual with this topography, and it may so cheapen the hauling cost as to make the mass type of construction cheaper than the relatively light, heavily reinforced types.

For streams in the second and third stages of development the channels, being now completely cut, are in general deeper, and the saving of headroom is often a minor consideration. A frequency encountered scarcity of concrete materials, and the resultant long haul for country highway bridge work, renders massive construction in general more expensive than the heavily reinforced type.

The greatest difference in behavior of streams in the three stages of development, and the one that most vitally affects bridge design is the difference in the eroding qualities. While the cutting power of a stream varies as the square of the velocity, the carrying capacity varies as the sixth power of the same. The eroding power, which lies between these two values, may, in alluvial soils, assume a value very near the latter value as the problem becomes practically one of carrying capacity. The results of this increased eroding power during periods of high water and consequent increased velocity are truly appalling. This factor in first-stage streams necessitates extra precaution as regards scour—such as aprons, cross walls, paving of stream beds, etc., and makes it imperative that all foundations shall be carried well below the ultimate scouring lines and be protected in every way against erosion.

Streams in the more mature stages, having lost the power of erosion and having in general well defined banks and broad flat flood planes, can often be bridged with the pedestal or viaduct type of substructure with entire safety. The stream is now in its meandering stage, and the instability of the stream must be taken into consideration and guarded against, although in general no new channel will erode below the established base level of the stream.

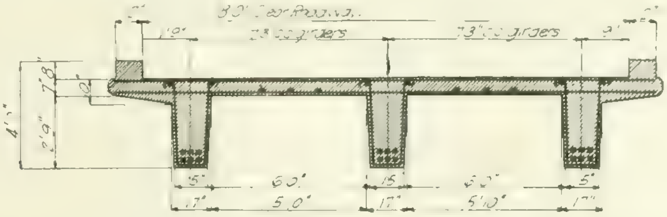


Fig. 2. Cross Section of Standard 24-Ft. Reinforced Concrete Deck Girder Bridge—Iowa Highway Commission.

The development of the stream may be arrested at any time by artificial conditions and made to assume characteristics of an entirely different stage of development.

In concluding the subject of stream behavior it must be pointed out that certain of the conditions affecting the selection of type, such as available headroom, accessibility of concrete materials, etc., are largely local, and must be worked out for each individual structure, but their relationship to stream development and topography is extremely important in fixing the type chosen for standard construction for small work over any considerable area.

The question of stream erosion cannot be too carefully studied. Probably 90 per cent of our concrete bridge failures are foundation failures, and by far the majority of these are due to erosion of foundations rather than to insufficient bearing. Bearing, either natural or artificial (piling), can be secured if careful soundings are made, but protection against erosion requires a careful study of stream conditions. The tendency of any stream, if the materials along its bed are equally resistant to abrasion, is to establish for itself a uniform grade; and therefore, if for a short distance on each side of a proposed bridge site a profile of the present stream bed is secured, a grade line, platted thereon, will furnish valuable information as to the probable future base level or grade of stream. The necessity for a study of this kind as a part of each bridge survey cannot be too strongly emphasized.

LOADINGS.

Next in the order of time and importance comes the factor of loadings. The actual weight of the dead and live load is, of course, a matter of unit weights of such materials as filling, paving, etc., and of the weights of the maximum artificial loads to which the structure (based upon past experience and future traffic requirements) is likely to be subjected. The determination of the distribution of load concentrations, and of the amount and effect of internal temperature variations, constitutes an equally important, although a much more complicated, problem. The distribution of load concentractions has of late been the subject of considerable experimentation, although no great amount of data has as yet been made public. Such a series of experiments are now under way by the Engineering Experiment Station of the Iowa State College and the State Highway Commission of Iowa. Two full size test spans, one a reinforced concrete slab and the other an I-Beam span with reinforced concrete floor, have been constructed for this purpose. The external loading is applied by means of a pair of hydraulic jacks of 30 tons capacity, and the distortions both in the concrete and in the reinforcing steel are measured. While the results of these tests are as yet too incomplete for presentation, so far as they have gone they seem to indicate that the assumptions usually made are safe.

The total load distribution may be considered as composed of two portions: that due to the strength of the section itself, and that due to the fill or covering material. The assumption as to load distribution due to both of these factors, for the standard traction engine loading adopted by the State Highway Commission of Iowa, is illustrated in Fig. 1. This may be said to represent present average engineering practice for highway loadings.

The determination of the internal temperature range in concrete, heretofore a matter of much conjecture, was, during the period 1908-1912, made the subject of a series of experiments by the Iowa State College Engineering Experiment Station and the Iowa State Highway Commission. These tests were made on two reinforced concrete arch structures. (For a description and results of these tests see Engineering and Contracting of Nov. 12, 1913.)

The tests showed a yearly range in temperature, for reinforced concrete structures typical of highway arch construction in Iowa, of about 80° F. Such a temperature range leads to stress values often several times in excess of those heretofore assumed to result from temperature variation. These tests have resulted in a considerable modification of the shape and size of the concrete highway arch as adopted in Iowa.

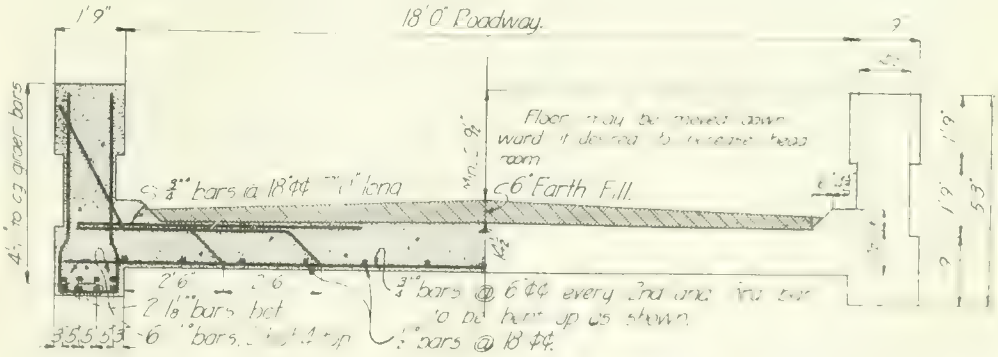

1'9"
18'0" Roadway.
4' to c.g. girder bars
Floor may be moved downward if desired to increase head room
Min. 9½"
$\frac{3}{4}$" bars @ 18" ¢¢
6" Earth Fill.
4½"
2'6"
2'6"
2 1⅛" bars
$\frac{3}{4}$" bars @ 6" ¢¢ every 2nd one to be bent up as shown.
bars @ 18" ¢¢.
1'9"
1'9"
5'3"

Fig. 3. Cross Section of Standard 30-Ft. Reinforced Concrete Through Girder Bridge —Iowa Highway Commission.

DETAILS OF DESIGN.

Next in order comes the calculation of stresses and the working out of details. While space will not permit a complete discussion of the various methods followed in highway bridge design, a brief discussion of a few of the more common types of concrete structures adopted as standard by the State Highway Commission of Iowa may be of interest as illustrative of the recent development along this line.

Superstructures.—The slab type of superstructure consists of a simple beam or slab, reinforced for main and diagonal tension by longitudinal rods, and for lateral distribution, shrinkage and temperature stresses by transverse rods.

The deck girder type (see Fig. 2) depends for its economy on the fact that the carrying capacity of a beam varies as the square of the depth but only as the first power of the width. Thus the use of deep narrow girders operates to reduce the amount of material and consequently cut down the cost. The stresses arising in the superstructure are transmitted into the girders by means of a thin doubly reinforced floor, which acts as a beam partially fixed and partially continuous. The girders themselves are reinforced for main and diagonal tension both by bent up rods and by stirrups.

In the through type of girder construction (see Fig. 3) two main side girders support the floor, which is hung or suspended between them. The main girders act as simple beams and the floor as a partially fixed beam, the point of contraflexure being taken at about 12 ins. from the girder, this distance being based upon experiment. A comparison of quantities for the three types of superstructure is graphically shown in Fig. 4. The economy of cost of the deck type over the through type is probably represented by the relative position of the quantity curves, the form work being equally difficult for both types. The cost of slab construction is, on the other hand, somewhat cheaper than the quantities would indicate, on account of the simple form work, and this type of construction is probably the economical one for spans below 20 or 22 ft. The economy of the through girder and the slab over the deck type is one of headroom rather than of cost.

Substructure.—The first type of concrete substructure was patterned after that of stone masonry, being heavy and massive and depending for its stability on the weight rather than the structural integrity of the material. From this type there evolved the cantilevered or reinforced stem, whose stability depends upon the weight not only of the structure itself but also of the earth filling placed over the cantilevered base. Considerable economy resulted in the use of this type of construction wherein reinforcing steel in tension was made to replace weight heretofore furnished only at the expense of extra material.

A distinct step in advance of this latter type is the so-called "unit" type wherein the wing-walls are made to give added stability to the entire construction. This is accomplished by anchoring securely the wings to the abutment body by means of tension rods so placed that in overturning the entire wing, together with the abutment, must be lifted about the point of rotation. The rigid anchorage of the wing produces a movement of the center of gravity backward, or away from the stream, and a consequent lowering of the earth pressure. The amount of this decrease in pressure is shown graphically in Fig. 5. The entire unit action is dependent upon the tension rods, which are proportioned to lift the entire wing wall at the beginning of rotation.

The safeguarding and beautifying of the approach is an important factor in bridge design and one to which too little attention has been paid in the past. Effusive ornamentation of the structure itself apparently has often been considered sufficient to compensate for a deplorable lack in this respect. As a simple, yet effective, method of producing a pleasing approach effect, and at the same time safeguarding against accident due to the sudden narrowing of the roadway at the bridge site (a condition that for reasons of economy will continue to exist for some time), the wing-walls on the standard short span construction have been carried level, out to a point sufficient to give a clear distance between them equal to the width of the traveled roadway, and handrails have been constructed thereon. The effect is simple, yet it gives a finished appearance not otherwise produced.

Arch Type.—No discussion of highway bridge design is complete without a treatment of the fixed reinforced concrete arch. From an architectural standpoint the arch has been and always will be a favorite because of the quiet, simple dignity of its lines. The stresses arising in the ring of an arch are indeterminate statically, and can be computed only from the theory of elasticity. They are thus seen to be dependent not only upon the loadings but also upon the size and shape of the ring as well.

The working out of the true economical shape and section for the arch type is a problem considerably involved and concerning which a great deal has been written. The recent data on temperature variation, however, have operated to modify to a considerable degree the limitations of design and the economical section of the arch type, and much of the data published is now of little value, especially for the lighter highway loadings. This is shown by a consideration of the following facts:

In the design of the concrete arch it has been customary among many designers to allow an arbitrary percentage (from 10 to 20 per cent) of the dead and live load stresses to cover stresses induced by temperature change. All stress values then become a function of the external loading and the following relationships can easily be shown to obtain:

(1) For a given span the movements are independent of the rise but the thrusts vary inversely as the same.

(2) The fiber stress, being largely determined by the bending moment rather than the thrust, does not increase rapidly with a decrease in rise, and analyses of very flat arches often fail to indicate serious overstress.

(3) The unit fiber stresses vary approximately as the bending moment and inversely as the square of the depth of section. Thus a condition of overstress can be remedied simply by increasing the section, as the moments and thrusts remain practically unchanged.

The tests conducted on the bridges previously referred to disclose a temperature condition far in excess of that formerly believed to exist, and the resulting moments are found to be nearer 100 per cent than 10 per cent of the dead and live load values, as is illustrated by a comparison of five typical arch spans given in Table I.

In view of the fact that the temperature variation, particularly for light highway loadings, becomes the determining factor the following relationships, which can easily be proven, seem to have an important bearing on the limitations of the arch design.

(1) For a given span the *moment due to temperature* varies inversely as the rise, and the corresponding thrust varies inversely as the second power of the same. Thus a slight decrease in rise will produce a material increase in ring stress.

(2) While the fiber stresses for a given moment vary *inversely* as the *square of the depth* of section it must be remembered that in dealing with temperature changes the moments themselves vary *directly* as the *cube of the depth of section.* Thus when the temperature moment constitutes the larger part of the total moment an increase in section often operates to increase rather than decrease the unit fiber stresses.

(3) The stresses due to temperature are a maximum at the crown and spring line of the arch but are of opposite signs. These decrease from crown to spring line, passing through a zero value and assuming their original or crown values near the quarter point (this point can be determined exactly for every arch, it being dependent upon the shape and size of the arch ring).

From the first two considerations it is at once apparent that for each span length there will be a limiting minimum rise beyond which it is not safe to design. From the third consideration it is apparent that for light highway loadings, in which temperature stresses are largely governing, there need be in general but slight increase in section between the crown and quarter point.

Thus far the discussion has been limited to superstructure design. For the substructure, inasmuch as the entire theory of stress distribution in a fixed arch is based upon a hypothesis of fixed and immovable abutments, great care should be exercised to insure such rigidity of base. Construction of the arch type over first-stage streams is extremely hazardous unless solid rock is encountered, and in any location the greatest precaution to secure adequate foundation bearings is absolutely essential to the integrity of the superstructure.

In concluding the subject of arch bridges it should be pointed out that by far too little information is available concerning the action of the arch. The larger portion of those small cracks, the elimination of which constitute such a problem to the concrete bridge builder, occur in the arch type. Very few arches are economically designed, and the great need of experimentation along this line is apparent to all who are familiar with the problems presenting themselves to the designer.

The State Highway Commission of Iowa is endeavoring to meet this need by a series of experiments based upon the results of which it is hoped to present a series of standard arch superstructures designed with a true regard for safety and economy.

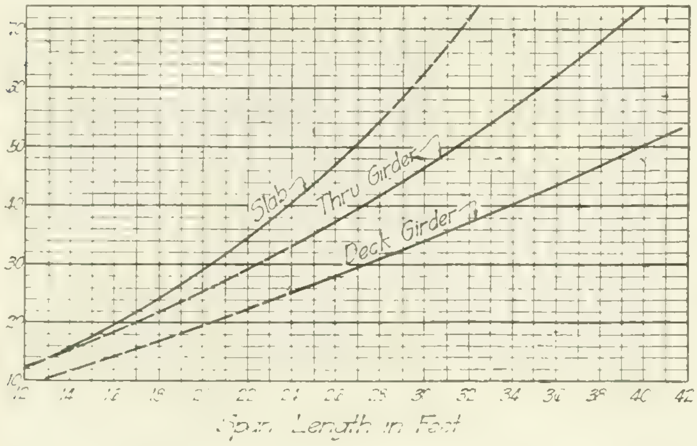


Fig. 4. Quantities of Concrete in Three Standard Types of Reinforced Concrete Superstructures—Iowa Highway Commission.

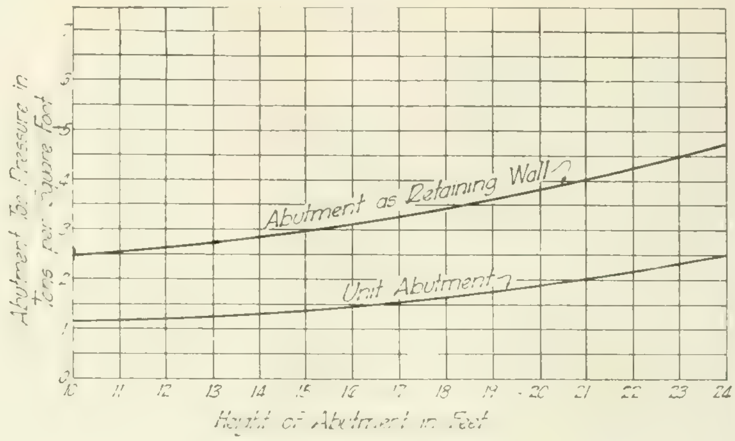


Fig. 5. Toe Pressure for Abutment Designed as Retaining Wall and as Unit Abutment.

TABLE I.—COMPARATIVE BENDING MOMENTS DUE TO DEAD AND LIVE LOADS AND TO TEMPERATURE VARIATION.

Arch ring.	Span, ft.	Bending moment, ft.-lbs. D. & L. load.	Bending moment, ft.-lbs. Temperature.	Live loadings.
A	40	8,466	30,302	100 lbs. per sq. ft.
B	55	34,050	43,800	200 lbs. per sq. ft.
C	60	30,791	38,310	60-ton elec. eng.
D	70	48,676	45,700	40-ton elec. eng.
*E	90	23,350	31,580	100 lbs. per sq. ft.
F	70	71,724	50,300	60-ton elec. eng.

*Light open spandrel construction.

Kinds of Paint and Painting Methods Used on Steel Work By Various Railroads.

The accompanying data on the practice of important railroads of the United States and Canada in regard to the kind of paint used on steel work, and the methods of its application, were obtained by the Committee on Iron and Steel Structures of the American Railway Engineering Association. A circular letter was sent to an official of each of the principal railroads (with a few exceptions) in the United States and Canada. The same letter was also sent to an official of each of several foreign railroads. The circular made inquiry by means of several questions grouped under the headings of: (1) shop coat on new fabricated steel; (2) field coats on new fabricated steel; (3) repainting or maintenance of bridges under traffic. These circulars were sent to 67 different railroads or railroad systems, and replies were received from 53 of them. A summary showing the extent of use of each kind of paint as indicated by the replies follows; the figures and percentages, (which do not include the New Zealand railways), refer to individual railroads:

(1) Shop Coat for New Steel:

Red lead pigment paint, 29 out of 50, equal to 58 per cent.

Linseed oil only, 5 out of 50, equal to 10 per cent.

Linseed oil, parts in contact after assembling with red led pigment paint, 2 out of 50, equal to 4 per cent.

Linseed oil, parts in contact after assembling with various proprietary paints, 4 out of 50, 8 per cent.

Graphite and carbon pigment paints, including lampblack paint, 8 out of 50, 16 per cent.

Miscellaneous, 2 out of 50, 4 per cent.

(2) Field Coats for New Steel:

Red led straight or in part, 12 out of 48, 25 per cent.

Carbon or graphite or both, 24 out of 48, 50 per cent.

Miscellaneous, 12 out of 48, 25 per cent.

(3) Repainting or Maintenance Under Traffic:

Carbon, 13 out of 46, 28 per cent.

Graphite, 7 out of 46, 15 per cent.

Both carbon and graphite, 4 out of 46, 9 per cent.

Red lead straight or in part, 11 out of 46, 24 per cent.

Various kinds, 11 out of 46, 24 per cent.

Design of the Reinforced Concrete Cantilever Bridge on Runnymede Ave., Cleveland, Ohio.

(Staff article.)

I.

The city of Cincinnati has recently completed a reinforced concrete bridge over West Fork Creek on Runnymede Ave., which possesses some unusual design features. The bridge was built to replace a light steel deck-truss span of about 60 ft., which rested on plain concrete abutments extending to a depth of only a few feet below the creek bottom. During the floods in March, 1913, the abutments of the old structure were undermined, and toppled forward, crushing the steel span between them. The new structure is on a 5 per cent grade. This article deals with the design features of the bridge; the construction features and costs will be treated in our April 7 issue.

DESIGN FEATURES.

General.—The new bridge, which was designed as a cantilever structure, consists of a 65-ft. center span and two 32-ft., 6-in. anchor spans. Its entire weight is carried by the two main piers adjacent to the center span, the end spans being balanced by the adjacent halves of the center span. The bridge has a clear roadway of 24 ft., with two 5-ft. sidewalks. The abutments retain the filled approaches and anchor the ends of the end cantilever spans. Figure 1, which shows a general plan and elevation of the bridge, indicates the type of structure and gives its general dimensions. It will be noted by referring to this drawing that the abutments have pile foundations, while the piers have spread footings carried to hard blue clay at a depth of about 23 ft. below the original ground surface.

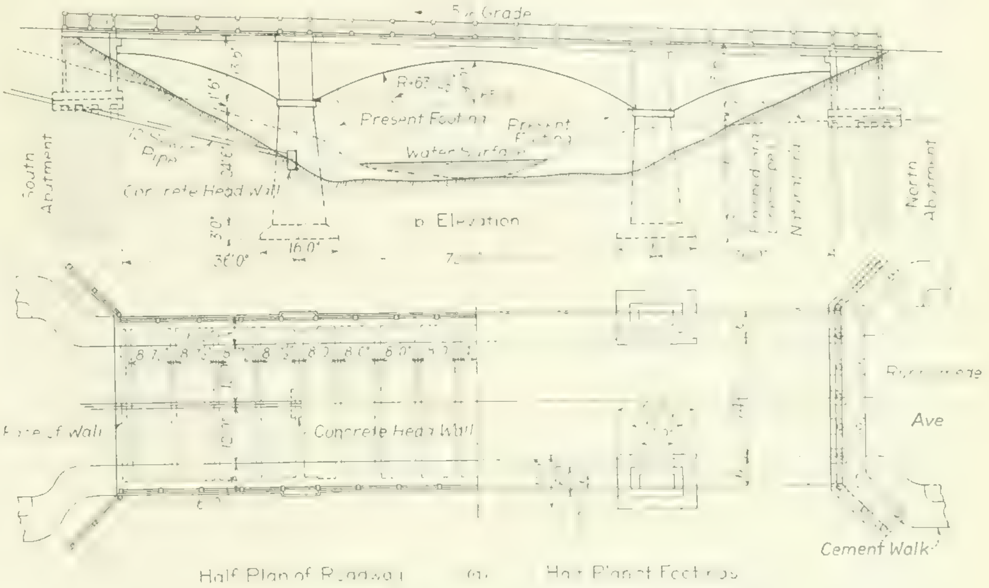


Fig. 1. Half Plans and General Elevation of Runnymede Ave. Bridge, Cincinnati, O., Showing Type of Structure and General Dimensions.

Loads and Allowable Stresses.—The roadway slab was designed for a live load of 600 lbs. per square foot and the sidewalk slab for 100 lbs. per square foot. The cross beams were designed to carry a 21-ton road roller having front and rear axles spaced 7 ft. on centers. The assumed distribution of the roller load was 7 tons at the front axle and 7 tons each on two rear wheels spaced 7 ft. apart on the rear axle. The main cantilever girders were designed for a live load of 150 lbs. per square foot on the roadway and for 100 lbs. per square foot on the sidewalks, the entire bridge being loaded.

The average load on the soil under the pier footings, due to full live and dead loads, is about 2½ tons per square foot. The unbalanced live load may produce a pressure at the toe of 3½ tons per square foot.

Both the superstructure and the substruc-

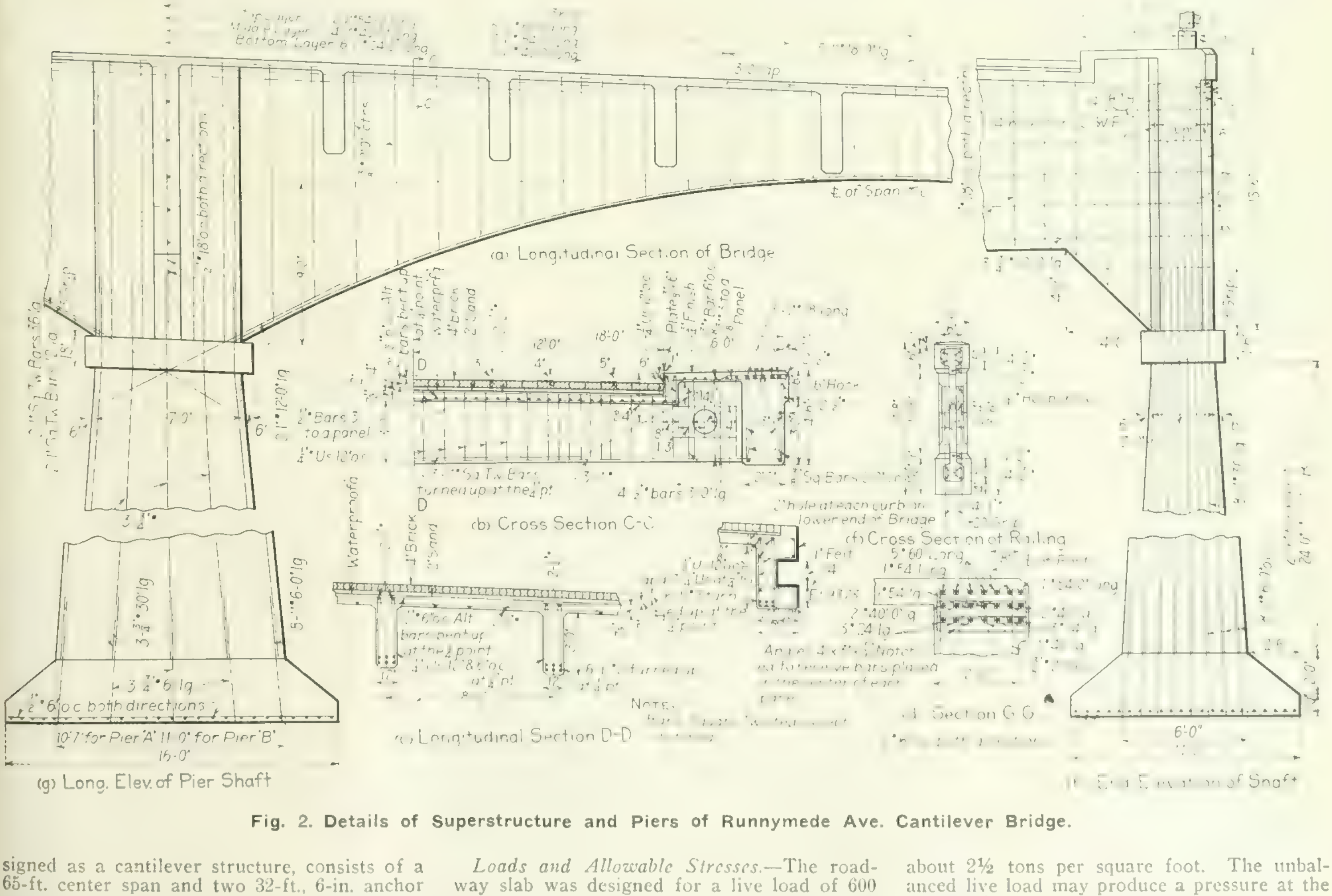

(a) Longitudinal Section of Bridge
℄ of Span
12'0"
18'0"
7'0"
6'
(b) Cross Section C-C
(c) Longitudinal Section D-D
(f) Cross Section of Railing
Section G-G
Waterproofing
Note:
2"6" o.c. both directions
10'-7" for Pier 'A' 11'-0" for Pier 'B'
16'-0"
6'-0"
(g) Long. Elev. of Pier Shaft
End Elevation of Shaft

Fig. 2. Details of Superstructure and Piers of Runnymede Ave. Cantilever Bridge.

ture were designed for the following allowable stresses:

Compression in extreme fiber of concrete, 700 lbs. per square inch.

Tension in reinforcing steel, 20,000 lbs. per square inch.

All piles were driven until they indicated a carrying capacity of at least 25 tons, as indicated by the "Engineering News" formula.

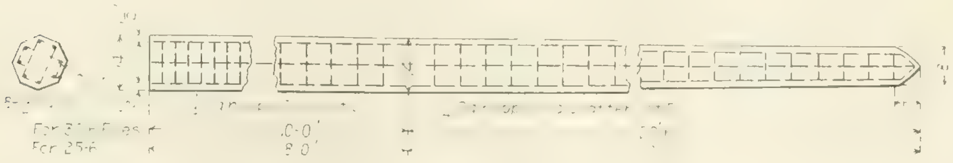


Fig. 3. Details of Reinforced Concrete Piles for Abutments of Runnymede Ave. Bridge.

Concrete Proportions.—The concrete used for the superstructure, substructure and piles consists of 1 part cement, 2 parts sand, and 4 parts crushed gravel 1 in. and under.

In casting the railing and posts a 1:3 cement mortar was used.

Superstructure Design.—The reinforced concrete superstructure consists of two main cantilever girders carrying a floor system consisting of floorbeams and slab construction. The cantilever girders are 2 ft. thick, and vary in depth from 4 ft. 6 ins. at the center of the span to 13 ft. 6 ins. over the piers, being curved on the bottom to a radius of 63 ft. 2½ ins. (see Fig. 2, a and b). The bottom reinforcement for these girders consists of two 1-in. square twisted bars, while the number and arrangement of the 1-in. bars in the top reinforcement varies along the length of the girders as shown in Figs. 2 (a) and (d). The top and bottom reinforcing bars are tied together with stirrups consisting of ⅜-in. square bars spaced 2 ft. on centers.

The floorbeams have a width of 12 ins. and a depth varying as shown in Fig. 2 (b), to conform to the crown of the roadway. For the center span these floorbeams are spaced 8 ft. on centers, while for the anchor spans their spacing is 8 ft. 7½ ins. on centers. Figures 2 (b) and (c) give complete details for these beams. The cantilever arms are anchored to the reinforced concrete abutments by means of a special form of end floorbeam which engages a projection on the abutment. Figure 2 (e) is a cross section of the end floorbeam showing its shape and reinforcement.

The reinforced concrete roadway slab is continuous over the floorbeams. It has a thickness of 7½ ins., and is reinforced as shown in Figs. 2 (b) and (c). The roadway slab is waterproofed with one layer each of burlap and felt coated with coal tar pitch.

The sidewalk slab has a thickness of 6 ins. and is reinforced as shown in Fig. 2 (b).

The reinforced concrete railing posts, which are spaced 8 ft. 1½ in. on centers, extend 3 ft. 8 ins. above the top of the sidewalk slab. The railing consists of an upper and lower reinforced concrete member and a paneled web 2 ins. thick. Figure 2 (f) is a cross section of the railing showing its principal details.

The roadway surfacing consists of a 4-in. layer of brick, with cement grout filler, laid on a 2-in. sand cushion. The crown of the 24-ft. roadway is 4 ins. The curb is formed by a 6x⅜-in. plate, anchored into the concrete with 1¼x3/16-in. hooked bars spaced 2 ft. on centers. At the ends of the anchor spans the surfacing consists of a strip of concrete 8 ins. wide, which is retained and protected by a 4x3x⅜-in. angle extending across the roadway and anchored into the end floorbeam as shown in Fig. 2 (e).

Substructure Design.—The divided piers are heavily reinforced to provide for bending stresses due to unbalanced live loadings. Both piers have spread footings extending to a stratum of hard blue clay—practically shale. The footing of each pedestal pier is 11x16 ft., the longer dimension being parallel to the longitudinal axis of the bridge. At the top of the footing the south pier shafts have dimensions of 6 ft. x 11 ft., while the north shafts are 6 ft. x 10 ft. 7 ins.; at the top of all pier shafts the dimensions are 3 ft. x 7 ft. The height of the north pier shafts is 21 ft. 6 ins., while that of the south shafts is 24 ft. 0 in. Figures 2 (g) and (h) are detail drawings of the piers. The pier shafts of each pier are connected at the top and braced by means of a deep reinforced concrete strut, as shown in Figs. 2 (g) and (h).

The abutments are founded on reinforced concrete pre-cast piles, 17 piles being used under each abutment. These piles are hexagonal in shape, with a long diameter at the top of 14 ins. and at the bottom of 8 ins.; two lengths of piles were used—30 ft. 6 ins. and 25 ft. 6 ins.—the six outside piles in each abutment having the shorter length. Figure 3 is a detail drawing of these piles. They were driven through loam, sand and yellow clay into hard blue clay.

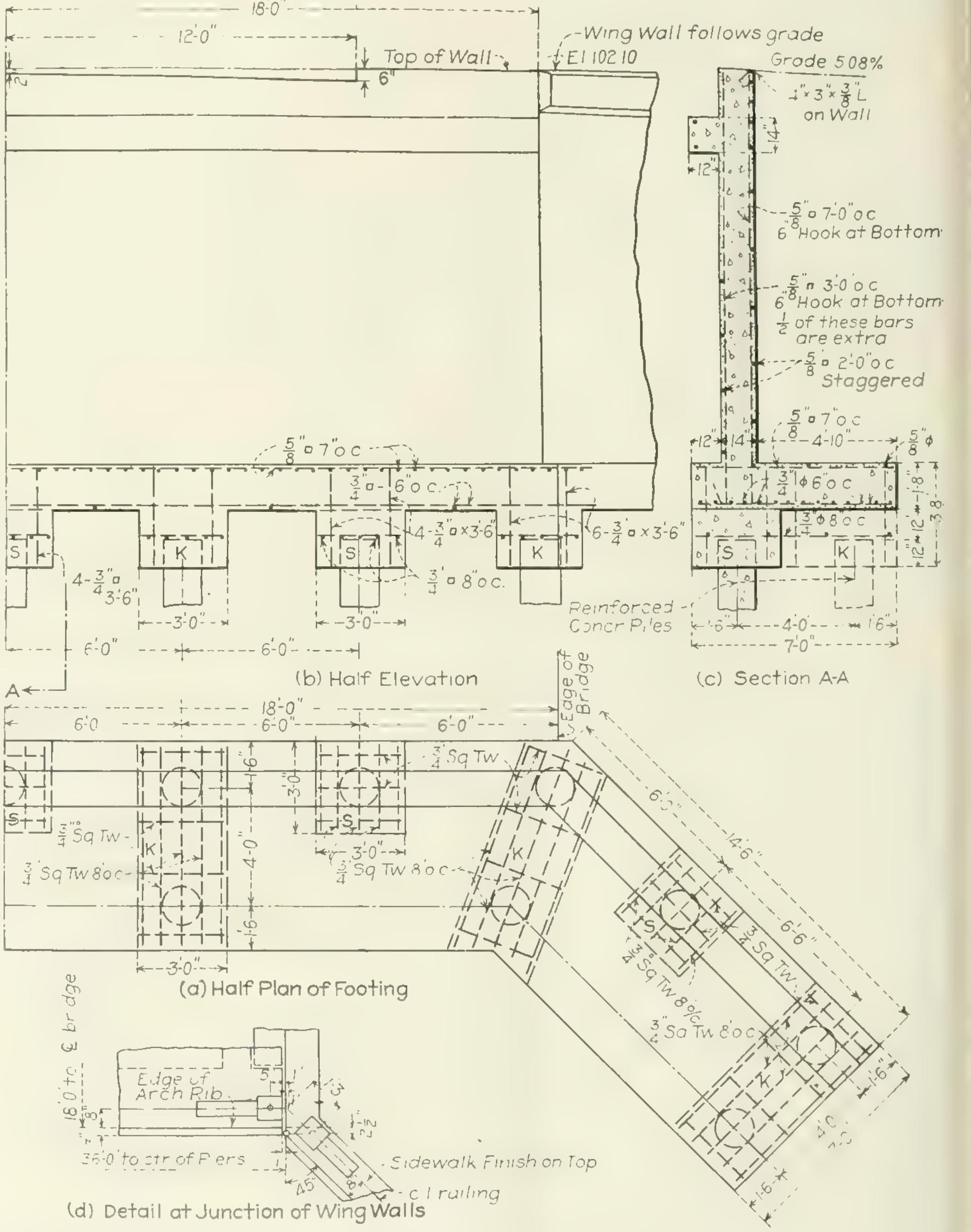


Fig. 4. Details of Abutments of Runnymede Ave. Bridge.—Note Anchorage for Adjacent Cantilever Arm.

The abutments, which are essentially reinforced concrete retaining walls of the cantilever type, also form support and anchorage for the end cantilever spans. Figure 4 (a) is a half footing plan of the north abutment, indicating the arrangement of the piles and pile caps. The reinforcing bars for the pile caps are shown in this drawing, but those in the footing proper have been omitted. Figure 4 (b) is a half elevation of the abutment wall, and Fig. 4 (c) is a cross section of it. These drawings indicate the type of wall used, and give the general dimensions and the size and arrangement of the reinforcement. The manner of providing support and anchorage for the end cantilever arms of the bridge is clearly shown in Figs. 4 (b) and (c) and in Fig. 2 (e). Figure 4 (d) is a detail showing, in plan, the junction of the wing-wall and abutment wall. The wing-walls, which form an angle of 45° with the axis of the bridge, have a length of 14 ft. 6 ins. and are provided with the same type of railing as the main structure.

PERSONNEL.

The bridge was designed by the Engineering Department of the City of Cincinnati, F. S. Krug, chief engineer; Frank L. Raschig, principal assistant engineer, and Edgar K. Ruth, assistant engineer in charge of office and design. We are indebted to Mr. Ruth for the data upon which this article is based.

WATER WORKS

Method of Relining a Small Brick-lined Water Works Reservoir with Asphalt and Concrete at Irwin, Pa.

Contributed by John M. Rice, Assistant Engineer with Morris Knowles, Consulting Engineer, Pittsburgh, Pa.

The reservoir here described is part of the Westmoreland Water Company's system and is located just outside the Borough of Jeannette on the Pittsburgh and Greensburg Pike. It supplies water to the higher portions of Irwin and provides a reservoir for fire protection for the whole of the town. This reservoir was built in the years 1888 and 1889 and originally had puddled slopes faced with riprap. As considerable trouble was experienced in keeping the reservoir tight, the riprap was torn out and a brick lining substituted in 1895.

This did not prove satisfactory and in 1913, the design was prepared for a complete reconstruction of the reservoir consisting in the consruction of a circular vertical wall near the toe of the existing slope and having a layer of asphalt and concrete over the existing floor. The space between the existing slope and the vertical wall was to be filled with excavated material obtained from the toe of the slope. Nothing was done in 1913, but in 1914 a further study of the situation, preliminary to letting contracts, showed that a somewhat cheaper construction might be secured by waterproofing the existing slopes and building a circular wall at the top. This design was adopted and plans were prepared on this basis.

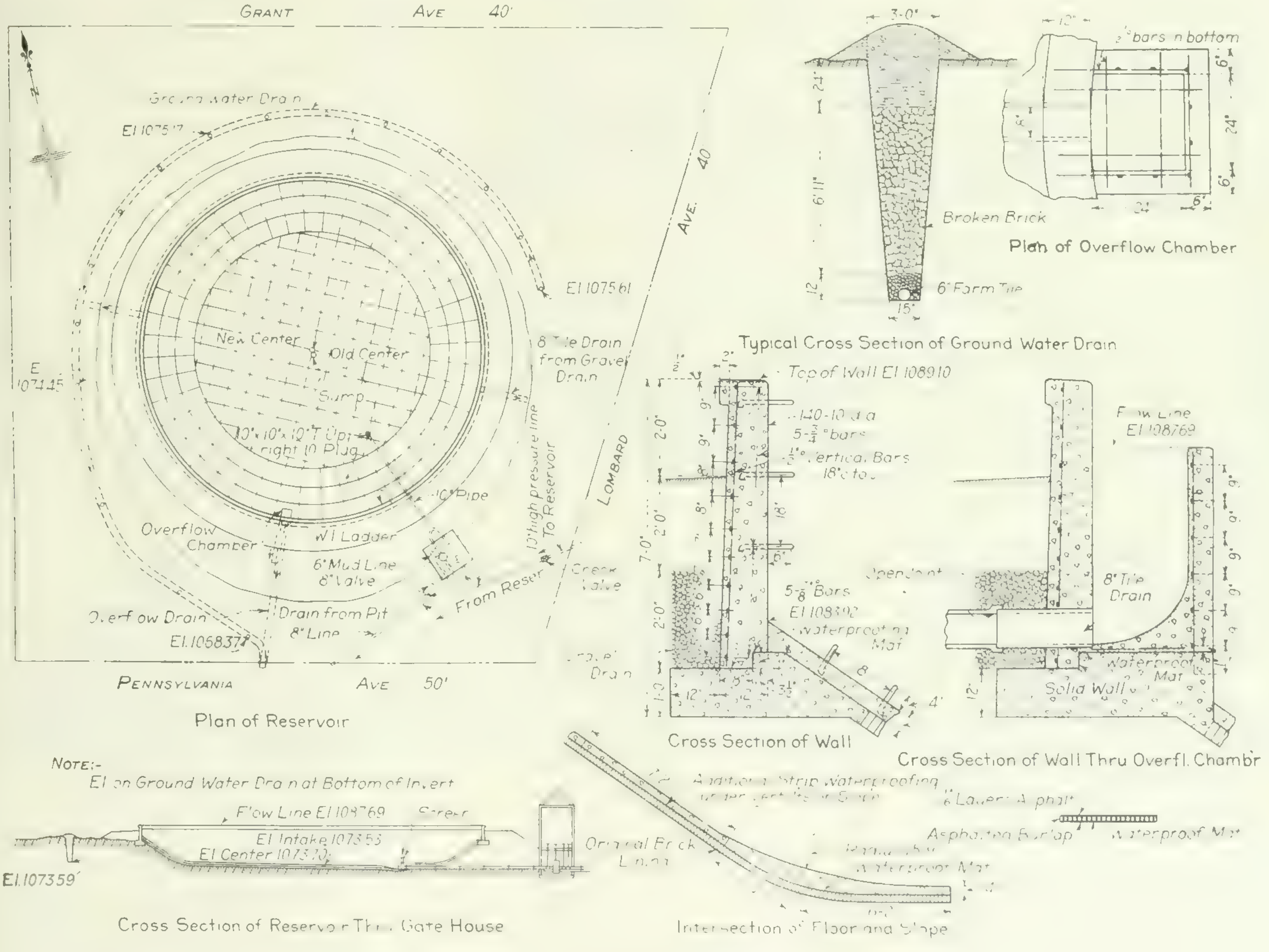


Fig. 1. Details of Design for Relining with Asphalt and Concrete the Reservoir of the Westmoreland Water Co., at Irwin, Pa.

The design of the completed work is shown on the drawing in Fig. 1. During the progress of the work, it was decided that a ground water drain should be constructed along the north and west sides of the reservoir to cut off any ground water flow which might either contaminate the water in the reservoir or break the waterproof lining, due to the building up of the hydrostatic pressure.

DESCRIPTION OF WORK.

The old reservoir had a diameter of 151 ft. at the top of the embankment and was lined with brick on a clay foundation. The maximum height of embankment was about 17 ft. on the south side and the minimum about 2 ft. on the north side. The embankment appears to have been made up of material from the excavation and was a heavy clay. It was well saturated with water, as was disclosed by test pits. It has leaked very seriously in the past and it was impracticable to keep more than 3½ ft. of water in the basin.

In order to remedy this condition and to secure a greater reserve quantity of water for fire protection at Irwin, the repairs and additions hereinafter described were determined upon. These consist of:

1. The removal of the top slope paving to a depth of 5 ft. 6 in. 2. Examination of the entire remaining lining and the removal of the portions which seemed to have an insecure foundation. 3. The cleaning of the floor and slopes, the filling up of all depressions of the brick work and the smoothing up of the original lining, preparatory to placing the waterproofing. 4. The placing of a waterproofing membrane on top of the old lining. 5. The protection of the waterproofing by a layer of concrete. 6. Increasing the capacity and pressure by the use of a circular and vertical wall 6 ft. high around the top. 7. The protection of waterproofing and the purity of reservoir's contents by a ground water drain.

ORDER OF WORK.

The contractor began work by excavating for the vertical wall foundation while the water was still in the reservoir. The material encountered was yellow clay for the most part, but some large stones were found. On the north side of the embankment, the original surface was cut through and it was found that the embankment had been placed upon it without stripping the top soil. Several test pits were dug when the elevation of wall footing was reached and the ground further tested by the use of bars and the material found to be of the same consistency throughout.

The footing of 1:2:4 concrete was next placed in blocks about 10 ft. 2 ins. long. When this work was finished, the reservoir was drained and the floor and slopes were carefully tested by tapping them with an 8-lb. hammer, and any hollow places beneath the brick work were discovered by the sound. In this manner a number of small holes were found and one large one. All of these places were filled with concrete and then the whole surface of the floor and slopes was plastered over and smoothed up to receive the waterproofing. After this coating had become dry, the waterproofing membrane was placed.

Waterproofing.—The specifications require that "A layer of asphalt heated to 400° F., 1/16 in. thick shall be spread upon the floor and while this is still hot, a layer of burlap shall be placed upon it and carefully rolled out to avoid wrinkles and air space. This shall be followed by a layer of heated asphalt, 1/16 in. thick." The contractor was required to submit samples of the asphalt and burlap, which he proposed to use, and the former was tested and gave the following analysis:

Bitumen soluble in carbon bisulphide	99.5%
Total bitumen soluble in 86° naphtha	69.9%
Specific gravity at 70° F.	.998
Loss after heating at 325° F, 5 hours	.6%
Penetration at 32° F, No. 2 needle, 200 grams, one minute	27.
Penetration at 77° F, No. 2 needle, 100 grams, 5 seconds	37.
Penetration at 115° F, No. 2 needle, 50 grams, 5 seconds	72.

The asphalt was heated in a large kettle up to about 350°, and was then transferred by a ladle to a smaller kettle, where the temperature was raised to about 440°. From this point it was taken to the work and applied to the surface of the floor and slopes by the use of mops. While it was still hot, a strip of burlap, 40 ins. wide and from 15 to 20 ft. long was rolled out upon it. The top coating of asphalt was applied soon afterwards, and before the burlap had become cold. It was also applied by mops.

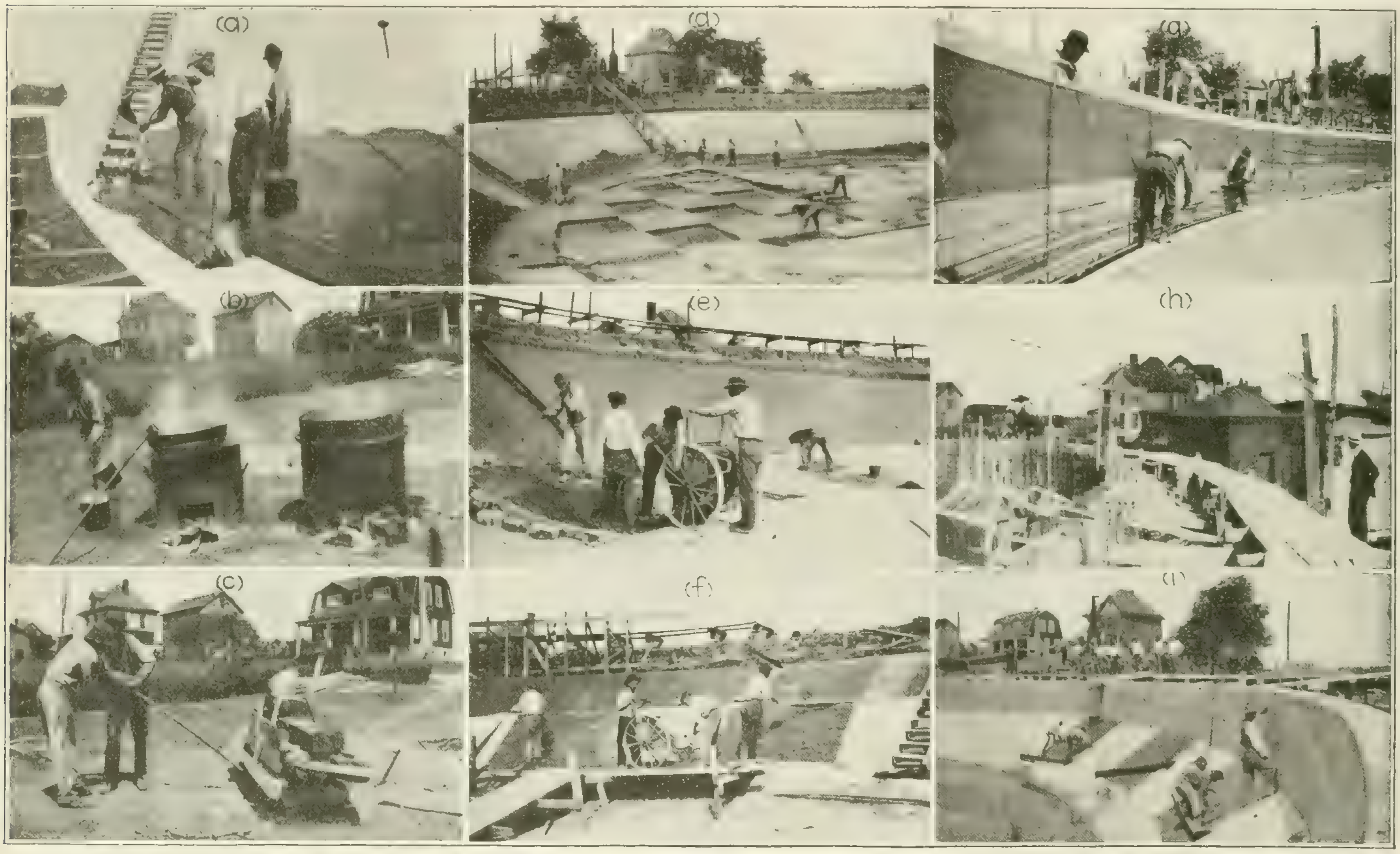


Fig. 2. Construction Views Showing the Relining with Asphalt and Concrete of a Brick-Lined Reservoir at Irwin, Pa.

(a) Application of Asphalt and Burlap. (b) Heating Asphalt. (c) Cutting Up Asphalt. (d) Placing Floor Blocks. (e) Placing Concrete in Curved Blocks at Toe of Slope. (f) Placing Concrete in Lower Tier Slope Blocks. (g) Placing Wall Reinforcement—Note Use of Building Paper Against Form. (h) Forms and Runway for Concreting Top of Wall. (i) Concreting Upper Tier of Slope Blocks.

The application of the waterproofing is shown in Fig. 2a, and the apparatus used for heating is shown in Fig. 2b. Figure 2c shows the method of cutting up the asphalt as received on the ground.

After the waterproofing mat had been placed upon the floor and before the work on the slopes had been finished, the concrete protection was placed. This consisted of alternate blocks about 7 ft. 8 ins. square, originally designed to have an average thickness of 4 ins., but due to the unevenness of the floor and to the desire to secure satisfactory drainage of the bottom to the sump, this actually averaged 5⅛ ins.

This concrete was 1:2:4 mixed, placed rather wet, screened and then troweled to give an impervious surface. The floor was laid in alternate blocks, as shown in Fig. 2d.

Meanwhile, the waterproofing of the slopes continued and as soon as the concrete floor had been placed, work was begun on covering up the slope waterproofing. Here again, the extreme unevenness of the original lining caused an excess of concrete to be used in order to bring the final surface to a smooth plane. Figures 2e and 2 f show the method employed in placing the concrete slope paving.

After the lower tiers of slope slabs had been placed, it was determined to put water into the reservoir, in order to provide fire protection for the borough; the floor and slopes were therefore cleaned and water turned in 21 days from the date of emptying the reservoir. This gave a depth of water of 7 ft. and storage of 535,000 gals., two days' supply for Irwin.

Before the upper tier of blocks was placed, it was decided to build the vertical wall, constructed to the dimensions shown on the drawing, Fig. 1. The horizontal rods were supported by channels spaced 6 ft. apart. The steel came in 35 ft. lengths and was lapped 30 ins. for the ¾ in. and 35 ins. for the ⅞ in. bars.

In order to secure as smooth a surface for the exterior of the wall as possible, the contractor placed a layer of building paper on the inside of the forms as shown in Fig. 2g which also shows the placing of the wall reinforcement.

The forms consisted of ⅞ in. hemlock or pine surfaced on both edges and one side. The outside studding was 2x6-in. hemlock, spaced 2 ft. center to center and braced from the embankment. The inside forms were wired to the outside at the bottom and midway at each rib of studding between top and bottom.

The specifications required this wall to be poured monolithic and to comply with this, the contractor began work at 7 p. m. on the evening of August 22 and completed the pouring at 2 p. m. on the 23d. The work during the night was well illuminated with lights and the construction proved satisfactory.

The top of the wall was finished with a 1-in. layer of 1:2 mortar well troweled and edged off. The concrete was a wet 1:2:4 mix and the wall was designed to have sufficient steel to take the full load at a stress of 12,000 lbs. per square inch. On the removal of the forms, the surface was rubbed down with wooden floats and carefully smoothed up. The forms and runway for concreting the top of the wall are shown in Fig. 2h.

After the vertical wall was finished, the upper floor slab was placed. The workmen were supported from the wall as shown in Fig. 2i, and the joint between the slab and the vertical wall was filled with hot asphalt. The water was then entirely removed from the reservoir and after a thorough cleaning of slopes and floor, it was filled.

The specifications required that the reservoir should not show a leakage of more than one vertical inch, measured at the surface, and although the final acceptance test has not yet been run, preliminary measurements indicate that less than ½ in. is lost. It is confidently expected that even this will be reduced after a short while.

As soon as the concrete work was finished the ground water drain was constructed. This consisted of a trench backfilled, in part, with coarse grained filling. This included the brick removed from the old lining of the reservoir.

ACKNOWLEDGMENT.

The work was designed by the writer working in the office of Mr. Morris Knowles. The design was approved by Mr. John N. Chester, Consulting Engineer, Pittsburgh, Pa. It was constructed by J. C. Bigler of Greensburg. W. R. Miller was resident engineer on construction. Mr. L. B. Smith is manager of the Westmoreland Water Co.

Methods and Apparatus Employed in Carrying on Continuous Water Waste Surveys in the District of Columbia.

The Pitometer Division was organized, in 1906, to carry on systematic waste water surveys after the city had narrowly averted a water famine in the winter of 1904-05. The per capita consumption had increased from 161 gals. in 1896 to 217 gals. in 1906. The Pitometer Division was enlarged several times until in 1913 it consisted of 40 men, 5 teams and 11 pitometers. The force has since been gradually reduced as leaks and waste were eliminated. The work is now performed throughout the entire year, each portion of the city's system being subjected to the most minute examination possible, and where faulty valves or lack of circulation prevent proper tests, these conditions are remedied in order that the pitometer surveys may be complete. The methods and apparatus employed in making these continuous water waste surveys were described by Mr. Paul Lanham, Pitometer Operator, in a paper before the Indiana Sanitary and Water Supply Association. The paper is here given practically in full.

The procedure is as follows: The city is divided into a number of large divisions, known as permanent pitometer districts, it being the intention to maintain the boundaries of these districts as nearly constant as circumstances will permit, in order that data may be collected, recorded, and compared. Only by keeping a close watch on the same district for several years can the causes of the fluctuations in the consumption be determined. The determination of the condition of a district is not a mere matter of pitometer records and computations, but rather the result of a close study of the territory extending over years.

The consumption in each district is measured for a period of seven days by recording pitometers placed on the large mains entering the district, and where important mains pass entirely through a district, at the same time feeding that district through side stops, a pitometer is also placed at the extreme boundary, a deduction of its measurement being made from the total indicated by the instrument at the point of entry. The work of running these instruments is assigned to one of the field parties and is carried on constantly, it being the desire to secure as many measurements as possible in each large district so that we may know what conditions should exist at any season of the year in the future.

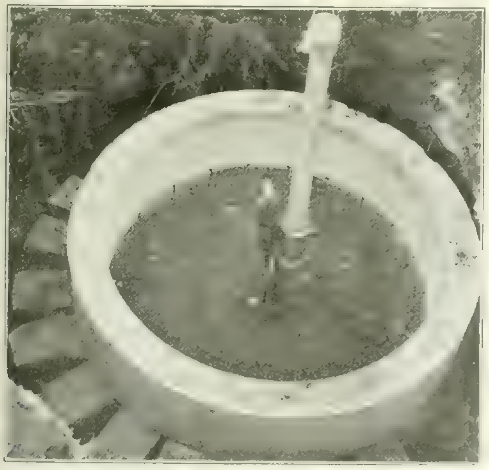


Fig. 1. Permanent Pitometer Connection Installed on 6 in. Water Main at Washington, D. C.

(Iron valve casing with flush cover is placed on top of concrete ring. A portion of fill is made with ashes to facilitate seepage of water due to leaky connections, rainfall and drainage from water jackets and water motors on recorder.)

Having selected a district for detailed examination with, for example, a night consumption of 75 per cent of the mean daily rate, which is the rule and not the exception in this city, each of the field parties is assigned a portion and proceeds to find the leaks as well as to analyze and account for all night flows. A recording pitometer is placed upon one of the permanent connections on one of the small mains within the territory, see Fig. 1, and valves are closed in such a manner that the entire feed for the territory under test must pass through that main. At the beginning of the test, however, only one square is included or the least number of squares necessary to include one fire hydrant. This hydrant is then opened sufficiently to produce a velocity of about 3 ft. per second past the pitometer. This is done to bring the instrument well within its accurate recording range, and thereby produce reliable indications on subsequent operations. Having allowed a short interval for the recorder to plot the rate of flow prevailing, the operators proceed to close off the square desired to be tested just beyond the boundaries of the small isolation previously described. Test is made of the shut off of this square and if it is found O. K. the closed valve lying between it and the pitometer is opened and a lantern signal is transmitted to the man at the instrument. Upon receipt of the signal, this man makes a mark upon the record and gives it a serial number, to be used later for the proper interpretation of the chart. This method is continued for all squares to be tested wherever practicable.

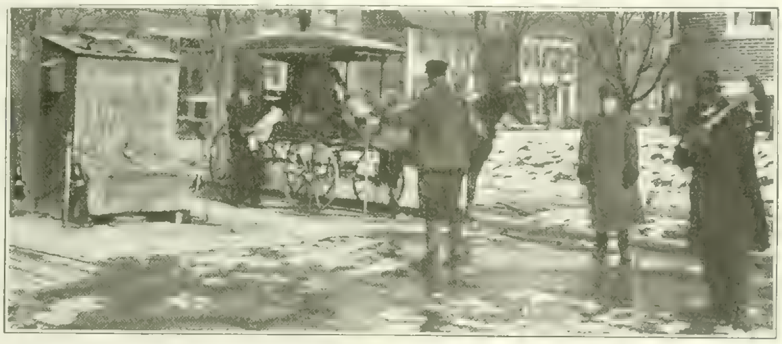


Fig. 2. Employes of Pitometer Division, Washington, D. C., Water Department, Prodding for Underground Leak, Indicated by the Pitometer.

(Steel frost pin is used to pierce asphalt and slender steel rod is then driven to the main. Use of aquaphone or mud on rod then gives knowledge of proximity of leak. Very small leaks as well as large ones are frequently located in this manner.)

In some cases it is considered desirable first to include the district including all squares to be tested and make the individual test by shutting off the successive squares and marking the chart at the instant the various valves are closed. In Washington this method has been entirely abandoned because of the interference caused by the fluctuations occurring in the squares. These tests are continued for all squares which can be tested from the connection and the pitometer is then shifted to a new location where the process is continued for the new squares.

When a flow is detected in a square, an inspection of all the curb stopcocks is made, these having previously been examined and placed in condition for inspection. Where flows are heard with the aquaphone the stopcocks are operated and the location of the flow relative to the curb line established, since the closure of the cock eliminates that portion of the pipe from the curb into the premises, the cessation of the flow, of course, showing the cause to be in that portion and vice versa. Where flows are thus found to be controlled by the stopcocks they are left off until a second pitometer test of the section of main supplying them is made, when by comparison of the two tests of the same square, with and without the flowing services, the rate of consumption and waste through these services is obtained.

Having by the operations just described located and measured all flows entering the houses or leaking from the pipes between the curb line and the premises, any balance must be due to underground leakage from the main itself, or from the service pipes between the curb and the main. This is all the information desired on the night inspection and the tracing up and elimination of the suspicious flows thus detected is prosecuted in the day time. Assuming that as a result of the night work a definite flow is detected on a particular service pipe, the inspector assigned to its investigation first listens on the pipe with the aquaphone, and if the flow is still present enters the house and makes a thorough inspection of all the fixtures. In case these are found to be defective and wasting water he has to use his own judgment as to the amount discharged and report conditions to his immediate superior in charge of the test. If no leaking fixtures are discovered and the noise on the pipe continues, an examination of the underground portion is made, and test holes on the line of the pipe are driven until water is detected on the steel prod used for that purpose, as shown in Fig. 2. An excavation exposing the leak is then opened and a notice served on the occupant of the premises to have repairs made under penalty of having the supply cut off.

It frequently happens that flows detected and measured entering the service pipes at night are found to have vanished when the inspector returns in the day time to determine their cause, and when this is the case the flow must have been due to fixtures left open. This information is recorded and the statements of the results of the surveys show the total night flow due to this cause in each district. The search for the underground leakage on the mains or on the portion of the service pipes between the mains and the curb lines is made in the same way, great reliance being placed upon the aquaphone. Digging through a thick surface of perfectly dry sheet asphalt or concrete to uncover leaks, the existence of which might never have been suspected, is made possible by the aquaphone. All information secured in the course of the surveys is recorded on cards by clerks.

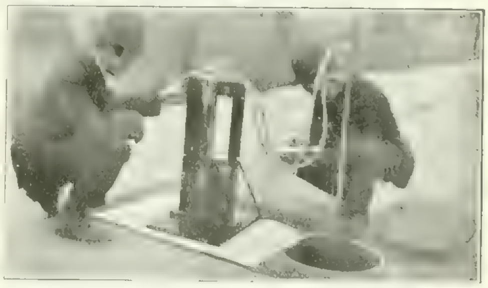


Fig. 3. Old Method of Traversing a 20-in. Water Main with Manual Recorder, Washington, D. C.—Now Done with Automatic Recorders.

The method of procedure given above is basic, and in practice is subject to alterations to suit varying conditions. For instance, while each house connection is required by law to have a stopcock at the curb line accessible through a suitable type of box, actually only about 20 per cent of the houses in the older section of Washington were found to be so equipped. The stopcocks themselves were seldom missing, but the curb boxes were in such a condition as to be almost useless for the purpose intended. This state of affairs made necessary the employment of a number of additional laborers to repair and clean these boxes in order that the stopcocks could be used for the localization of the suspicious flows detected by the tests. Constant attention to the boxes for the past eight years has placed them in a fairly good condition, facilitating the resurveys considerably. This work, while undertaken primarily to assist in the pitometer tests, has a substantial, permanent value in the improvement of the water system, which should not be overlooked when considering costs.

The question of the subdivision of the mains into small sections is largely dependent upon the number, location and character of the valves. The ideal arrangement would be that in which the valves were so situated that all sections of mains between street intersections could be tested separately, this arrangement giving tests of convenient extent, easily identified. In Washington conditions at the time the pitometer tests were begun were very favorable to subdivisions of this nature and since that time the rapid replacement of the four way single stem valves, which had been the favored type, with four way four stem valves has facilitated the tests. In spite of these very favorable conditions, however, a number of instances have arisen where the proper localization of the flow could not be made because of either the lack of a valve or its failure to control the main under test. The investigations in these cases were never abandoned, however, for these reasons, but either a valve was installed or the defective one repaired. In this way also the pitometer surveys produced in addition to water economy, improvement in the distribution system.

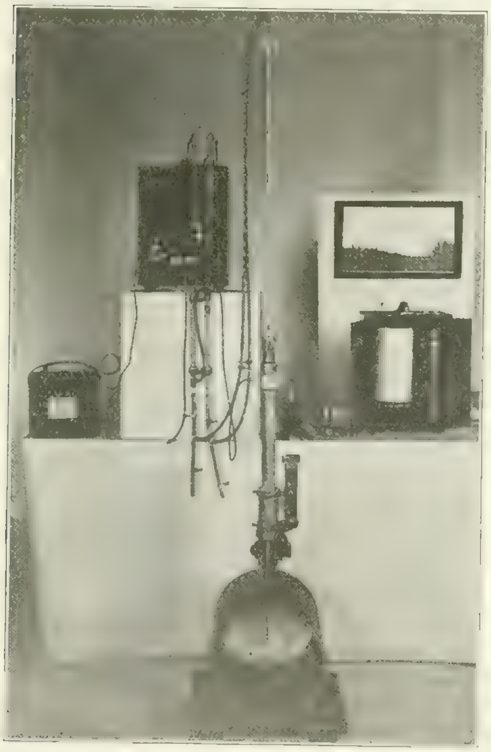


Fig. 4. View of Assembled Photographic Recording Pitometer, Formerly Used in Washington, D. C.

(Inverted U-tube uses a red fluid, lighter than water, for indicating velocities. Tube is water jacketed to prevent errors due to expansion and contraction. Sample chart in upper corner. This photographic recorder was set up in small houses or sheds, called field boxes, in the field. Small oil stoves were used in these sheds when necessary to prevent freezing of tubes.)

As the primary intent of the surveys is the detection and prevention of water waste, it is obvious that legitimate consumption of water may be excluded from the tests when possible. As practically all of the legitimate consumption occurs during daylight and evening hours, while the leakage will be continuous through the 24 hours, it logically follows that the better time for the prosecution of the work is during the hours between midnight and dawn. This not only refers to the actual pitometer tests, but also to the aquaphone inspections of all service pipes, valves, and other appurtenances, as in this branch of the work the absence of street noises is very important. The tracing of flows detected at night, however, must frequently be continued in the day time when the houses are accessible and exposed fixtures visible.

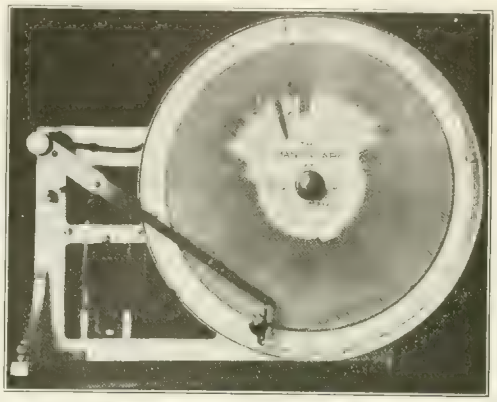


Fig. 5. Front View of Pitometer Recorder Now Used Exclusively in Washington for Making Flow Measurements. Generally.—Manograph, Type B.

During the early years of the surveys the large number of underground leaks existing made it possible to show substantial results by relatively rough tests. Figure 3 shows the traversing of a 21 in. main with a manual recorder; this work is now done by automatic recorders. As the large leaks were detected and remedied the work became more and more difficult until the necessity for giving closer attention to the small flows, previously ignored in practically all squares, was evident. For this close study, however, the photographic recorders of the type shown in Fig. 4 were found inadaptable and no suitable instrument for the work could be secured. The aggregate quantity of waste involved made the problem of prime importance and experiments were therefore made, resulting in the production of an extremely sensitive and accurate portable recorder, which after several years of use, has been found entirely satisfactory, and has amply repaid the expense involved. The chief points striven for in this instrument were quick response to changes in flow upon the night tests and a visual record of these changes, together with portability and convenience in manipulation. The successful termination of the experiments has permitted us to continue the surveys for the localization of very small flows and produce profitable results otherwise impossible. A front view of the pitometer recorder now used in Washington for making flow measurements generally is shown in Fig. 5. The recorder for making subdivision night tests and all special tests of short duration is shown in Fig. 6.

The total underground leakage located and prevented to date in the District of Columbia amounts to 40,000,000 gals. daily and the mean daily water consumption for the entire city is today 11,000,000 gals. less than when the surveys were started in 1906, and equals the consumption 13 years ago, in spite of the fact that the population has increased by over 69,000 inhabitants, and previous to the inauguration of the surveys the daily rate of consumption had been increasing approximately 2,500,000 gals. per year. The average cost for carrying on the investigation for the past six years was $32,000 per year, which includes extensions of plant in addition to operation costs. The average saving in the mean daily water consumption was 5,000,000 gals. per year. Placing a value of 1 ct. per 1,000 gals. upon the water, this saving represents an average return of 57 per cent on the investment. Our aim is to reduce the per capita consumption from 151, its present figure, to 130 gals. daily, and with the systematic pitometer inspections for the elimination of the underground leakage and universal metering of service pipes for the prevention of careless waste, we are already in sight of our goal.

Famous Bubbly Creek Filter Plant Adopts Liquid Chlorine Treatment.

In the summer of 1908 the Bubbly Creek filter plant at the Chicago Stock Yards set the lead, in this country, in the use of hypochlorite of lime for water disinfection. Very recently a liquid chlorine apparatus was purchased. Chlorine is received in cylinders that hold 105 lbs. of the liquified gas. The experience gained by operating this apparatus during the first month (February, 1915) was described by Mr. C. A. Jennings, Superintendent of Filtration, in a paper before the recent annual meeting of the Illinois Section of the American Water Works Association.

Mr. Jennings has concluded that in comparison with the use of "hypo" at the Bubbly Creek filter plant the use of liquid chlorine has the following advantages: (1) There is considerably less labor involved; (2) the absorption of the gas by the water is more rapid; (3) there is no loss of chlorine and smaller quantities can be used to accomplish equivalent results; (4) there is no deterioration of the chlorine in the cylinders while using or while stored; (5) the changing of the rate of application is easily, quickly and accurately accomplished; (6) there is no odor of chlorine about the plant; (7) the cost is considerably less.

There are mechanical features about the Bubbly Creek filter plant which are believed to be peculiar to it. These features are the enormous amount of hypochlorite necessary to disinfect the water, the poor mechanical means for getting into solution all of the hypochlorite used, which resulted in a large loss of available chlorine, and the irregularity in the operation of the plant due to a varying consumption and small storage capacity. This often caused it to be necessary to run one or two filters for a time and then suddenly have to use eight filters. Naturally the coagulant and germicide must be proportioned to the amount of water being filtered. Now while using liquid chlorine, the regulation of the germicide is much more simple, accurate and economical

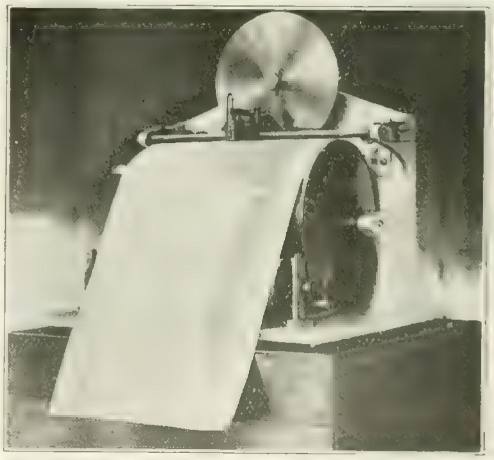


Fig. 6. Front View of Pitometer Recorder, Now Used in Washington for Making Subdivision Night Tests and All Special Tests of Short Duration.

(This instrument is built especially for this purpose, has very rapid paper feed, and is very sensitive. It is the Type A Manograph.)

than with hypo. The ratio of costs during one month's operation with liquid chlorine with an average raw water supply and the treated filtered water as low in bacteria as when using hypo, was 1 to 3 in favor of liquid chlorine. It is hardly probable that every plant will show such a large difference in the costs of disinfection by the two methods.

Data on "Coppering" a Reservoir at Hartford.

Once each month from May to September inclusive, in 1913, microscopic examinations were made of samples of water taken from all the reservoirs in the Hartford, Conn., water works system. Special examinations of certain of the samples were made when it seemed advisable.

Early in the summer a heavy growth of algae developed in Reservoir No. 4 and the odor became so objectionable that the supply could not be used. On July 24, the reservoir was treated with copper sulphate (one part to 3.36 million parts of water), a method now commonly used to destroy odor-producing vegetable growths in drinking supplies, and the following summary of microscopical examinations shows the success of the treatment and the rapidity of its action.

Date of examination.	Reduction in microscopic organisms. Per cent.
July 26 (2 days after treatment)	81.0
July 28	98.7
July 30	99.3
August 1	99.6

On August 26 Reservoir No. 6 was similarly treated with one part of copper sulphate to 3.36 million parts of water. An examination of the water two days after treatment showed a reduction of 90 per cent of the micro-organisms.

These data are from the 60th annual report of the Board of Water Commissioners of Hartford.

ROADS AND STREETS

The Economic Limit of Pavement Repairs.

The determination of the point in the life of a pavement at which renewal becomes more economical than further repairs was discussed by G. E. Norton in the Cornell Civil Engineer and his method of determining this point of renewal is given here.

However well a roadway may be constructed there must be repairs and such will increase in extent and expense until a limit is reached where renewals are dictated by considerations of economy. While there may be an interesting possibility of maintaining a roadway in satisfactory service by continued repairs for an indefinite time, such today appears a remote contingency.

Comparatively little attention has been given to a true limitation between repairs and renewals although the basic theory has been developed. (See Gillette's Cost Data; second edition, page 27.) The theoretical problem involved is a most interesting one from a purely engineering consideration. Were all roadways repaired and renewed from a common source of revenue and under a common supervision and determiantion this question might reasonably be left to the judgment and knowledge of the engineer. However, main highways are often constructed by the state and repairs demanded of a county or town in which located. City pavements are often repaired at general expense, but a portion or all the cost of reconstruction is assessed locally. Wherever there is a transfer of responsibility or financial obligation, when repairs cease and reconstruction is demanded, this problem will become not only an engineering one but one of most general interest, and the limits placed or recommended by the engineer must be susceptible of explanation to others and of such sound and simple elements as to appeal to the lay judgment. The requirement to be met is that of minimum expense for providing a roadway for an indefinite continuous period of time, or determination of the limit where maintenance by repair exceeds in cost maintenance by renewal. To determine this limitation we must know the cost of repairs year by year and the cost of renewal, which may theoretically be the same as the cost of original construction.

Some hold that sinking fund provisions, etc., should enter into this determination, but a full consideration of the various methods by which funds are provided and the varying values of moneys to the diverse contributers to the expense seem to make this an unnecessary refinement, at least until a general theory is better founded and accepted.

For this discussion we accept the fact that pavement repairs increase with the age of pavement and will further assume that the cost of renewal of wearing surface is equal to the original cost of providing such surface.

Where repairs increase directly as the first power of the age then the economical limit of life is reached when the total cost of repairs equals the cost of the article. When these repairs increase with the square of the age then the limit is reached when repair cost equals one-half that of the article. If the repair rate increases by any uniform rate then a mathematical solution can be reached for minimum cost of providing a continuous surface by repairs or renewal.

Unfortunately the variations in soil, climate, traffic, and materials plus the ever present limitations of human judgment make most unlikely any regular curve of increase in repair cost of a single road or pavement. No average result of a number of examples can be truthfully used as a criterion for a single case. The determination must, therefore, be made from the record of the individual pavement, although such determination may well be made in the light of a knowledge of general behavior and limitations of other similar construction. The method here proposed is simple in its application, readily understood by the layman, and is apparently as accurate as this problem at its best will warrant.

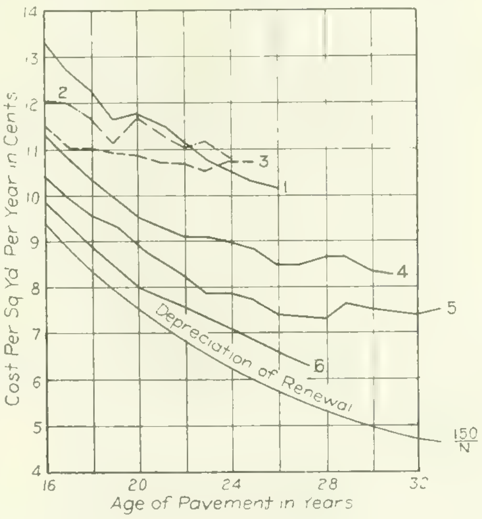


Fig. 1. Annual Cost of Certain Pavements at Various Ages.

Cost of surface plus cost of repairs divided by age of pavement, with depreciation or renewal curve for determination of minimum cost.

To determine the economical limit of repairs two variables must be considered and the limit will occur at the minimum of their sum. If a pavement surface is used 20 years, one-twentieth of its cost may be taken as its annual depreciation, but if in use but 10 years then one-tenth the cost is the annual depreciation. For any particular class of pavements there may be prepared a table of depreciation by dividing the cost of renewable surface by numbers representing the age of pavement. For the cost of repairs, if at end of 10 years 10 cts. per yard have been expended for repairs, the average rate has been 1 ct. per year. If at 20 years 60 cts. per yard have been expended then the average repair rate has been 3 cts. per yard per year. For an application of this method Table I is made.

TABLE I.—COST OF REPAIRS BY YEARS BASED ON RENEWAL AT $1.50 A SQUARE YARD.

Age N.	Annual cost of repairs.	Total cost of repairs.	Average annual cost of repairs.	Annual allowance for renewal.	Annual cost of pavement.
1 to 7	....	3.0	...	....	....
8	2.7	5.7	0.7	18.8	19.5
9	0.8	6.5	0.7	16.7	17.4
10	12.9	19.4	1.9	15.0	16.9
11	4.9	24.3	2.2	13.6	15.8
12	0.6	24.9	2.1	12.5	14.6
13	2.1	27.0	2.1	11.5	13.6
14	2.2	29.2	2.1	10.7	12.8
15	1.4	30.6	2.0	10.0	12.0
16	0.9	31.5	2.0	9.4	11.4
17	2.9	34.4	2.0	8.8	10.8
18	3.0	37.4	2.1	8.3	10.4
19	0.3	37.7	2.0	7.9	9.9
20	3.1	40.8	2.0	7.5	9.5
21	5.8	46.6	2.2	7.1	9.3
22	3.5	50.1	2.3	6.8	9.1
23	9.6	59.7	2.6	6.5	9.1
24	5.9	65.6	2.7	6.3	9.0
25	4.2	69.8	2.8	6.0	8.8
26	...	69.8	2.7	5.8	8.5
27	8.3	78.1	2.9	5.6	8.5
28	12.5	90.6	3.2	5.4	8.6
29	6.9	97.5	3.4	5.2	8.6
30	5.0	102.5	3.4	5.0	8.4
31	5.2	107.7	3.5	4.8	8.3

In Table I the cost of renewable surface is assumed at $1.50 per square yard. This amount is divided by the consecutive numbers representing age of pavement (column 1), and gives the annual allowance for depreciation as shown in column 5. The actual expenditure made annually for repairs per square yard are given in column 2. In column 3 is shown the totals of such repair cost to the given year and in column 4 the average cost of repairs per year to that date (column 3 divided by column 1). Column 6 (the sums of columns 4 and 5) shows the cost of depreciation plus cost of repairs and in this is to be found the minimum or limit of repairs. This example shows that the cost of providing the pavement over a term of years, depreciation plus repairs, had been a decreasing one excepting in the 28th year, where a large repair expenditure had raised the annual cost, but that a lower cost was thereafter reached.

An immediate use of such a tabulation is found in determination of the allowable repairs for any year. An inspection at once shows, with an annual cost of 9.5 cts. per yard per year at the 20th year, that if 9.5 cts. be expended in the 21st year the annual cost rate will remain the same. As the repairs in the 21st year were less than 9.5 cts. (5.8 cts.) the average annual cost was reduced to 9.3 cts. Had it exceeded 9.5 cts. the average annual cost would have been increased. From the above consideration the following rule is formulated:

The allowable repairs for a succeeding year should not exceed the sum of the total cost of repairs to date, plus the cost of the wearing surface, divided by the age of pavement, and when the necessary repairs will exceed such amount the street should be resurfaced. This rule, like the celebrated artist's paints, should be applied with brains. It is believed to be sound, simple, easy of application, and a valuable aid to an engineer's broad judgment.

To fairly discuss the rule some applications are given. These are from maintenance records of sheet asphalt pavements in Buffalo, N. Y., where detailed records of yearly costs are available for nearly 700 contracts. In Fig. 1 are shown annual costs, repairs plus depreciation for six streets with fairly uniform repairs. There is also plotted for reference the curve of depreciation, cost 150 divided by age, all figures in cents per square yard. Figure 2 shows the same record for three streets in which the rule of minimum cost has been violated and repairs continued.

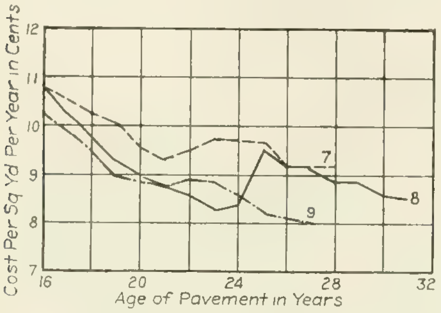


Fig. 2. Annual Cost of Certain Pavements at Various Ages.

Cost of surface plus cost of repairs divided by age of pavement where minimum cost rule has been violated.

These streets may be briefly described as follows:

(1) 17,235 sq. yds., heavy traffic, about 5,000 tons per day, now in good condition except somewhat uneven.

(2) 5,800 sq. yds., heavy traffic street. Condemned in 24th year.

(3) 19,100 sq. yds., medium traffic street. General conditions warrant an early condemnation.

(4) 22,500 sq. yds., medium traffic. Condemned in 31st year and repaved in 32nd year. This street is used for further study in Fig. 3.

(5) 8,900 sq. yds., residence street. Laid on a bituminous base. Surface worn very thin, but bituminous base prevents deep holes.

(6) 5,800 sq. yds., short residence street of exceptionally low repair costs, 0.8 cts. per yard per year for 27 years, apparently destined for long life.

(7) 7,000 sq. yds., residence street in fairly serviceable condition. In its 22nd and 23rd years 27.6 cts. per yard were expended for repairs.

(8) 13,400 sq. yds., medium traffic street. One of several streets laid same year on which guaranty was voluntarily extended 3 years. In its 24th and 25th years 48.6 cts. per square yard were expended for repairs. Now in fair condition.

(9) 18,200 sq. yds., medium traffic residence street, now in fair condition. In 22nd and 23rd years 20.9 cts. per square yard were expended in repairs.

Some irregularities in these lines are due to known insufficiencies of repairs or entire omission for one year.

In applying this rule several points should be borne in mind:

(a) Repairs due to settlements or other local causes may warrant a high rate when such repairs may place the whole surface in a satisfactory condition.

(b) Known deficiencies of repairs for a period followed by such as replace deficiencies must be given due consideration.

(c) Due regard for general condition of whole surface. Occasionally pavements exhibit some traits of the celebrated "one-horse shay."

(d) If a pavement is plainly of quality below the average of its kind its annual costs, while decreasing, may be so much above the reasonable expectations for its successor that the rule should be tightly drawn or perhaps forced, while with the reverse condition some leniency may be felt for one which is giving better than average service. This is illustrated by No. 5 above.

The impossibility of making such uniform repairs as to create a smooth curve of annual cost demands a careful study of the line and a smoothed or average curve of cost may well be sketched and studied in making final decision.

This rule has been applied in Buffalo for about three years, at first as a check upon the opinions of those long in charge of such work and later as a guide in the formation of such opinions, and has been found to be most sound and to conform to judgment based on extended experience.

The argument for use of sinking fund curve instead of a straight depreciation, while theoretically warranted, has little practical merit. In Fig. 3 is shown line A, straight depreciation or cost divided by age; line B is the sinking fund curve at 4 per cent compound interest to produce $1.50 at the given age. They depart from the parallel by only about 0.1 ct. between 20 and 30 year ages—an immaterial amount. Above these lines have been plotted as lines A and B, the record of street No. 4 of Fig. 1, based respectively on straight and sinking fund depreciation; they show no appreciable difference in character to warrant use of the more complicated sinking fund provision.

Another element may well enter into this problem. In the above discussion no allowance has been made for deteriorated condition of a roadway during its determined life. Generally an old surface will be uneven and less desirable even if intact and serviceable; and at times some weight should be given to such condition. It is possible in the rule herein suggested to make allowance for a deteriorated useful value of a wearing surface and also give weight to losses occasioned through interruption of traffic in resurfacing by decreasing or increasing the assumed value of the wearing surface.

No attempt has here been made to discuss the various theories which have been advanced for this purpose as such would of necessity be somewhat controversial. The pure theory of limitation of repairs may well have more extended and public discussion than generally accorded to it. It is of the essence of sound engineering and of vast financial import.

The intent in this presentation is but to suggest a simple rule for guidance in an important determination and one which is equally applicable in any elimination between repairs and renewals.

Definitions of Terms Used in Road Construction.

The following recommended nomenclature for materials and methods used in road construction was presented in the report of a special committee of the American Society of Civil Engineers published in Vol. XL, p. 3010 of the Proceedings of that society. The committee was constituted as follows: W. W. Crosby, chairman; H. K. Bishop, A. W. Dean, N. P. Lewis, C. V. Tilden, G. W. Tillson, and A. H. Blanchard, secretary. The derivation and use of the nomenclature recommended is stated in the report.

For the sake of uniformity and clearness, the committee recommends that the following lists of terms of frequent use in expressions relating to highway work be recognized as having the meanings set forth in the list, unless otherwise definitely stated at any time by a user of such term or terms. The committee further recommends that new terms or phrases, coined with the idea of expressing delicate shades of meaning through the medium of one or two words rather than by longer expressions, be suggested or used only after full, careful, and conservative consideration for the sake of avoiding the utmost further confusion in the use of terms.

In the list given will be found some terms and definitions adopted by the American Society for Testing Materials noted thus *, others by the American Reporters on Communication No. 10 at the Third International Road Congress, designated thus †, and other terms and definitions which have been proposed by the Committee on "Standard Tests for Road Materials" (Committee D 4) of the American Society for Testing Materials, which have been indicated thus ‡. The committee wishes to acknowledge here its obligations for suggestions thus reaching it.

DEFINITIONS.

Aggregate.—The mineral material, such as sand, gravel, shells, slag, or broken stone, or combinations thereof, with which the cement or the bituminous material is mixed to form a mortar or concrete. Fine aggregate may be considered as the mineral inert material which will pass a ¼-in. screen, and coarse aggregate the material which will not pass a ¼-in. screen.

Asphalt.—† Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt on the application of heat, and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

Asphalt Block Pavement.—One having a wearing course of previously prepared blocks of asphaltic concrete.

Asphalt Cement.—A fluxed or unfluxed asphaltic material, especially prepared as to quality and consistency, suitable for direct use in the manufacture of asphaltic pavements, and having a penetration between 5 and 250.

Ahphaltenes.—† The components of the bitumen in petroleum, petroleum products, malthas, asphalt cements, and solid native bitumens, which are soluble in carbon disulphide, but insoluble in paraffin naphthas.

Asphaltic.—Similar to, or essentially composed of, asphalt.

Base.—Artificial foundation.

Binder.—(1) A foreign or fine material introduced into the mineral portion of the wearing surface for the purpose of assisting the road metal to retain its integrity under stress, as well as, perhaps, to aid in its first construction. (2) The course, in a sheet-asphalt pavement, frequently used between the concrete foundation and the sheet-asphalt mixture of graded sand and asphalt cement.

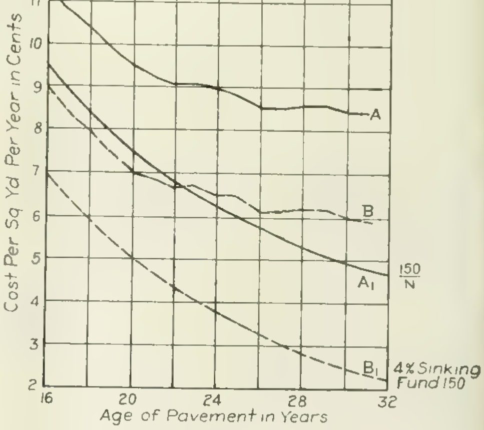


Fig. 3. Flat Depreciation or Renewal Compared With Sinking Fund Provision to Show Parallelism at Critical Ages.

Repair cost of Street No. 1, Fig. 1, added to show similarity of lines of cost.

Bitumen.—* A mixture of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

Bituminous Cement.—A bituminous material suitable for use as a binder having cementing qualities which are dependent mainly on its bituminous character.

Bituminous Concrete Pavement.—One composed of stone, gravel, sand, shell, or slag, or combinations thereof, and bituminous materials incorporated together by mixing methods.

Bituminous Macadam Pavement.—One having a wearing course of macadam with the interstices filled by penetration methods with a bituminous binder.

Bituminous Material.—Material containing bitumen as an essential constituent.

Liquid Bituminous Material.—‡ Bituminous material showing a penetration at normal temperature under a load of 50 grammes applied for 1 sec. of more than 350.

Semi-Solid Bituminous Material.—‡ Bituminous material showing a penetration at normal temperature under a load of 100 grammes applied for 5 sec. of more than 10, and under a load of 50 grammes applied for 1 sec. of not more than 350.

Solid Bituminous Material.—‡ Bituminous material showing a penetration at normal temperature under a load of 100 grammes applied for 5 sec. of not more than 10.

Bituminous Pavement.—One composed of stone, gravel, sand, shell or slag, or combinations thereof, and bituminous materials incorporated together.

Bituminous Surface.—A superficial coat of bituminous material with or without the addition of stone or slag chips, gravel, sand, or material of similar character.

Blanket.—See "Carpet."

Bleeding.—The exudation of bituminous material on the roadway surface after construction.

Blown Petroleums.—† Semi-solid or solid products produced primarily by the action of air upon originally fluid native bitumens which are heated during the blowing process.

Bond.—The combined action of inertia, friction, and of the forces of adhesion and cohesion which helps the separate particles composing a crust of pavement to resist separation under stress. Mechanical bond is the bond produced almost wholly, in a well-built broken-stone macadam road, by the interlocking of angular fragments of stone and the subsequent filling of the remaining interstices with the finer particles.

Bound.—Bonded.

Water-Bound.—Bonded with the aid of water.

Bituminous Bound.—Bonded with the aid of bituminous material.

Brick Pavement.—One having a wearing course of paving bricks or blocks.

Bridge.—A structure for the purpose of carring traffic over a gap in the road-bed measuring 10 ft. or more in the clear span.

Camber of a Road.—See 'Crown."

Camber of a Bridge.—The rise of its center above a straight line through its ends.

Carbenes.—† The components of the bitumen in petroleums, petroleum products, malthas, asphalt cements, and solid native bitumens, which are soluble in carbon disulphide, but insoluble in carbon tetra-chloride.

Carpet.—A bituminous surface of appreciable thickness, generally formed on top of a roadway by the application of one or more coats of bituminous material with gravel, sand, or stone chips added.

Cement.—An adhesive substance used for uniting particles of other materials to each other. Ordinarily applied only to calcined "cement rock," or to artificially prepared, calcined, and ground mixtures of limestone and silicious materials. Sometimes used to designate bituminous binder used in bituminous pavements, when the expression "bituminous cement" (q. v.) is understood to be meant.

Cement-Concrete.—An intimate mixture of gravel, shell, slag, or broken stone particles with certain proportions of sand or similar material, cement and water, made previous to placing.

Cement-Concrete Pavement.—One having a wearing course of hydraulic cement concrete.

Cemented.—Bonded. Referring to water-bound macadam, the term "cemented" is used to designate that condition existing when, after rolling the stone forming the crust, the remaining voids have been filled with the finer sizes, and the stone dust or "flour" has, under the action of water, taken a "set," as does cement itself.

Chips.—Small angular fragments of stone containing no dust.

Clay.—Finely divided earth, generally silicious and aluminous, which will pass a 200-mesh sieve. Also see "Gravel."

Coal-Tar.—† The mixture of hydrocarbon distillates, mostly unsaturated ring compounds, produced in the destructive distillation of coal.

Coat.—See "Carpet." (1) The total result of one or more single surface applications. (2) To apply a coat.

Coke-Oven Tar.—† Coal-tar produced in by-product coke ovens in the manufacture of coke from bituminous coal.

Consistency.—‡ The degree of solidity or fluidity of bituminous materials.

Course.—One or more layers of road metal spread and compacted separately for the formation of the road or pavement. Courses are usually referred to in the order of their laying as first course, second course, third course, etc. Also a single row of blocks in a pavement.

Crown.—The rise in cross-section from the lowest to the highest part of the finished roadway. It may be expressed either as so many inches (or tenths of a foot), or as rate per foot of distance from side to center, *i. e.*, "the crown is 4 in.," or "the crown is ½ in. to the foot."

Crusher Run.—The total unscreened product of a stone crusher.

Crusher-Run Stone.—The product of a stone-crusher, unscreened except for the removal of the particles smaller than remaining on about a ¼-in. screen.

Crust.—That portion of a macadam or similar roadway above the foundation consisting of the road metal proper with its bonding agent or binder.

Culvert.—A structure for the purpose of carrying traffic over a gap in the road-bed, measuring less than 10 ft. in clear span.

Cut-Back Products.—Petroleum, or tar residuums, which have been fluxed, each with its own or similar distillates.

Dead Oils.—* Oils, with a density greater than water, which are distilled from tars.

Dehydrated Tars.—† Tars from which all water has been removed.

Ditch.—The open-side drain of a roadway, usually deep in proportion to its width, and unpaved.

Drainage.—Provision for the disposition of water.

Side-Drainage.—That along the sides of the roadway.

Sub- or Under-Drainage.—That below the surface.

Surface Drainage.—That on the roadway or ground surface.

V-Drainage.—That provided by the construction of troughs in the sub-grade of the roadway, which troughs are like a "V," with flat sloping sides, and are filled with stone.

Dust.—‡ Earth or other matter in fine, dry particles, so attenuated that they can be raised and carried by air currents. The product of the crusher passing through a fine sieve.

Dust Layer.—Material applied to a roadway for temporarily preventing the formation or dispersion under traffic of distributable dust.

Earth Road.—A roadway composed of natural earthy material.

Emulsion.—A combination of water and oily material made miscible with water through the action of a saponifying or other agent.

Expansion Joint.—A separation of the mass of a structure, usually in the form of a joint filled with elastic material, which will provide opportunity for slight movement in the structure.

Fat.—Containing an excess. A fat asphalt mixture is one in which the asphalt cement is in excess and the excess is clearly apparent.

Filler.—(1) Relatively fine material used to fill the voids in the aggregate. (2) Material used to fill the joints in a brick or block pavement.

Fixed Carbon.—* The organic matter of the residual coke obtained upon burning hydrocarbon products in a covered vessel in the absence of free oxygen.

Flour.—†Finely ground rocks or minerals pulverized to an impalpable product.

Flush Coat.—See "Seal Coat."

Flushing.—(1) Completely filling the voids. (2) Washing a pavement with an excess of water.

Flux.—† Bitumens, generally liquid, used in combination with harder bitumens for the purpose of softening the latter.

Footway.—The portion of the highway devoted especially to pedestrians. A sidewalk.

Foundation.—The portion of the roadway below and supporting the crust or pavement.

Artificial Foundation.—That layer of the foundation especially placed on the sub-grade for the purpose of reinforcing the supporting power of the latter itself, and composed of material different from that of the sub-grade proper.

Free Carbon.—* In tars, organic matter which is insoluble in carbon disulphide.

Gas-House Coal-Tar.—† Coal-tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal.

Grade.—(1) The profile of the center of the roadway, or its rate of rise or fall. (2) Elevation. (3) To establish a profile by cuts and fills or earthwork. (4) To arrange by sizes, broken stone, gravel, sand, or combinations of such materials.

Gravel.—Small stones are pebbles usually found in natural deposits more or less intermixed with sand, clay, etc., but in which mixture the particles which will not pass a 10-mesh sieve predominate, gravel clay, gravel sand, clayey gravel, and sandy gravel indicate the varying proportions of the finer-sized particles. The differentiation between gravel, sand, silt, and clay should be made on the following basis:

Size of particles.	Names.
Retained on a 10-mesh sieve	Gravel
Passing a 10-mesh and held on a 200-mesh sieve	Sand
Passing a 200-mesh sieve	Silt or clay

Pea Gravel.—Clean gravel the particles of which equal peas in size.

Grit.—Stone, slag chips, or small gravel free from finer material.

Gutter.—The artificially surfaced and generally shallow waterway provided usually at the sides of the roadway for carrying surface drainage. Occasionally used synonymously with "ditch," but incorrectly so, as "gutters" are always paved or otherwise surfaced, and ditches are not.

Haunches.—The sides or flanks of a roadway. Sometimes also called "quarters."

Highway.—The entire right of way devoted to public travel, including the sidewalks and other public spaces, if such exist.

Layer.—A course made in one application.

Loam.—Finely divided earthy material containing a considerable proportion of organic matter.

Macadam.—A road crust composed of stone or similar material broken into irregular angular fragments compacted together so as to be interlocked and mechanically bound to the utmost possible extent.

Mastic.—A mixture of bituminous material and fine mineral matter suitably made for use in highway construction and for application in a heated condition.

Mat.—† See "Carpet."

Matrix.—A composition or material forming a cushion, or binding the aggregate together.

Mesh.—The square opening of a sieve.

Metal.—See "Road-Metal."

Mortar.—A mixture of fine material such as sand, cement, and water or other liquid suitably proportioned and incorporated together for the purpose for which it is used.

Mush.—A greasy mud sometimes found on bituminous crusts.

Normal Temperature.—‡ In laboratory investigations, 25° cent. (77° Fahr.)

Oil-Gas Tars.—Tars produced by cracking oil vapors in the manufacture of oil gas.

Patching.—Repairing or restoring small isolated areas in the surface of the metaled or paved portion of the highway.

Palliative.—A short-lived dust layer.

Pavement.—The wearing course of the roadway or footway, when constructed with a cement or bituminous binder, or composed of blocks or slabs, together with any cushion or "binder" course.

Penetration.—In laboratory investigations, the distance, expressed in tenths of a millimeter, entered a sample by a No. 2 cambric needle operated in a machine for the purpose and under known conditions of loading, time, and temperature. The degree of solidity of bituminous materials.

In construction, the entrance of bituminous material in to the interstices of the metal of the roadway.

Penetration Method.—The method of constructing a bituminous-macadam pavement by pouring or grouting the bituminous material into the upper course of the road metal before the binding of the latter has been completed.

Pitch.—† Solid residue produced in the evaporation or distillation of bitumens, the term being usually applied to residue obtained from tar.

Hard Pitch.—Pitch showing a penetration of not more than ten.

Soft Pitch.—Pitch showing a penetration of more than ten.

Straight-Run Pitch.—‡ A pitch run in the initial process of distillation, to the consistency desired without subsequent fluxing.

Pocket.—A hole or depression in the wearing course.

Pot-Hole.—A hole extending below the wearing course.

Profile.—A longitudinal section of a highway, generally taken along the center line.

Quarters.—The four sections of equal width which, side by side, make up the total width of a roadway.

Raveling.—The loosening of the metal composing the crust.

Refined Tar.—† A tar freed from water by evaporation or distillation which is continued until the residue is of desired consistency, or a product produced by fluxing tar residuum with tar distillate.

Renewals.—Extensive repairs over practically the whole surface of the metaled or paved portion of the highway.

Repairs.—The restoration or mending of a considerable amount of the metaled or paved portions of the highway, but not usually of a majority of the surface area. More extensive than "Patching" but less so than "Renewals."

Resurfacing.—The renewal of the surface of the crust or pavement.

Road.—A highway outside of an urban district.

Road-Bed.—The natural foundation of a roadway.

Road Metal.—Broken stone, gravel, slag, or similar material used in road and pavement construction and maintenance.

Roadway.—That portion of a highway particularly devoted to the use of vehicles.

Rock Asphalt.—Sandstone or limestone naturally impregnated with asphalt.

Rock Asphalt Pavement.—A wearing course composed of broken or pulverized rock asphalt with or without the addition of other bituminous materials.

Sand.—Finely divided rock detritus the particles of which will pass a 10-mesh and be retained on a 200-mesh screen. Also see "Gravel."

Sand-Clay Road.—A roadway composed of an intimate mixture of sand and clay.

Scarify.—To loosen and disturb superficially.

Screen.—In laboratory work an apparatus, in which the apertures are circular, for separating sizes of material.

Screenings.—Broken rock of a size that will pass through a ½ to ¾-in. screen, depending on the character of the stone.

Seal Coat.—A final superficial application of bituminous material during construction to a bituminous pavement.

Setting Up.—The relatively quick change such as takes place in a bituminous material after its application to a roadway, indicated by its hardening after cooling and exposure to atmospheric and traffic conditions, as opposed to the slower changes later occurring gradually and almost imperceptibly.

Shaping.—Trimming up and preparing a subgrade preparatory to applying the first course of the road metal or artificial foundation.

Sheet-Asphalt Pavement.—One having a wearing course composed of asphalt cement and sand of predetermined grading, with or without the addition of fine material, incorporated together by mixing methods.

Sheet Pavement.—A pavement free from frequent joints such as would accompany small slabs or blocks, and which has an appreciable thickness (say, in excess of 1 in. on the average) for its wearing course.

Shoulders.—The portion of the highway between the edges of the road metal or pavement and the gutters, slopes, or watercourses.

Side Drains.—See "Drainage."

Sidewalk.—The portion of the highway reserved for pedestrians.

Sieve.—In laboratory work an apparatus, in which the apertures are rectangular, for separating sizes of material.

Silt.—Naturally deposited fine earthy material, which will pass a 200-mesh sieve. Also see "Gravel."

Spalls.—Fragments broken off by a blow, irregular in shape, and of sufficient size to be comparable to the original mass.

Squeegee.—A tool with a rubber or leather edge for scraping or cleaning hard surfaces, or for spreading and distributing liquid material over and into the superficial interstices of roadways.

Squeegee Coat.—An application by means of the squeegee.

Stone Block Pavement.—One having a wearing course composed of stone blocks quite or nearly rectangular in shape.

Street.—A highway in an urban district.

Sub-Grade.—The upper surface of the native foundation on which is placed the road metal or the artificial foundation, in case the latter is provided.

Superficial Coat.—A light surface coat.

Surface Coat.—See "Carpet."

Surfacing.—(1) The crust or pavement. (2) Constructing a crust or pavement. (3) Finally finishing the surface of a roadway. (4) Treating the surface of a finished roadway with a bituminous material.

Surface Treatment.—Treating the finished surface of a roadway with bituminous material.

Tailings.—Stones which after going through the crusher do not pass through the largest openings of the screens.

Tar.—† Bitumen which yields pitch upon fractional distillation and which is produced as a distillate by the destructive distillation of bitumens, pyro-bitumens, or organic material.

Telford.—Properly an artificial foundation advocated by Thomas Telford (1757-1820), and consisting of a pavement of stone about 8 in. thick, laid by hand and closely packed and wedged together. The individual stones were desired to be about 16 sq. in. in section, and about 18 in. in length. They were set close together on the prepared sub-grade, their longest dimension vertical and on their larger ends, their interstices chinked with smaller stones, and the whole rammed (or rolled) until firm and unyielding.

Telford Macadam.—Macadam with an artificial foundation of Telford.

Under-Drain.—See "Drainage."

Upkeep.—Maintenance.

V-Drain.—See "Drainage."

Viscosity.—The degree of fluidity of bituminous materials.

Volatile.—Applied to those fractions of bituminous materials which will evaporate at climatic temperatures.

Water-Bound.—Bound or bonded with the aid of water.

Water-Gas Tars.—Tars produced by cracking oil vapors in the manufacture of carbureted water gas.

Wearing Coat.—The superficial layer of the crust or pavement exposed to traffic.

Wearing Course.—The course of the crust or pavement exposed to traffic.

Wood Block Pavement.—One having a wearing course composed of wood paving blocks, generally rectangular in shape.

Some Costs of Street Repair Work in Philadelphia in 1914.

Complete cost records of all street repair work by city forces are kept by the Philadelphia Bureau of Highways. In the Bureau's report for 1914 costs are given for all work done during the year named and from these we summarize the data given for Bituminous Surface Treatment. The total area of bituminous surface treatment work was 1,034,470 sq. yds., requiring 334,377 gals. or 14,435,347 lbs. of bituminous material. Gravel cost per ton delivered on the street $2.14 and the average cost of trap rock chips per ton was $2.30.

TABLE I.—DETAIL COSTS OF BITUMINOUS SURFACE TREATMENT WORK, PHILADELPHIA BUREAU OF HIGHWAYS, 1914.

	Average per sq. yd.		—Average labor cost per sq. yd.—					Average mat. cost per sq. yd.			Av. total cost per sq.yd.	Average total cost per sq. yd. 1st and 2d treat.	
	Gal. bit. mat.	Lb. cov'g mat.	—Sweeping.— Hand.	Mach.	Chip'g.	Clean. up.	Total labor.	Bit. mat.	Cov'g mat.	Total mat.		1914.	1913.
Refined coal tar, heavy (Tarvia A), 1st treatment	.464	16.2	.0051	.0017	.0046	.0026	.0140	.0373	.0175	.0548	.0688	.0641	.0824
Refined coal tar, heavy (Tarvia A), retreatment..	.291	15.6	.0033	.0009	.0112	.0024	.0182	.0244	.0167	.0411	.0593		
Refined coal tar, light (Tarvia B), 1st treatment.	.389	15.7	.0069	.0024	.0067	.0047	.0207	.0258	.0168	.0426	.0633	.0566	.0658
Refined coal tar, light (Tarvia B), retreatment...	.314	14.6	.0044	.0011	.0055	.0034	.0144	.0200	.0155	.0355	.0499		
Refined water gas tar, light (Ugite), 1st treatment	.299	16.3	.0030	.0004	.0039	.0026	.0099	.0248	.0171	.0419	.0518	.0509	.0698
Refined water gas tar, light (Ugite), retreatment.	.301	13.4	.0034	.0006	.0067	.0003	.0110	.0239	.0149	.0388	.0500		
Asphalt cutback, 1st treatment..................	.346	17.5	.0057	.0021	.0061	.0042	.0181	.0420	.0188	.0618	.0799	.0738	.0868
Asphalt cutback, retreatment.....................	.297	18.5	.0026	.0014	.0057	.0039	.0136	.0309	.0223	.0532	.0677		

Table I gives the square yard costs. The costs per gallon applied were:

	Cts.
Tarvia A	8½
Tarvia B	7
Ugite, cold	8
Ugite, hot	9

Studies in Stream Flow Measurements.—From studies of the variation in the flow of streams it has been concluded that the flow of any stream which is to be used for any purpose should be known for at least five years, and that the value of the records of the flow of any stream increases practically in direct ratio to the length of the records up to about 20 or 30 years. If the flow of all streams having 100 square miles or more of drainage area were known for a 10 to 20 year period and a certain number for longer periods, there would be no problem relating to the flow of streams which could not be definitely, economically, and safely solved. The greater part of the controversy in regard to which plan is best adapted for the control of floods is due almost wholly to the lack of data in regard to the habits and the eccentricities of the streams involved.

A careful investigation of the number of gaging stations needed for a detailed study of the stream flow in the Ohio basin exclusive of Cumberland and Tennessee Rivers indicated that there should be at least 350 gaging stations maintained simultaneously for a period of about 10 years, for the purpose of obtaining full data for use in determining every factor with relation to the floods in the Ohio River basin and how they may best be controlled. At present some 60 stations are being maintained. Until detailed information is available, opinions as to the best general method of flood control in the Ohio basin must be based on preconceived ideas and are without the foundation of facts which should be available to prove their truth or falsity.

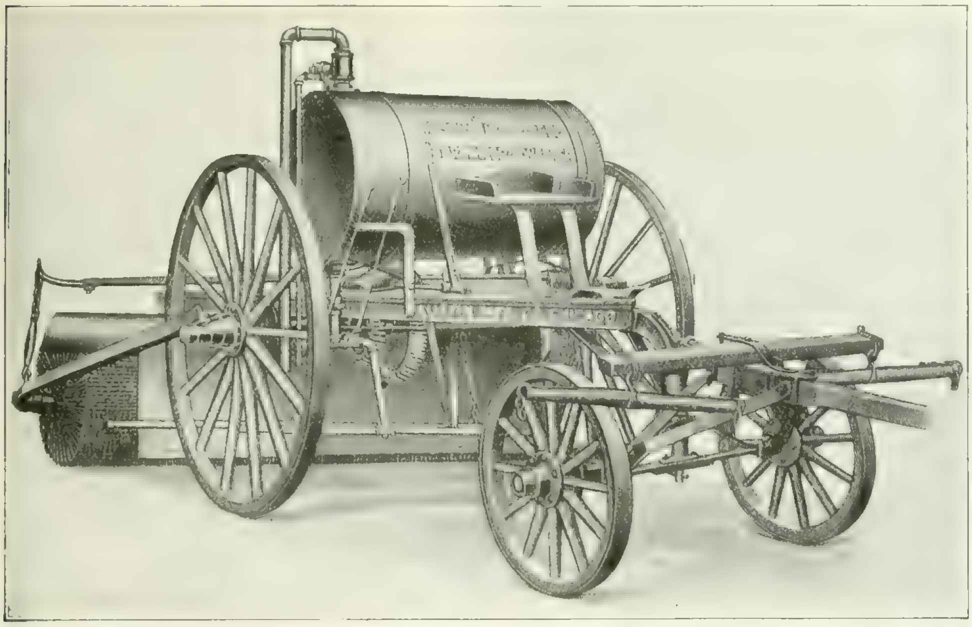
CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A Combined Sweeper and Sprinkler for Street Cleaning.

(Contributed.)

The illustration shows a rotary sweeper combined with a water spray for laying the dust. Besides the regular rotary sweeper features the new machine has a double speed broom covered with a steel housing and capable of being thrown into high or low speed by a lever. A tank on top of this sweeper and fitted with filling hose and overflow pipe carries the water for sprinkling. Water is sprayed just ahead of the broom through either or both of two perforated pipes. Valves controlling the spray are at the right hand of the driver. All parts of the spray arrangement from the tank down are made of brass.



Combination Two-Speed Rotary Sweeper and Sprinkler.

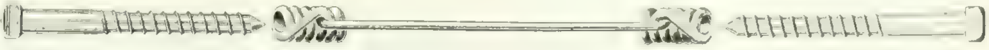
It is claimed by the manufacturers that the variation possible in the speed of the broom is of great value, because on machines not so fitted, the surface speed of the broom decreases as its diameter is reduced, with a corresponding loss of cleaning efficiency, but with this machine the broom can be run at high speed after it has worn down, and the maximum capacity retained until it is entirely worn out. Also there are some streets in every town that get much dirtier than others, and with the old style one-speed broom sweepers the cleaning of such streets has been difficult. They had to be gone over several times, or the team was speeded up to increase the speed of the broom, but this latter method defeated its own ends, because while the revolutions of the broom were increased the rate of travel was faster and the capacity of the broom was no greater. The two-speed broom sweeper meets such a condition perfectly. The team is driven at the regular rate, but the broom thrown into high gear, securing exactly the same results as going over the work several times, but doing it in one trip.

Then there is the spring cleaning to be considered, when all the dirt that has accumulated during the winter must be removed. Formerly, it has been necessary to do most of this work by hand, but by running the broom of this sweeper at high speed with an extra horse if necessary for additional power on this special occasion, it will be possible to greatly reduce the expensive and but partly efficient hand work.

The sweeper and sprinkler is manufactured by the Austin Manufacturing Co., Chicago, Ill.

A New Wall Form Tie and Spacer.

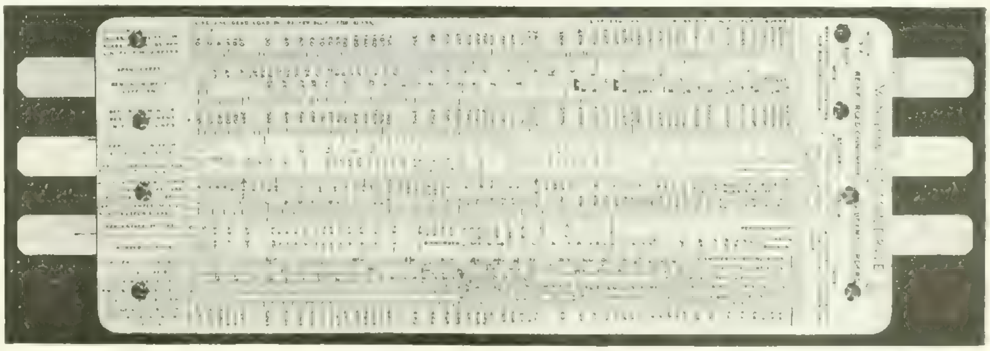
A simple and neat tie and spacer for wall forms and for a variety of other purposes of form anchorage and support is shown by the sketch. The construction and action of the tie is clear from the drawing. The ties are made of steel spring wire in lengths from 6 to 30 ins. and with diameters corresponding to lengths. The ends require standard ⅝-in. lag screw bolts. Bent ties and copper coated or galvanized ties are made to order. This tie is marketed by the Unit-Wall Construction Co., Inc., 1328 Broadway, New York, N. Y.



Wall Form Tie and Spacer.

A Slide Rule for Computing Reinforced Concrete Beams and Slabs.

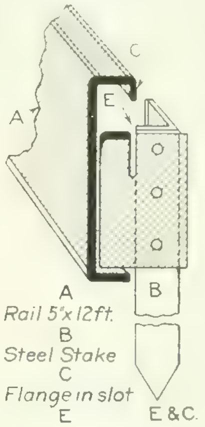
A new slide rule for computing reinforced beams and slabs having single reinforcement has just been placed on the market. This rule, which is shown in the accompanying illustration, covers: Spans from 6 ins. to 70 ft.; loads from 10 to 100,000 lbs.; bending moments from 100 to 1,000,000 ft.-lbs.; various kinds of reinforcement, including rods, triangular mesh, expanded metal, etc.; percentages of reinforcement ranging from 0.01 to 5 per cent; and various concrete and steel stresses in common use. The device is 4 ins. x 10 ins. x 3/16 in. thick; it is made of hard fiber, waterproofed, and weighs about 4 ozs. The scope and application of the rule is explained fully, by a set of instructions which accompanies each rule. The device was invented by Benjamin E. Winslow; its mechanical construction was designed, and the rule is manufactured, by Henry W. Tomlinson, 66 E. Van Buren St., Chicago. Mr. Winslow is also the inventor of a slide rule for designing steel and wooden beams.



Winslow's Concrete Computing Slide Rule.

A Steel Side Form for Concrete Road Construction.

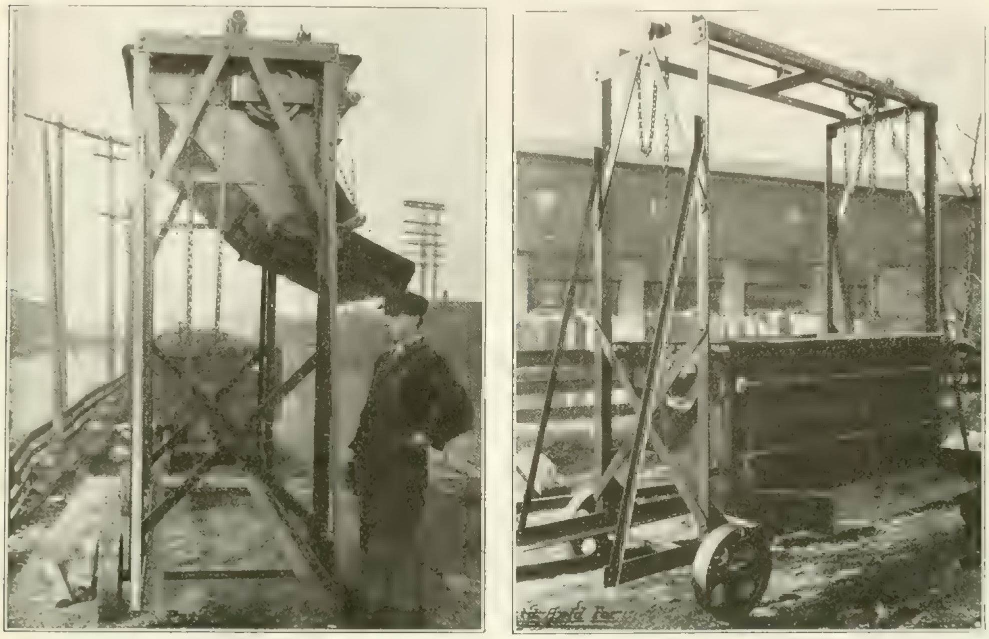
The steel road form illustrated is made in 12-ft. standard length sections and in 5 and 6-in. depths. The steel rails are made of high carbon, open hearth steel with right angle bent flanges on the top and bottom. In setting up, the steel stakes are driven in the ground and the rails placed, a patented sleeve connection serving to fasten them securely together. No hammer or bolts are required. Rails are readily taken up at any point along the job to permit a wagon to pass through. The forms are manufactured by the Heltzel Steel Form and Iron Works, Warren, Ohio.



A Steel Side Form for Concrete Roads.

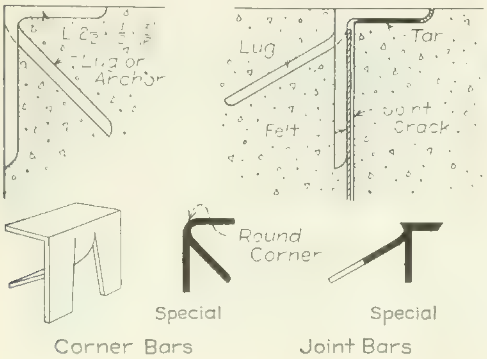
A Portable Variable Height Wagon Loader for Contractors.

With the increased use of motor trucks and the greater consideration, in horse hauling, of the importance of reducing time waiting for load to be received, mechanical wagon loaders are becoming of great importance. The accompanying illustrations show in two positions a new wagon loader designed by Mr. Frank J. Monahan. A thoroughly braced four-leg frame 10 ft. high carries inside a bin or hopper of No. 10 gage steel fitted with gate and chute. The bin is suspended from the frame top by a chain hoist by which it can be elevated and lowered and adjusted to any height desired between top and bottom. The two illustrations show the bin at its highest and lowest positions. The chain hoist has a capacity of 4 tons and the bin holds 2 cu. yds. The loader is, however, made of any capacity, height, etc., that the user may desire. The wheel mounting makes the loader portable, a handle is provided for hauling. When the bin is at the top it is the right height to be shoveled into from a gondola car. At its lowest point it can be shoveled into directly from stock pile, and, when filled, quickly hoisted high enough to discharge into wagons. The gate and chute are operated by a hand wheel which permits control of the discharge. This loader is marketed by William Heggie, Joliet and Crowley Aves., Joliet, Ill.


Elevating Bin Portable Wagon Loader in High and Low Positions.

Corner Bars and Joint Bars for Concrete Construction.

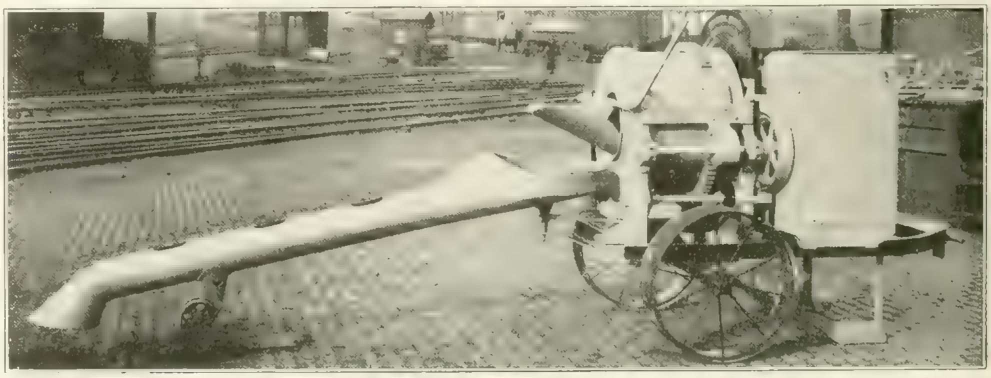
The protection of concrete columns and curb corners and of joints in pavement and bridge floors calls frequently for steel armoring. In the accompanying sketches are shown corner and joint bars of several forms. As shown by the sketch one leg of the bar is cut at intervals so as to form a tongue or lug which anchors the bar to the concrete. Stock bars are made of soft steel angles 2½x1½x3/16 ins., weighing about 2½ lbs. per foot, with lugs every 6 ins. clear, and are furnished in a variety of lengths. These bars are made by the Universal Concrete Bar Co., 167 W. Washington St., Chicago, Ill.



Corner and Joint Bars for Concrete Work.

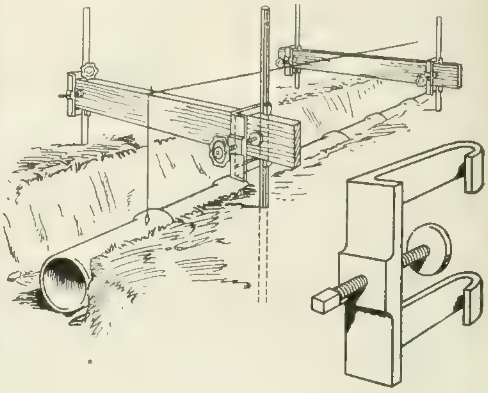
A Mixer and Grouter for Paving Work.

Grout filler for brick and block pavement has been always mixed by hand and grout mixing boxes of various shapes and degrees of portability have been frequently described. A machine substitute for the grout mixing box, grout pouring buckets, scoops and hoes is illustrated here. It consists, as will be seen, of a drum mixer which discharges into a swinging chute which spreads the grout over a wide area without moving the mixer. The mixer is of the non-tilting drum type operated by a housed in 2 hp. gasoline engine, all mounted on wheels for ready transportation. All parts of the machine are steel. The drum is gear driven. The bottom of the chute end is a circular plate perforated with 30 holes 1 in. in diameter. The dimensions of the mixer are: Height 5½ ft. and width 51 ins; it weighs 1,000 lbs. The five point support gives great rigidity and all details are strong and durable. This mixer is made by the Marsh Capron Mfg. Co., 467 Old Colony Bldg., Chicago, Ill.


A Grout Mixer and Distributor for Paving Work.

An Adjustable Grade Board and Clamp for Scaffolding.

The sketch here shows an adjustable grade board outfit that offers several claims of advantages compared with the usual construction of stakes with nailed cross boards. In the outfit shown the uprights are steel rods or pipes to which the grade board is held by special clamps. These clamps will take any board 6 ins. wide up to 2 ins. thick; 1-in. diameter uprights are used. The illustration shows clearly the method of attaching the clamps and boards. With these clamps runways for barrows and elevated mixing boards can be quickly made. The outfit is particularly useful when hard streets offer difficulties in driving stakes. There is no waste by nailing of boards and the several parts can be used many times. These clamps are listed at $22 per dozen by the inventor, Russell H. Peck, World Bldg., New York, N. Y.


Adjustable Grade Board Outfit for Pipe Laying.

Gas and Electric Rate Schedule.—One of the most far-reaching orders that has been issued in years by the New York State Public Service Commission in the Second District requires the rate schedules of all gas and electric corporations and all municipalities subject to the regulation of the Commission to be filed in the Commission's office, and also to be kept in convenient form for the inspection of customers at all offices of such corporations and municipalities where contracts for service are made, or payment for services received.

This order follows out the plan of the Commission in regulating other corporations under its control, and requiring the fullest publicity of all rate schedules in order to prevent discrimination. The order specifies that the rate schedules are to be printed in uniform style and that when asked for by a customer the person having charge of them in the corporation's office shall give all necessary assistance in gaining information therefrom. The schedules include not only rates, present or proposed, but regulations for service and privileges and facilities under each rate.

Engineering and Contracting

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Editorial on the scarcity of data and literature on the work of scroll case and draft tube form construction, and calling attention to an article in this issue describing one installation. E. & C., Mar. 24, 1915; ⅔ col.

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Comments on the system proposed by the Bureau of Highways of Philadelphia to charge rental for the use of streets by contractors for stock piles, etc., and to use the money so earned for street repairs. E. & C., Mar. 24, 1915; ⅓ col.

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Construction Plant and Methods for Concrete Work on the Lock Twelve Dam, Coosa River, Alabama................. 260

Describes the construction of concrete work on the dam, giving details as to construction plant, storage and care of materials, forms used, handling and placing of concrete, etc. E. & C., Mar. 24, 1915; 15 cols.

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Design, Cost and Operation of New Sewage Treatment Plant at the State Hospital, Warren, Pa..................... 265

Describes and illustrates features of design comprising pumping station, Imhoff tank, dosing chamber, percolating filter, chemical house, secondary settling tank, and sand filters for sludge. Fully describes and illustrates the operation of the automatic "hypo" feeding apparatus. Shows analytical results of operation. Gives unit contract prices. E. & C., Mar. 24, 1915; 7 cols.

SANITARY SURVEY: Vincennes, Ind.; Results of.

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Describes methods of making survey and records and discusses results obtained. Population 17,000. City has filtered public water supply and most complete sewerage system in state. There are 3,989 residences, 3,229 privies and 187 cesspools; 3,000 wells used for drinking water supply and 24.7 per cent were found polluted. E. & C., Mar. 24, 1915; 1 col.

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A discussion by C. B. McCullough of the various factors influencing the design of concrete highway bridges, particularly standard types. Gives specific data and diagrams showing the effect of stream behavior, loadings, temperature stresses, etc., and illustrates some standard types of the Iowa Highway Commission. E. & C., Mar. 24, 1915; 7½ cols.

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Design of the Reinforced Concrete Cantilever Bridge on Runnymede Ave., Cincinnati, Ohio 271

Describes and illustrates in detail the design of a reinforced concrete cantilever bridge consisting of a 65-ft. clear center span and two 32-ft. 6-in. anchor spans. The bridge, which possesses some unusual features, crosses West Fork Creek on Runnymede Ave., Cincinnati, O. E. & C., Mar. 24, 1915; 6 cols.

RESERVOIR, WATER WORKS: Relining, Concrete and Asphalt over Brick.

Method of Relining a Small Brick-Lined Water Works Reservoir with Asphalt and Concrete at Irwin, Pa............... 273

Illustrates details of design and shows nine views of various features of the construction. E. & C., Mar. 17, 1915; 5½ cols.

WATER WASTE SURVEYS: Continuous, Washington, D. C.

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Shows effect and rapidity of action when one part of copper sulphate was added to 3.36 million parts of water in two of the Hartford, Conn., reservoirs. E. & C., Mar. 24, 1915; ⅓ col.

PAVEMENTS: Economic Point of Renewal.

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Gives table and charts and discusses the life, cost of repairs and point at which pavement renewal becomes economical. E. & C., Mar. 24, 1915; 6½ cols.

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Association of Commerce Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Power Lawn Motors.—Sales agent in Canada wishes names and addresses of manufacturers of power lawn rollers. No. 15984. [For address see first paragraph.]

Engines.—Firm in Russia desires to purchase small alcohol, benzine, or kerosene engines for boats, etc.; mountings for central heating and water supply; and crank shafts, etc. Correspondence should be in the Russian or German language. Prices, etc., should be stated in Russian equivalents, and quotations should be c. i. f. Russian ports. No. 15958. [For address see first paragraph.]

Clay-Working Machinery.—Business man in Latin America desires to receive catalogues, prices, and full information relative to machinery for making clay products. Correspondence, catalogues, etc., should be in Spanish. No. 15965. [For address see first paragraph.]

Railway Supplies, Etc.—Government contract agent in Europe desires to communicate with American manufacturers and exporters of railway supplies and equipment, including machinery and locomotives. Prompt replies are requested. Correspondence should be in the Italian language, and weights, measurements, etc., should be in the metric system. Prices should be quoted in gold lire, f. o. b. destination. Reference is given. No. 15967. [For address see first paragraph.]

Pumps, Road-Making Machinery, Etc.—Engineer in Russia desires to get in touch with American manufacturers of electrical and plumbing supplies, pumps, boilers, road-making machinery, fire engines and extinguishers, stump-pullers, and material for municipal laundries and bathing houses. Correspondence may be in English. No. 15991. [For address see first paragraph.]

Street Sweeper and Flusher.—Canadian city may purchase street sweeper and flush cart. No. 15993. [For address see first paragraph.]

Brick Making Machinery.—Russian firm wishes catalogues and price lists of brick-making machinery, together with estimates for a complete plant, including automatic transportation devices. Correspondence should be in Russian or German. Prices, etc., should be stated in Russian equivalents, and be made c. i. f. Russian ports. No. 15999. [For address see first paragraph.]

Motor Trucks.—American consular office in Central America reports an opportunity to sell automobile trucks. No. 16011. [For address see first paragraph.]

Grain Elevators and Refrigerating Machinery.—Mechanical Engineer in South America is desirous of securing prices and full information relative grain elevators and refrigerating machinery. Correspondence, catalogues, etc., should be in Spanish. No. 16015. [For address see first paragraph.]

Motor Trucks.—Firm in Southern Europe wishes catalogues, price lists, etc., of motor trucks. No. 16022. [For address see first paragraph.]

Iron Pipes, Etc.—A merchant in one of the neutral European countries wishes to represent American manufacturers and exporters of foundry pig iron, sheet metal, malleable iron, and pipes for gas and water conduits. He wishes to represent on a commission basis. No. 16020. [For address see first paragraph.]

Pipe, Turbines, Etc.—Firm of Agents and importers in Russia wishes to represent American manufacturers of textile machinery, laundry and ventilating machinery, malleable fittings and pipes, steam and water turbines, electrical machinery, etc. Correspondence may be in English. Prices, etc., should be stated in Russian equivalents and quotations should be made c. i. f. Russian ports. No. 16016. [For address see first paragraph.]

Water Pipes, Etc.—City in South America is contemplating replacing the old earthen water tubes in use in the city water-supply system. It is believed there will be an opportunity for American firms to secure business in connection with this work. (No. 16030. [For address see first paragraph.]

Railway Supplies.—An American consular officer in the Far East has transmitted specifications for the following railway supplies: Fire-box steel, boiler tubes and staybolt iron, brushes, copper wire, tube-hole liners, files, hammers, spanners, oilers, feeders, buckets, and cans. The specifications may be examined at the Bureau of Foreign and Domestic Commerce or its branch offices. No. 16000.

Shovels.—Business man in Canada desires to establish commercial relations with American manufacturers and exporters of shovels. No. 15991. [For address see first paragraph.]

Harbor and Port Construction.—An American consular officer in the Near East has transmitted a detailed report and drawings relative to harbor and port improvements which are to be undertaken in the near future. Copies of the full report and the drawings may be inspected at the bureau and its branch offices. No. 15998.

INDUSTRIAL NOTES

The Terry Steam Turbine Co., Hartford, Conn., has opened an office in the Michigan Trust Bldg., Grand Rapids, Mich., in charge of Mr. A. L. Searles, to cover the southern peninsula of Michigan. The Chicago office of the Terry Co. is now in charge of Mr. A. W. de Revere, and located in the Peoples Gas Bldg.

Among the contracts recently awarded the Raymond Concrete Pile Co. of New York & Chicago, are the following: Placing Raymond concrete piles in the foundation of apartment building for Nels Gross, Delaware Place, near Seneca St., Chicago, Ill. Wm. Ernest Walker, architect. Building marine railway at the plant of the Maryland Steel Co. of Sparrows Point, Md. Placing concrete piles for the Hardy Apartment at 200 E. Delaware Pl., Chicago, Ill. Chatton & Hammond, architects; McLennan Construction Co., contractor. Placing concrete piling for the foundation of the Union National Bank Bldg., Cleveland, O. Walker & Weeks, architects; Crowell-Lundoff-Little Co. general contractors.

NEW CATALOGUES

Concrete Mixers.—Paper, folder; T. L. Smith Co., 1125 32nd St., Milwaukee, Wis.

Folder describing the Smith Mixerette, with views of the machine and equipment. Gives weight, capacity, price, etc.

Galvanized Conduit.—Paper, 4x9 ins.; 8 pp., Sprague Electric Works, New York City.

Description, price list and list of installations of "Greenfielduct," a hot galvanized conduit made from an especially selected soft, mild steel.

Punching and Shearing Machine.—Paper, 8½x11 ins.; 4 pp., Joseph T. Ryerson & Son, Chicago.

Bulletin No. 11,101, describing Ryerson quintuple combination punching and shearing machine. Illustrated.

Metal Coating.—Paper, 6x9 ins.; 8 pp. Hess & Son, 1031 Chestnut St., Philadelphia, Pa.

Describes "Epicassit," a metallic protective coating for metal articles or structures of all kinds. Describes the various brands and gives instructions for application.

Wire Rope.—Paper, 3½x6 ins.; 94 pp. A. Leschen & Sons Rope Co., St. Louis, Mo.

Catalogue No. 35, containing tables and data relative to wire rope and aerial wire rope tramways. Gives considerable general information on the uses of wire rope for logging, cableways, power transmission, etc. Illustrated.

Wire Rope.—Paper, 8x10 ins.; 16 pp., A. Leschen & Sons Rope Co., St. Louis, Mo.

Exposition number of "Leschen's Hercules," devoted to the Panama-Pacific Exposition, and describing some instances in which Leschen wire rope was used in installing exhibits.

Oxyacetylene Welding.—Paper, 6x9 ins.; 30 pp. Vulcan Process Co., Minneapolis, Minn.

Catalogue No. 4, describing the Vulcan process of oxyacetylene welding and cutting of metals. Shows the apparatus and gives data relative to the various plants furnished. Tables of weights, pressure, gas consumption, costs, etc., are also included.

Cableways.—Paper, 9x12 ins.; 8 pp. Lidgerwood Manufacturing Co., 96 Liberty Street, New York City.

Bulletin No. 32, "Cableways on Filtration Work," describes and illustrates the installation of Lidgerwood traveling cableways and their work at the Cleveland, Ohio, filtration plant. Also shows a traveling cableway at work on concrete filters at Aspinwall, Pa.

Concrete Atomizer.—Paper, 8½x11 ins.; 4 pp., Harold P. Brown, 124 Liberty St., New York City.

Describes and illustrates a concrete mixer and atomizer designed for mixing and placing concrete by steam ejections, of particular use in repairing walls, or to apply plaster, cement, whitewash and paint, to join old and new concrete, etc.

CATALOGUE REVIEWS

Steel Windows.—Paper, 9x11 ins., loose leaf form, 12 sections; Detroit Steel Products Co., Detroit, Mich.

Catalogue No. 6, describing Fenestra solid steel casements. The book is loose leaf in form, each general subject being discussed in a separate section. The subjects of the 12 sections included in the catalogue are Fenestra Side Wall Sash, Fenestra Monitor Sash, Fenestra Steel Channel Doors, Fenestra Steel Partitions, Fenestra Powerhouse Sash, Fenestra for Textile Mills, Fenestra Detention Sash, Fenestra Underwriters' Sash, Fenestra for School Buildings, Detroit and Fenestra Solid Steel Casements, Fenestra Erection and Glazing, Fenestra Installations.

A complete index to all the sections, a general explanation of the uses and advantages of Fenestra, a history of its origin, and a list of the types of construction included in the Fenestra line, appear in the first section. Each section is fully illustrated with half-tones and line cuts showing construction details, standard sections, etc. Considerable tabular data as to sizes, weights, spacing, etc., are also given. Section 11 consists of directions for handling and installing Fenestra, and Section 12 of photographic reproductions of many typical installations.

Concrete Reinforcing.—Paper, 4½x7 ins., 48 pp., American System of Reinforcing, 10 S. La Salle St., Chicago, Ill.

Handbook of Concrete Construction, outlining briefly the methods of design used by the engineering department of the above company. Explains the advantages of the "Unit System" over "Loose Bar Construction," theory of design, general design of slab and beam, column design, "Unit Frames" for concrete beams and girders, "Unit Spirals" and the advantages of the American system of reinforcing. Gives information on structural steel fireproofing, the "American" bar, less than carload shipments, etc.

The tables give areas of columns, rods, bars, fabric for roads, safe loads for spiral columns, slab thickness and reinforcing, tests of "Unit" spirals, weights and extras of "American" bars, "Unit" fabric for concrete slabs, etc. The little book is well illustrated with views of construction work or completed structures in which "Unit" frames for concrete beams, "Unit" spirals for concrete columns, "Unit" fabric for concrete slabs or the "American system" throughout, has been used.

CURRENT NEWS

The Doings of the Week.

No developments affecting adversely the industry and commerce of the country took place during the past week. The steady but slow advance of business activities continued. Progress was made in railroad financing and large additions were made to new security issues. A number of municipal bond issues found ready markets. The excess of exports for the week ended March 13 exceeded $47,000,000, which is the largest balance in favor of the United States ever produced by a single week's foreign trade. There were distinct indications of sustained recovery in the leading industries, in building construction and in general merchandising. All in all the developments of the past week were such as support confidence in a coming period of activity. In the construction field there was no slowing up. Many undertakings of importance reached the call for bids stage, many good sized contracts were placed, and much new work made its appearance. State, county and township highway construction is furnishing many opportunities for contractors. Municipal paving work is opening up in good shape and state and county bridge jobs are abundant. Large construction jobs in the waterworks and sewerage fields have been few as yet. Many small municipal undertakings in these lines, however, are now being advertised, and prospects are good that some of the larger work will be ready for contractors in the near future. In the Iron and Steel Trade the improvement of previous weeks has continued. *The Iron Age* reports that the scale of mill operations for the entire steel industry is around 60 per cent. During part of last week the Steel Corporation's steel ingot plant was working at 69 per cent. Structural and bar business is increasing. The Steel Corporation has announced its intention of building a new steel tie plant at Homestead, and also will undertake important improvements at New Castle. Rail buying has been light but ship building has furnished much business to the plate mills. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending March 17 were as follows:

Finished Iron and Steel.	Mar. 17.	Mar. 10.
Per Lb. to Large Buyers—	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia	1.15	1.15
Iron bars, Pittsburgh	1.10	1.10
Iron bars, Chicago	1.10	1.10
Steel bars, Pittsburgh	1.15	1.15
Steel bars, New York	1.319	1.319
Tank plates, Pittsburgh	1.10	1.10
Tank plates, New York........	1.269	1.269
Beams, etc., Pittsburgh	1.15	1.15
Beams, etc., New York......	1.269	1.319
Skelp, grooved steel, P'gh...	1.10	1.10
Skelp, sheared steel, P'gh...	1.15	1.15
Steel hoops, Pittsburgh	1.25	1.25
Sheets, Nails and Wire.		
Per Lb. to Large Buyers—		
Sheets, black, No. 28, P'gh.	1.80	1.80
Galv. sheets, No. 28, P'gh...	3.40	3.40
Wire nails, Pittsburgh......	1.60	1.60
Cut nails, Pittsburgh........	1.55	1.55
Fence wire, base, P'gh......	1.40	1.40
Barb wire, galv., P'gh......	2.30	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 cts.

Railways.—The railroads, as far as the beginning of new construction is concerned, are still watchfully waiting—and so are the contractors. Nothing has developed during the past week that would indicate that the carriers were ready to give out any large amount of work. The Chicago & Northwestern Ry. has awarded about $150,000 worth of bridge work on various parts of its system. The Cleary-White Construction Co., Chicago; Widell Co., Mankato, Minn., and the Koss Construction Co., Des Moines, Ia., secured the contracts. The Illinois Central R. R. will award a contract early this week for 6 miles of line near West Frankfort, Ill. The Ohio Valley Traction Co., Portsmouth, O., was to let contracts Saturday for a 21-mile extension. The Public Service Commission of the First District, New York City, is calling for bids on another section of the Dual System of Rapid Transit. About 20 more sections of this improvement are yet to be placed under contract, and it is hoped to advertise them all within six months.

Roads and Streets.—A great deal of work in the state and county highway improvement fields is now being advertised for bids. California is asking proposals on 6 contracts aggregating 29 miles of road; Ohio opens bids April 2 on 20 construction contracts and two repair jobs; Illinois is calling for bids on 7 contracts. New Jersey, Ohio and Washington counties also are asking proposals on several road jobs. In the municipal paving field a large number of jobs reached the call for bids stage last week. Houston, Tex., opens bids April 12 on a contract estimated to cost $187,000. Eagle Grove, Ia., is calling for bids on 52,000 sq. yds. of pavement; Walla Walla, Wash., on a $90,000 job; Phillipsburg, N. J., on a 61,000 sq. yd. contract, and Cumberland, Md., on 57,000 sq. yds. The road and street contracts let recently include: A $95,000 job at Moline, Ill.; a $142,000 job at Topeka, Kan.; a large amount of work at Wilkesbarre, Pa.; a $100,000 road contract in Nez Perce County, Idaho. The McNichol Paving & Construction Co., Philadelphia, at $151,591 was low bidder March 16 for improvement of Parkway at Philadelphia.

Bridges.—A considerable amount of small bridge and culvert construction is now being advertised for proposals. No especially large undertakings in this field, however, appear to have reached the call for bids stage during the past week. One Iowa county is calling for bids on 75 reinforced concrete bridges and culverts. Several other counties also are asking proposals on groups of small bridges and culverts. The Chesapeake & Ohio R. R. has finally financed the bridge to be erected at Sciotoville, O., and has awarded the contract for 15,000 tons of steel.

Waterworks.—No particularly large undertakings in the waterworks field appear to have come up for advertising during the past week. Bids are being asked by several cities for the supply of pumps, pipe, and other supplies. Union, S. C., is calling for bids for an extension requiring 21,000 ft. 8-in. pipe; Laramie, Wyo., is asking proposals on an 18,000-ft. extension; Morning Sun, Ia., opens bids April 5 for waterworks to cost $25,000. Cleveland, O., has awarded a $272,000 contract for a filtered water reservoir; Salem, Mass., let a $51,000 job for additional work for supply from Ipswich River; Holton Kan., awarded contracts for waterworks extensions and Chillicothe, Mo., placed contracts for a new water system.

Sewerage.—Grinnell, Ia., is asking bids on 69,000 ft. of sanitary sewers; Butte, Mont., is readvertising the construction of 13 miles of sewer; York, Pa., opens bids April 2 on a sewage disposal plant to cost $90,000. Roundup, Mont., is asking proposals on 20,000 ft. of sewer; Salem, O., on 52,000 ft., and Fitchburg, Mass., on 3,400 ft. of main intercepting sewer.

Railway Legislation.

When state legislatures convene the open season for the railways begins. They are a shining target and any statesman who wishes may take a shot at them. Of late there has been some let-up in the amount of legislation aimed at the common carriers. But they are still a favorite subject for the law makers and no legislative session is considered complete without the passage of a few acts that affect the treasuries of the railroads. Some person with a sharp pencil has figured out that 14 bills now before the Minnesota legislature, if they all become laws, will cost the railroads operating in that state $7,000,000 the first year. In addition there is a bill providing for the establishment of the municipal depot at Minneapolis, calling for an expenditure of $17,000,000 and annual maintenance charges of $1,600,000. There are 47 other state legislatures in this country and in each one of them some representative or senator has a pet bill for reducing the revenues of the railroads. This is one of the reasons for the dullness in the railway construction field.

Highway Construction.

The highway construction season is beginning. New York opens bids in a few days on its first letting of the year. Ohio is calling for proposals on 22 contracts estimated to cost $600,000. California is asking estimates on 29 miles of state highway. Connecticut and Massachusetts are beginning to show signs of activity and Maine soon will ask bids on the first roads in its 1915 construction program. The Highway Commissioner of Arkansas estimates that $5,000,000 or $6,000,000 will be expended this season on road work in that state. North Carolina has a highway commission and the legislature of that state at its last session helped matters along by passing some 100 bills affecting road improvements in the various counties and townships. The legislature of Washington appropriated $6,000,000 for highway construction and maintenance during the next two years. Illinois already has awarded contracts for two highway lettings and is now taking bids on the third. Reports from all sections of the country indicate that there will be great activity in highway construction during the present year. A record-breaking amount of road work will be undertaken during the next few months by states, counties, townships and districts.

Idle Team Outfits.

The idle team outfit is a serious proposition for its owner. Mules are so peculiarly constructed that they insist on their daily rations even when they are not earning their feed. The contractor with a steam shovel plant can sit tight and wait until something turns up. He doesn't have to fork out hay and pass around grain. The contractor with the team outfit, however, must hustle around for another job, for even a short period of idleness means the eating up of the season's profits. Very little railroad grading is underway at the present time and as a consequence many contractors have had to hunt another paymaster. Government irrigation developments are furnishing work for many team outfits. Others are employed in levee construction and in drainage ditching. Some contractors, who in the past engaged only in railway grading, have now taken up the construction of earth, sand-clay and gravel roads in southern states. Other contractors are taking subcontracts for the hauling of materials for use in road building. Several contractors have secured good contracts from real estate firms for grading for new subdivisions. One man with a 10-team outfit kept busy in grading lots for building contractors.

Arbitration Clause in Contracts.

After many years of agitation and two years of determined effort, building contractors have secured more equitable contract conditions. On March 8 the Joint Committee of the American Institute of Architects and the National Association of Builders' Exchanges ratified the contract documents that have been under consideration by these two organizations for the last two years. The new documents provide for arbitration of all matters in dispute and make many other changes that have heretofore perceptibly increased the cost of erecting buildings. The new form of contract in eliminating drastic arbitrary powers that existed in documents governing building construction will prove of great benefit not only to contractors but also to the owners.

HIGHWAY CONSTRUCTION IN ILLINOIS.

Details of Work Contemplated in 24 Counties.

Earth Roads—Gravel—Macadam—Brick—Concrete.

The first contracts under the state aid law in Illinois were let early in July of 1914. During the period from July 1 to Dec. 1 contracts covering approximately 100 miles of state-aid roads were let. Of this total about 80 per cent were concrete and 20 per cent brick on a concrete base. These contracts called for work in 48 of the 102 counties of the state. It is estimated that of the contracts placed last year some 75 per cent of the work had been finished before weather conditions necessitated a shutdown, leaving about 25 per cent to be completed this spring. For the present season plans already had been prepared on Feb. 1 for the construction of roads and bridges in 28 additional counties, and this work will be carried on in the spring and summer of 1915. Plans also were under way for work in 17 other counties. In all probability 93 counties will avail themselves this season of the state aid allotments of the Highway Commission. It is expected that the expenditures in 1915 from the appropriation of the 48th General Assembly will be approximately the same as were made in 1914.

The following table from Illinois Highways shows the sections of state-aid highway that have been completed and accepted by the state previous to Feb. 1, 1915:

County.	Sec.	Type.	Miles.	Total cost.
Sangaman	B	Concrete	0.63	$ 7,537
Sangamon	D	Concrete	0.62	6,651
Champaign ...	C	Brick	1.33	18,539
Edgar	A	Brick	0.98	14,896
Cass	A	Concrete	0.74	6,901
Iroquois	B	Concrete	2.52	22,785
Sangamon	C	Concrete	0.45	6,664
Tazewell	A	Concrete	0.81	9,825
Will	A	Concrete	1.87	19,903
Bond	A	Brick	0.38	9,685
Cook	A	Concrete	0.50	6,917
Cook	B	Concrete	1.34	19,501
McHenry	A	Concrete	0.49	5,963
Sangamon	E	Concrete	0.63	7,705
McHenry	B	Concrete	0.28	3,571
Livingston	A	Concrete	2.37	26,240
Sangamon	A	Concrete	0.63	6,493
Tazewell	C	Concrete	0.44	4,152
Clay	A	Concrete	0.70	6,289
Douglas	B	Brick	0.48	6,008
Cook	E	Concrete	3.68	65,808
Kankakee	A	Concrete	1.79	22,682
Menard	A	Concrete	0.44	6,207
Total			24.10	....

The first state-aid road letting for 1915 was held on Feb. 23, when bids were opened for seven sections of highway. These sections and the contract price were as follows:

County.	Section.	Route.	Type.	Length, ft.	Contract price.*
Cook	G	3	Concrete	12,957	$27,070
Madison	A	1+11	Brick	9,000	29,893
Winnebago .	B	11	Concrete	6,200	14,400
Winnebago .	A	10	Concrete	5,280	10,947
Whiteside ..	B	1	Concrete	4,400	......
Whiteside ..	C	1	Concrete	2,000	†10,888
Alexander ..	A	1	Gravel	5,100	5,448

*Exclusive of cement, which is furnished by state. †For Sections B and C.

The second letting was held on March 10, at which time bids were opened on four sections of highway. The sections and the prices at which the work was let were as follows:

County.	Section.	Route.	Type.	Length, ft.	Contract price.*
Monroe	A	1	Concrete	1,900	$ 2,300
Union	A	1	Gravel	3,200	†
Bureau	A	7	Concrete	4,000	......
Bureau	B	4	Concrete	3,928	‡12,866

*Exclusive of cement, which is furnished by state. †Not let. ‡Combined brick for Bureau A and B.

The third letting of the present year is now being advertised. This work, bids on which will be opened March 31, comprises the following:

County.	Section.	Type.	Length, ft.	Engineer's estimate of cost of work, exclusive of cement furnished by the state.
Morgan .	A	Concrete	4,468	$10,529
Clinton	A	Concrete	5,550	9,598
Effingham ..	A	Concrete	7,560	9,276
Piatt	A	Brick	5,000	13,106
Peoria	B	Concrete	10,452	30,458
Union	A	Gravel	3,200	*3,130
Johnson	A	Bridges	†205	*2,760

*No materials furnished by state. †Cu. yds. reinforced concrete.

Several counties in the state also will start work this season on highway improvements to be carried out under bond issues. Vermillion County will expend about $1,500,000 for its work. In Cook County a $2,000,000 bond issue was authorized last November for road work.

A tentative outline of the road work proposed for this season in 24 Illinois counties is given in Table I. Further details regarding these improvements follow: Alexander County has $36,000 available for highway purposes and will repair 50 miles of earth road and construct 3 miles of gravel road. The latter work will be done by contracts, which will be let in August or September. W. N. Moyers, Mound City, Ill., is County Superintendent of Highways.

Boone County has $51,627 available for township work. No construction, however, had been determined on. T. W. Humphrey, Belvidere, Ill., is County Superintendent of Highways.

Bureau County has $43,000 of county and state funds available for state-aid roads. Four miles of concrete road will be constructed, the contracts for which will be let by the State Highway Commission. About $10,000 will be expended by the townships in the county for special gravel construction. Contracts for this will be let about August. The total township road and bridge funds amount to $114,000. This will be expended as the Commissioners may determine. F. R. Bryant, Princeton, Ill., is County Superintendent of Highways.

Champaign County has $8,000 available for construction purposes. About ¾ mile of brick road will be built. Contracts for this will be let in the spring by the State Highway Commission. G. C. Fairclo, Urbana, Ill., is County Superintendent of Highways

Crawford County has $55,000 available for state roads and about $40,000 of road and bridge funds. About 4 miles of gravel road and 6 miles of macadam will be constructed. In addition 4 miles of state-aid road in this county are now under construction, and are about 50 per cent completed. Part of the new work will be done by contract, the lettings to be held sometimes between May and July. J. P. Lyon, Robinson, Ill., is County Superintendent of Highways.

De Kalb County has $129,000 available for construction purposes. It will probably construct 35 miles of gravel road and 8 miles of macadam. Most of the work will be done by contracts, which will be let in the spring. Wm. C. Miller, Sycamore, Ill., is County Superintendent of Highways.

De Witt County has $30,000 available for road purposes. It will construct 2 or 3 miles of new earth road and will carry out the usual amount of repairs and upkeep on earth roads, all work being done by the Township Commissioners of Highways. A new steel and concrete bridge is planned for the highway on the county line between Rutledge and Empire Townships, De Witt and McLean Counties. E. F. Campbell, Clinton, Ill., is temporary County Superintendent of Highways.

Franklin County will have 1½ miles of concrete state-aid road constructed this season. Contracts for the work will be let about June by the State Highway Department. The county has $10,000 available for construction purposes. George F. Benton, Hampton, Ill., is County Superintendent of Highways.

Grundy County has 9,000 ft. of concrete road under construction. The contract for this was awarded on Sept. 29 for $15,489. F. W. Stine, Morris, Ill., is County Superintendent of Highways.

Hardin County has $3,000 available for construction purposes and will grade 10 miles of earth road by force account. W. M. Ball, Elizabethtown, Ill., is County Superintendent of Highways.

Henry County will have probably 2 miles of concrete state-aid highway constructed this year. The contract will be let by the State Highway Department. James H. Reed, Cambridge, Ill., is County Superintendent of Highways.

Iroquois County has $165,262 in its road and bridge fund and $21,200 available for township hard roads. Probably 8 miles of gravel road and about 2½ miles of macadam will be constructed. About 1¼ miles of concrete state-aid road also will be built. Only the latter work will be done by contract. Benj. Jordan, Watseka, Ill., is County Superintendent of Highways.

Jasper County has $7,200 available for bridges on state-aid roads. The work will be done by contract; time for letting has not been determined. S. A. Connor, Newton, Ill., is County Superintendent of Highways.

Kane County has $119,515 available in township road funds. It will construct 40 miles of gravel road and 2 miles of concrete. No contracts will be let. It is also probable that 6 or 8 miles of 18-ft. concrete road will be built by county and state funds as state-aid work. G. N. Lamb, St. Charles, Ill., is County Superintendent of Highways.

Marion County has $14,825 available from joint county and state fund. Of this sum $6,325 will be expended on a 10-ft. concrete road, bids for which will be opened in April or May. The balance will be expended on permanent bridge work. In addition there will be $45,000 of township funds, of which ½ will be spent on permanent bridge work and the remainder on maintenance work on the present roads. Lee S. Trainor, Centralia, Ill., is County Superintendent of Highways.

Mason County has $49,500 available for construction purposes. H. V. Schoonover, Havana, Ill., is County Superintendent of Highways.

Ogle County's probable construction program for 1915 includes 50 miles of earth work, 20 miles of gravel, 10 miles of macadam and 2 miles of brick. The work will be done by contract. The county has $50,000 available for construction purposes. Alex Anderson, Polo, Ill., is County Superintendent of Highways.

Piatt County has $58,868 available for construction purposes. Five miles of brick-paved roads. Lee S. Trainor, Centralia, Ill., is Coun- done by contract. One letting for 1½ miles probably will be held this month. T. J. An-

TABLE I.—HIGHWAY IMPROVEMENTS PROPOSED FOR 1915 IN 24 ILLINOIS COUNTIES.

	Type of road				
County.	Earth, miles.	Grav., miles.	Mac., miles.	Brick, miles.	Conc., miles.
Alexander	50[1]	3	..	..	..
Boone	..	..	..	..	..
Bureau	..	..	..	..	4
Champaign	..	..	..	¾	.
Crawford	..	4	6	..	4[2]
De Kalb........	110	35	8	..	..
De Witt........	3	..	..	..	..
Franklin	..	..	..	..	1¼
Grundy	..	..	..	..	1 4 5[3]
Hardin	10	..	..	..	..
Henry	..	..	..	..	2
Iroquois	..	8	2½	..	1¼
Kane	..	40	..	..	2[4]
Marion	..	..	..	..	?
Mason	?	?	?	?	?
Ogle	50	20	10	2	..
Piatt	..	..	..	5	..
Pulaski	30[1]	1½	..	..	..
Vermillion	..	..	..	..	175[5]
Wabash	..	20	..	..	..
Will	?	?	?	?	?
Whiteside	..	..	..	..	2
Williamson	..	..	2[6]	..	1¼
Winnebago	?	?	?	?	1

[1] Repairs. [2] By state aid, now about 50 per cent completed. [3] Under contract. [4] Probable that 6 or 8 miles additional of concrete will be built as state-aid work. [5] 175 miles of concrete and brick paved roads; will probably build ⅓ of this total this year. [6] Also ½ mile of bituminous work.

derson, Monticello, Ill., is County Superintendent of Highways.

Pulaski County has $17,000 available for construction purposes. It will repair 30 miles of earth roads and will build 1½ miles of gravel road. The latter work will be done by contract, which will be let in August or September. W. N. Moyers, Mound City, Ill., is County Superintendent of Highways.

Vermillion County on Nov. 3, 1914, voted to authorize a bond issue of $1,500,000 for the construction of a system of improved roads in the county. This improvement was outlined in the Jan. 6, 1915, issue of ENGINEERING AND CONTRACTING. About 175 miles of road are to be surfaced with concrete or brick. Most of the surfacing will be concrete. The roads are to be paved for a width of 10 ft. It is planned to spread the work over three years, expending about $500,000 per year. Contracts will be let about June 1. Wm. S. Dillon, Danville, County Superintendent of Highways, is engineer in charge of the $1,500,000 worth of road work.

Wabash County will construct 20 miles of gravel road. A bond issue for this work was voted on Feb. 8. The improvements will be carried out by contract. Guy W. Courter, Mt. Carmel, Ill., is County Superintendent of Highways.

Whiteside County has $19,000 available for state-aid roads and $106,000 for general township work. Two miles of concrete road will be constructed, contracts for which will be let by the State Highway Department. V. N. Taggart, Morrison, Ill., is County Superintendent of Highways.

Williamson County has $26,000 available for construction purposes. Two miles of macadam, 1¾ miles of concrete road and ½ mile of bituminous work will be undertaken. The work will be done by contract. P. B. Wilson, Marion, Ill., is County Superintendent of Highways.

Winnebago County will construct during 1915 1 mile of 18-ft. concrete road and 1½ mile of 10-ft. concrete road. Contract will be let by the State Highway Department. No definite plans have been prepared as yet for the other road work in this county. A. R. Carter, Rockford, Ill., is County Superintendent of Highways.

Woodford County has a total road and bridge tax of $65,000. No new work, however, will be undertaken this season. A. B. Hurd, El Paso, Ill., is County Highway Superintendent.

RECLAMATION OF OVERFLOWED TERRITORY IN SOUTH.

Large Areas of Cut-Over Lands to Be Reclaimed.

Plan for Districts on Big Black River, Mississippi.

Reclamation of overflowed cut-over lands in southern states will during the next few years offer many construction opportunities. With the cutting of the most valuable timber from the swamp and overflowed lands it has become evident that future returns from these acreages must be sought in agriculture. Each year this condition is becoming more prominent in the South. Formerly, heavy growths of valuable timber afforded a revenue from these lands; but with the cutting of this timber the land becomes valueless unless drained and put under cultivation. It is probable that the increasing demand for land for agriculture will in the near future make necessary the reclamation of a good portion of these lands.

Drainage engineers of the U. S. Department of Agriculture have been studying the question and have completed recently an extensive survey of conditions along the Big Black River, Mississippi, with the object of formulating plans for reclaiming overflowed land in that section. This river enters the Mississippi River at a point about 20 miles below Vicksburg, and conditions along it are fairly representative of those that exist in greater or less degree on many southern streams.

Under present conditions from 75 to 100 per cent of the Big Black River bottoms are overflowed to a depth of from 3 to 8 ft. by each heavy rainstorm that lasts from 2 to 3 days and covers the entire watershed. The problem is to restrict the area flooded and to reduce the durations of the overflows by promoting a quick passage of the flood waters through the valley. The plan for ultimate reclamation as devised by the U. S. Drainage Engineers, involves the excavation of a main ditch and laterals in the upper portion of the valley and construction of leveed floodway through the remaining portion. Provision for tributary streams and for interior drainage also is made. To carry out this work, 30 drainage districts having a total area of 96,088 acres are planned.

The estimated cost of the work, exclusive of that of clearing the main floodway, varies in the different drainage districts from $15.72 to $44.36 per acre, the average cost per acre for the 36 districts being $23.06. The engineers recommend that the clearing of the main floodway be done by a separate organization comprising all of the overflowed land below District No. 1, exclusive of that of the floodway itself. On this basis the cost of clearing would be $5.21 per acre benefited. Especial attention is called to the necessity of providing sedimentation areas at the lower extremities of the several tributaries of the river, and of taking immediate steps to arrest the hillside erosion now taking place within the watershed. According to a report by the U. S. Drainage Engineers it is doubtful if conditions in the valley at this time justify the expenditure necessary for the complete reclamation as outlined. It is stated, however, that the work in at least one of the districts (No. 1) should be carried out at once. A feature that contributes greatly to the high cost per acre for the levee districts is the narrowness of the bottoms as compared with the large amount of water that must be provided for. It has seemed advisable, however, to propose plans for the reclamation of the entire part of the valley under consideration, as the increasing demand for agricultural land will doubtless make the reclamation of these lands desirable.

Twenty-nine Miles of State Highway in California Advertised for Bids.

The California Highway Commission is now asking bids on first state highway letting of the present year. The work advertised covers six contracts and includes an aggregate of 233,000 cu. yds. of unclassified excavation and 27,530 cu. yds. of concrete pavement. In all 29 miles of highway are to be improved.

Table I shows the quantities in the six contracts. Contract III Yub.-3-A is located in Yuba County, and extends from the southerly to Morrison's Crossing. It is about 3 miles in length and is to be built of Portland cement concrete. Two sections of the highway are in Yolo County. Contract III-Yol.-6-A extends from Davis to Yolo By-Pass, is about 5 miles in length and is to be graded and a portion built of Portland cement concrete. Contract III-Yol.-6-C is about 3½ miles in length and is to be built of Portland cement concrete. It extends from Yolo By-Pass to the Sacramento River.

TABLE I.—QUANTITIES IN SIX STATE HIGHWAY CONTRACTS IN CALIFORNIA.

	III-Yub. 3-A.	III-Yol. 6-A.	III-Yol. 6-C.	VI-Tul. 4-E1.	VI-Tul. 4-E2.	VII-Ora. 2-A.
Excavation, without classification, cu. yds.	15,000	65,000	18,000	24,000	34,000	77,500
Corrugated iron pipe, 12-in., lin. ft.	80	300	168	180	60	....
Corrugated iron pipe, 18-in., lin. ft.	200	50	48			[illegible]
Corrugated iron pipe, 24-in., lin. ft.	48	.			[illegible]	[illegible]
Corrugated iron pipe, 36-in., lin. ft.	....	...	160		..	
Concrete, culverts and monuments, cu. yds.	80	[illegible]	[illegible]	125	121	[illegible]
Concrete pavement, cu. yds.	3,210	7,210	[illegible]	5,200	8,210	..
Gravel resurfacing, tons	......		[illegible]	......	...	
Guard rail, lin. ft.	1,320		[illegible]	4,000	.	
Monuments, haul and set	38	[illegible]	20	58	84	16
Wooden piles, lin. ft.	.....	..				1,440

Contract VI-Tul.-4-E1 is located in Tulare County and extends from Travers to northerly boundary. It is about 5 miles in length and is to be built of Portland cement concrete. Contract VI-Tul.-4-E2 also is in Tulare County. It extends from Goshen to Travers, is about 8½ miles in length and is to be built of Portland cement concrete. Contract VII-Ora.-2-A covers about 4 miles of road in Orange County, extending from Section 32, T. 8 S., R. 7 W., to Serra. This section is to be graded.

Bids for the above improvements will be received until 2 p. m. April 5, by the State Highway Commission, 515 Forum Bldg., Sacramento, Cal. Austin B. Fletcher is State Highway Engineer.

COUNTY HIGHWAY CONSTRUCTION.

Details of Work to Be Done in Iowa, Kentucky, Minnesota and Wisconsin.

In previous issues details were given of the highway construction contemplated for the present season in various counties in Iowa, Kentucky, Minnesota and Wisconsin. Since the publication of these figures returns have been received from additional counties in the four states. A summary of the construction in these counties follows:

County and state.	Type of road—Earth, miles.	Gravel, miles.	Mac., miles.
Jones, Iowa	30	..	..
Polk, Iowa	2	3	..
Winnebago, Iowa	47[1]	..	..
Greenup, Kentucky	100[2]	..	..
Todd, Kentucky	..	..	7
Chippewa, Minnesota	25	..	..
Kanabec, Minnesota	10	..	..
Kandiyohe, Minnesota	40	7	..
Marshall, Minnesota	35	.	.
Wright, Minnesota	10	17	..
Washburn, Wisconsin	?	..	..
Wood, Wisconsin	20	..	5[3]

[1] 35 miles engine grader work; 12 miles permanent road. [2] Will make start. [3] Also 2½ miles concrete road.

Further details regarding these improvements follow:

Jones County, Iowa, has $40,000 available for bridge construction and $38,000 for road purposes. It will construct 30 miles of earth road, the work being done by contract. Lettings will be held in March or April. J. F. Whalen, Anamosa, Ia., is County Engineer.

Polk County, Iowa, will construct 2 miles of earth road and 3 miles of gravel road. The work probably will not be done by contract. The county has $33,000 available for highway purposes. H. C. Curtis, Des Moines, Ia., is County Engineer.

Winnebago County, Iowa, has $40,000 available for construction work. It will undertake 35 miles of engine grader work on earth roads and also will construct 12 miles of permanent earth road. The latter work will be done by contract; letting will be held in April. The 35 miles of grader work will be done by county crew. O. N. Gjellefold, Forest City, Ia., is County Engineer.

Greenup County, Kentucky, has $200,000 available for construction purposes. It will begin work on 100 miles of earth road improvement. The work will be done by contract. R. M Scott, Greenup, Ky., is County Engineer.

Todd County, Kentucky, has $14,000 available for construction purposes and will build about 7 miles of macadam. No contracts will be let. J. B. Miller, Elkton, Ky., is County Engineer.

Chippewa County, Minnesota, will construct 25 miles of earth road during the present season. The work will be done by contract, the letting to be held April 12. About $21,000 is available. F. O. Nelson, Montevideo, Minn., is District Engineer.

Kanabec County, Minnesota, has $27,000 available for construction purposes and will build about 10 miles of earth road. No contracts will be let. A. H. Merrill, Mora, Minn., is District Engineer.

Kandiyohi County, Minnesota, has about $23,000 available for construction purposes and about $5,700 for maintenance. It is proposed to construct 40 miles of earth road and 7 miles of gravel. Bids will be taken in April, May or June. Charles J. Estlund, Willmar, Minn., is District Engineer.

Marshall County, Minnesota, has $30,000 available for construction purposes during the present year. About $25,000 will be expended on 35 miles of earth road (state roads). The work will be done by contracts which will be let in April. Oswald Lind, Warren, Minn., is District Engineer.

Wright County, Minnesota, has $40,000 available for construction purposes. It will build 10 miles of earth road and 15 miles of gravel road. Contracts will be let about April 15 to June 15. F. W. Van Krevelen, Buffalo, Minn., is District Engineer.

Washburn County, Wisconsin, has $18,000 available for construction purposes, and will expend this money on earth roads. No contracts will be let. F. L. Irwin, Spooner, Wis., is County Highway Commissioner.

Wood County's construction program for the present season includes 20 miles of earth road, 5 miles of macadam and 2½ miles of concrete. The latter will be constructed by contract, letting to be held after March 15. The county has about $70,000 available for construction purposes. Louis Amundson, Grand Rapids, Wis., is County Highway Commissioner.

Twenty-two State Highway Contracts In Ohio Now Being Advertised for Bids.

The first state highway letting of importance of the present year in Ohio is now being advertised for bids. The work includes 20 construction contracts and 2 contracts for the Bureau of Maintenance and Repairs. One of the latter improvements provides for work on a section of the National Road (west) in Franklin and Prarie Township, Franklin County. It includes grading shoulders and ditches, constructing waterbound gravel side drive 8 ft. in width and 39,200 ft. in length, constructing waterbound macadam 16 ft. in width and 573 ft. long, surfacing with tar and screenings 16,473 ft. for a width of 16 ft., surface treating with screenings for a 16-ft. width a length of 22,727 ft., and making other repairs. The total length of the road is 7.42 miles and the estimated cost of construction is $19,396. The other job for the Bureau of Maintenance and Repairs calls for paving the roadway with concrete in Section L of the Mansfield-Golin Road in Madison Township. The work covers .74 mile of road for a width of 20 ft. and is estimated to cost $15,257.

Details of the other 20 contracts are given in Table I. On each of these bids are asked for constructing the bridges and culverts and grading roadway and paving. The bids will be received until 2 p. m. April 2, by James R. Marker, State Highway Commissioner, Columbus, O.

TABLE I.—DETAILS OF 20 CONTRACTS NOW BEING ADVERTISED BY THE STATE HIGHWAY DEPARTMENT, COLUMBUS, OHIO.

County	Section.	Road.	Township.	Type.	Length, miles.	Width paving, ft.	Width roadway, ft.	Estimated cost.
Allen	G	Lima-Ottawa	German and Bath	Brick	.47	18	28	$11,912
Champaign	K	Troy-Urbana-Southern	Concord	Concrete	1	14	26	11,571
Clark	H	Springfield-Washington C. H.	Harmony	W. B. macadam	2.87	16	26	26,518
Defiance	C	Hicksville-Defiance	Mark	Concrete	4.03	16	26	51,776
Erie	L	Cleveland-Sandusky	Berlin	Concrete	4.56	16	28	81,221
Fayette	G	Springfield-Washington C. H.	Union	Brick	.16	16	31	2,872
Hancock	E	Lima-Sandusky	Union	W. B. macadam	1.02	16	26	8,594
Huron	K	Plymouth-Norwalk	Norwalk	Concrete	1.07	10	26	12,920
Lake	H	Cleveland-Buffalo	Mentor	Brick	4.69	18	27	132,363
Montgomery	I	Dayton-Troy	Harrison	Brick	1.48	15	30	33,310
Paulding	E	Defiance-Delphos	Brown	W. B. macadam	1.00	14	24	10,502
Paulding	D	Continental-Paulding		W. B. macadam	1.02	14	24	7,805
Putnam	H	Van Wert-Ottawa	Monterey	W. B. macadam	1.97	16	26	14,264
Sandusky	F	Fremont-Castalia	Riley	W. B. macadam	2.00	16	26	18,630
Shelby	B	Piqua-Sidney	Clinton-Sidney	W. B. macadam	1.78	16	26	17,809
Tuscarawas	K	Wooster-Canal Dover	Franklin	Brick	1.20	15	28	23,108
Tuscarawas	I	New Comerstown-Urichsville	Clay	Brick	1.00	15	36	22,094
Tuscarawas	J	New Philadelphia-West Lafayette	York	Brick	2.00	14	29	34,938
Warren	B	Cincinnati-Chillicothe	Harlan	W. B. macadam	2.15	14	26	17,529
Williams	J	Bryan-Pioneer	Madison	W. B. macadam	1.03	14	24	10,351

SEWERAGE DEVELOPMENT FOR CLEVELAND, O.

Expenditure of $1,677,000 Proposed for Present Year.

Construction of Diversion Sewer and Treatment Works.

A large amount of work is contemplated for the present season by the city of Cleveland in connection with the construction of its improved sewerage and sewage treatment works. The estimated total cost of the entire completed project is $3,859,000. Of this sum work to cost $1,353,000 has been completed, is under contract or is provided for by ordinance. The work contemplated for 1915 is estimated to cost $1,677,000. The status of the improvement is shown in the following tabulation:

	Work completed, under contract, or provided for by ordinance.	Work contemplated for 1915 for which bonds have not been sold.	Estimated total cost of entire completed project
Sewerage:			
Southerly interception	$ 583,000	$ 577,000	$1,160,000
S. Walworth Run diversion sewer proper	......	400,000	400,000
Connections to Walworth Run diversion sewer.	....	....	110,000
Morgan Run sewer	150,000	....	210,000
Southern Brooklyn branch	......	....	10,000
Sewage Disposal:			
Southerly—			
Land	160,000	....	160,000
Treatment works	100,000	600,000	700,000
Westerly—			
Land	33,000	......	33,000
Treatment works (screens)	26,000	100,000	200,000
Easterly—			
Land	110,000	......	110,000
Shore protection	110,000	......	110,000
Treatment works.	*25,000	....	600,000
Sewage testing station	56,000	....	56,000
Total	$1,353,000	$1,677,000	$3,859,000

*Can be expended in preparation of site.

The plan of sewerage developments provides for three main outlets. The city accordingly has been divided into three sanitary districts, called for convenience the southerly, westerly and easterly districts. The main sewers have been designed to have a capacity to accommodate an estimated population of 1,700,000 people, on the basis of 400 gals. per capita.

The Southerly Sanitary District includes that part of the city south of Kingsbury Run and east of the Cuyahoga River. The intercepting sewer for this district will terminate on land now owned by the city in Newburgh Heights village, at which point a sewage treatment plant comprising grit chambers, sedimentation tanks and sprinkling filters will be constructed. In the westerly sanitary district the entire sewage from the west side will be collected at the lake front near W. 58th St., where a treatment plant will be constructed. This will comprise grit chambers, fine mesh screen, disinfection apparatus. The sewage will be discharged through a submerged outlet out in the lake. The Easterly Sanitary District excludes the entire northeasterly portion of the city, taking in the area east of the Cuyohoga River and north of Kingsbury Run, and including the Doan Brook Valley, East Cleveland and the newly annexed territory of Nottingham and Euclid Village. Most of the sewage from this district already passes into the lake at E. 140th st. It is intended to install on the land at this point a sewage treatment plant comprising grit chambers, sedimentation tanks of relatively small capacity and disinfection apparatus. A breakwater now under construction at this point will protect the city property and permit the reclamation of some 30 acres of land.

The general plans for collecting the entire sewage of the city have been approved by the State Board of Health. Partially detailed plans for the westerly and southerly treatment plants have been submitted to the Board, and general plans for the easterly treatment plant were to be ready for submission this month.

The contract for sewers in the valley of Morgan Run was let in May, 1913, and the work was completed. Contracts for the construction of the southerly intercepting sewer from Kingsbury Run to Morgan Run were let in June of last year. These contracts covered 11,220 lin. ft. of sewer, and of this about 3,000 ft. had been completed up to Feb. 1 last. The construction of the remaining portion of the sewer, from the city limits to the treatment plant, is being delayed until some permission is obtained from the officials of Newburgh Heights to construct a sewer within the village. The contract for the excavation preliminary to building the southerly treatment plant has been let. The contract for the E. 140 St. breakwater was let in September, 1914, and up to about Feb. 1 approximately 700 ft. of the total length of 2,600 ft. had been placed.

R. Winthrop Pratt is Engineer in charge of the improved sewerage and sewage treatment work of Cleveland.

Highway Construction in North Carolina.

A considerable amount of highway construction will be undertaken in North Carolina during the present season. The State Legislature, which adjourned recently, passed nearly 100 bills providing for road improvements in nearly every county in the state. Several of these bills authorized good-sized county bond issues.

The legislature also passed the bill providing for a State Highway Commission. This will consist of Governor Craig and State Geologist Joseph Hyde Pratt, ex-officio members; Prof. Marvin H. Stacy of the Engineering Department of the University of North Carolina; Prof. W. C. Riddick of the Engineering Department of the North Carolina College of Agriculture and Mechanical Arts; E. C. Duncan, Raleigh, and Col. Benehan Cameron, Sagville; Guy V. Roberts, Asheville. The Commission will select a State Road Engineer. The act provides an appropriation of $10,000. Engineering assistance will be given to county authorities applying for aid in the location and construction of public highways. Already some 20 counties have filed applications with the Commission.

Reorganization of Idaho State Highway Commission.

The Legislature of the state of Idaho has passed a bill for the reorganization of the State Highway Commission. The act has been approved by the Governor. The bill provides for a commission of three members, one to be the Secretary of State, who also is Secretary of the board, and two to be appointed by the chief executive of the state. The Commissioners are to have terms of four years. The present board consists of five members. Under the reorganization, the State Engineer and the head of the department of engineering of the state university, members of the old board, are not included in the membership of the new one Changes also are made in the present highway law. The highway tax is apportioned 60 per cent to the county and 40 per cent to the highway fund. Authorization is given for the employment of convict labor on state highways at $5 per month. New rates of license fees required of automobile owners are as follows: 30 hp., $15; from 30 hp. to 40 hp., $20; up to and including 50 hp. $40; motorcycles, $5; manufacturer or dealer, $35 for each make carried.

Vermont Society of Engineers.—The third annual meeting of the Vermont Society of Engineers was held at Hotel Vermont in Burlington, March 11. The morning and afternoon session were given over to business and the reports and discussions of standing committees. A dinner was given and a public meeting was held in the evening, when several interesting addresses were given. The officers elected for the coming year are: President, A. C. Grover, Rutland; vice-president, H. M. McIntosh, Burlington; W. H. Vorce, St. Albans; secretary, G. A. Reed, Barre; treasurer, A. S. Winslow, Northfield; Director for three years, J. W. Votey, Burlington. The reports show an increase in membership of 19 during the year, making a total enrollment of 102 at this time.

PERSONALS

Mr. Arthur L. Mullergren, consulting engineer, formerly of Poteau, Okla., is now connected with the Benham Engineering Co., consulting engineers, of Oklahoma City.

Mr. James A. Smith assumed the presidency and active management of the Cleveland Engineering Construction Co., engineers and contractors, Cuyahoga Bldg., Cleveland, Ohio, on March 1. Mr. Smith has a wide experience in the construction of harbors, railroads, foundations and in dredging work.

Mr. Gustav J. Requardt, 2235 Eutaw Place, Baltimore, Md., has been appointed acting division engineer, sewage disposal division, Baltimore Sewerage Commission. He succeeds Mr. H. C. McRae and will have charge of the operation of the plant and the completion of a contract for the building of 28 40-ft. radial-flow Imhoff tanks, 16 40-ft. sludge tanks and 5½ acres of sludge beds. Mr. Requardt has been connected with the Baltimore Sewerage Commission since 1909, and has worked on the construction of the sewage disposal plant, practically from its beginning, first as a "line and grade" man, then as assistant engineer and recently as assistant division engineer in charge of contracts.

Mr. Charles L. Fish, who was chosen as secretary of the American Concrete Institute, is a graduate in civil engineering of the Worcester Polytechnic Institute, class of 1901. He was instructor in mathematics and civil engineering in the Agricultural and Mechanical College of North Carolina for two years. For six years he was with Milliken Brothers of New York City in the designing and contracting departments. Since that time he has been employed in the capacity of sales manager and building superintendent for V. J. Hedden & Sons Co., Tucker & Vinton of New York, and the Emerson, Norris Co., manufacturers of artificial stone. Mr. Fish will take up the business management of the Institute and is also editor of the journal published by that association. His headquarters are at 1418 Walnut St., Philadelphia.

Mr. C. C. Elwell has been appointed a member of the Public Utilities Commission of Connecticut for a term of six years, beginning July 1, 1915. Mr. Elwell has been chief engineer for the Commission since its creation in September, 1911. Mr. Elwell is a graduate from the University of Maine, class of 1878. He was in the Lighthouse Engineer Department in South Carolina until 1882, when he entered railway service, being connected with the New York & New England, Wilmington & Northern and Baltimore & Ohio Railways as assistant engineer, roadmaster or engineer, maintenance of way, until 1893. In that year he became connected with New York, New Haven & Hartford Railroad Co. as roadmaster in charge of four-tracking between New York and New Haven. For 13 years he was division superintendent and for three years was engineer of the company's trolley lines in Connecticut and New York. He left that position in 1911, when he was employed by the Connecticut Public Utilities Commission.

Mr. Butler Smith, civil engineer of Milbank, S. D., has been appointed county surveyor for Grant County, South Dakota. Mr. Smith specializes in bridge work and ditching, and during his term of office will have the superintendency of construction of the Grant County court house, a $100,000 building. Mr. Smith has been connected with railroad work through most of his professional career. He began in 1899 as rodman for the Atlantic, Valdosta & Western, and has held positions as follows: Assistant chief engineer, Indianapolis Southern; assistant engineering corps, Pennsylvania lines, and the Vandalia; resident engineer, Indianapolis, Newcastle & Toledo Electric; resident engineer, Chicago, Milwaukee & St. Paul; chief engineer, division and resident engineer on various preliminary steam and electric railways, including the Logansport, Hammond & Chicago, the Lima & Toledo, and the Oakland, Charleston & Western. In May, 1912, he began on double-track work in South Dakota for the Chicago, Milwaukee & St. Paul.

Mr. Edward Wegmann and Mr. A. G. Hillberg announce that they have taken offices in the South Ferry Bldg., New York City, to engage as consulting hydraulic engineers on water works, waterpower developments, sewer systems, irrigation and drainage products, under the firm name of Wegmann & Hillberg. An extensive biographical sketch of Mr. Wegmann appeared in these columns March 25, 1914. He was for more than 30 years connected with the construction of the Croton water works for New York City, was the last chief engineer for the Aqueduct Commissioners, and subsequently for four years was consulting engineer for the Department of Water Supply, Gas and Electricity. He is well known through his books, "Design and Construction of Dams" and "The Water Supply of the City of New York." Mr. Hillberg has been connected with large hydro-electric developments, notably the Mississippi River Power Co.'s plant at Keokuk, Iowa. For the past two years he has been associate editor of *Engineering Record*, in charge of hydraulics.

Mr. Andrew A. Woods has been made superintendent of the New Orleans & Northwestern Railroad Co., with headquarters at New Orleans, succeeding the late S. E. Flanagan. Mr. Woods is a graduate in civil engineering from Tulane University, and entered the railway field as rodman on the New Orleans & Western, now the New Orleans Terminal Co. For one year he was draftsman in the maintenance of way department of the New Orleans & Northwestern and in 1898-99 was draftsman and inspector on bridge pier construction for the Alabama & Vicksburg, and Vicksburg, Shreveport & Pacific railways. For two years following he was assistant engineer of maintenance of way for the New Orleans & Northwestern, and from November, 1901, to July, 1913, was resident engineer in charge of maintenance of way for the two Vicksburg lines. Since July, 1913, until receiving his present appointment in February last, Mr. Woods has been resident engineer in charge of maintenance of way for New Orleans & Northwestern at New Orleans.

Mr. James Walker and Mr. George H. Cressler have announced their association under the firm name of Walker & Cressler, Consulting Engineers, with offices at 742 First National Bank Building, Chicago. Both men are graduates of the Sheffield Scientific School of Yale University, Mr. Walker as a civil engineer in the class of 1894, and Mr. Cressler as a mechanical engineer in the class of 1902. Mr. Walker has been engaged in consulting practice in Chicago for ten years, being identified during that period with work in connection with the Chicago Elevated Railways Co., the Chicago Surface Lines, the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals, various electric railroad, lighting and power companies, and financial institutions interested in public utility properties. Mr. Cressler, for the past ten years vice-president and chief engineer of the Kerr-Murray Manufacturing Co., Fort Wayne, Ind., is a member of the American Society of Mechanical Engineers, American Gas Institute, National Commercial Gas Association, and several state and district associations. He has designed and constructed gas works installations in more than one hundred cities of the United States and Canada. The firm is now engaged in work embracing all phases of the relation of railway, gas and electric utilities to the investor and the public, including construction, operation, management, examinations, appraisals, reports, determination of rates, and representation in connection with the exercise of public authority.

OBITUARIES

John C. Breedlove, assistant engineer of the Northern Pacific Ry., died recently in St. Paul. Mr. Breedlove graduated from Cornell in 1901 and has served in the Northern Pacific engineering corps for ten years. He was 39 years old.

Maurice J. Hickey, a retired railroad contractor, died at his home in Tacoma, Wash., March 13, aged 62. Mr. Hickey was for 12 years in the service of the Northern Pacific, and was superintendent of construction of roundhouse and car shops in South Tacoma. He then entered the contracting field from which he retired several years ago.

Morton Riddle, general manager of the Florida East Coast Railway Co., died at his home in St. Augustine, Fla., March 4. Mr. Riddle entered service with the Norfolk & Western in 1887 and was with that company and the Charleston, Cincinnati & Chicago Ry. in general engineering work until 1890, when he became roadmaster for the Atlantic Coast Line Railroad. He was made superintendent for the railroad in 1900, assistant chief engineer in 1904 and general superintendent in 1905. He left the service of that road in February, 1914, to take the position of general manager for the Florida East Coast Ry.

CIVIL SERVICE NEWS

The United States Civil Service Commission announces examination as follows:

Surveyor-Draftsman; forest service; $1,200 to $1,500 per annum; April 28-29.

Gas Waste Engineer; Bureau of Mines; $2,400 to $3,600 per annum; April 20.

Hull Draftsman; office of chief of engineers; $1,800 per annum; April 28-29.

RAILWAYS

BIDS ASKED.

Ontario:

Toronto, Ont.—Until noon, March 30, by Mayor T. L. Church, Chairman, Board of Control, for sweeper body and equipment. Equipment for machine shop, mechanical and electrical equipment for car bodies and 4 car bodies all for Toronto Civic Railway.

PROSPECTIVE WORK.

Alaska:

Cordova, Alaska.—Report of Alaska Engineering Commission on its surveys for government railroad has been submitted to President Wilson. Secretary Lane is reported to have asked $2,000,000 for commencement of work.

Arizona:

Tucson, Ariz.—Advices from this city state that there is some prospect of the Calumet & Arizona Copper Co. starting work soon on a line to its mines at Ajo in Pima County. The railway may be built from Tucson, a distance of 125 miles, or from Gila Bend, 50 miles. It probably would be part of El Paso & Southwestern system.

Indiana:

Lafayette, Ind.—Surveys have been completed for Lafayette & Northwestern R. R. proposing interurban from Lafayette to Kankakee, Ill., and it is believed construction will be started this spring. George M. Sewell, Wabash, Ind., is Superintendent of Construction.

Indianapolis, Ind.—Union Railway Co. has awarded contracts for 8,000 tons of steel for track elevation here, and it is understood that construction work will be started in a few days. P. J. Landers is Engineer.

Sullivan, Ind.—J. B. Dorris, Sullivan, Ind., has a 40-team outfit idle.

North Carolina:

Beaufort, N. C.—Norfolk Southern R. R. is reported contemplating extending its line from Beaufort to Cape Lookout.

Durham, N. C.—Proposition is before Commercial Club of this city for aid in constructing proposed Alamance, Durham & Orange R. R. This is interurban proposition for line between Durham, Chapel Hill and Burlington. It is suggested that Durham Township vote $150,000 bonds for the road.

Burlington, N. C.—The Alamance-Durham-Orange Railway & Electric Co. has applied for charter. Company proposes 50-mile electric railway from Ossippee to Durham, to cost about $2,000,000. Junius Hardin, Burlington, N. C., is interested.

Edgemont, N. C.—Engineering work will be started on April 7 for proposed line of Newland Avery Northern R. R. Company projects line from Edgemont to Newland, N. C., opening up large body of timber land and mining land. P. M. Brown, Newland, N. C., is President; J. W. Ragland, Newland, N. C., is General Counsel; and W. W. Barber, Edgemont, N. C., is Manager.

Newton, N. C.—Carolina & Northwestern Ry., J. W. Fletcher, Jr., Chief Engineer, Chester, S. C., will undertake betterment work shortly. Company also proposes 21-mile extension from Edgemont.

Ohio:

Toledo, O.—Incorporation papers have been filed for extension of St. Joseph Valley Ry. (electric), Elkhart, Ind., from Indiana state line to Toledo.

Cleveland, O.—City Council has passed ordinance authorizing letting of first contracts on Union Ave. S. E. grade crossing elimination.

Utah:

Ogden, Utah.—Ogden, Logan & Idaho Ry. may have work started soon on connecting electric railway between Brigham City and Wellsville. This involves some 36 miles of work and will require some heavy construction.

Virginia:

Cape Charles City, Va.—New York, Philadelphia & Norfolk R. R. is stated to contemplate a number of improvements for this spring.

Wisconsin:

New Richmond, Wis.—Minneapolis, St. Paul & Sault Ste. Marie Ry. is reported contemplating extension from Dresser Junction to New Richmond.

Wyoming:

Sheridan, Wyo.—Beaver Hills Coal Co., according to reports, will expend about $100,000 for constructing 10-mile steam line between Sheridan and its mines.

BIDS OPENED; CONTRACTS LET

North Carolina:

Shelby, N. C.—S. S. Royster and O. Elam, Shelby, are reported to have taken contract to build and equip steam railroad from Shelby to Casar, 21 miles. Belwood-Fallston and Casar districts have voted $80,000 of bonds and the county $40,000 for the road.

Ohio:

Portsmouth, O.—Ohio Valley Traction Co., 10th and Offnere Sts., Portsmouth, has opened bids for extension of its lines from Sciotoville to Hanging Rock, 21 miles.

ROADS STREETS

BIDS ASKED.

California:

Sacramento, Cal.—Until 2 p. m., April 5, by California Highway Commission, A. B. Fletcher, Highway Engineer, for 6 contracts as follows: 3 miles concrete in Yuba County; 5 miles in Yolo County, to be graded and portion paved with concrete; 3½ miles concrete in Yolo County; 5 miles concrete in Tulan County; 4½ miles concrete in Tulare County; 4 miles to be graded in Orange County.

Fairfield, Cal.—Until April 6, by County Commissioners for improvements to road between Valejo and Valejo Cemetery.

Connecticut:

Manchester, Conn.—Until 5 p. m., April 3, by Selectmen for construction of 7,000 to 10,000 ft. of curbing, a quantity of radius and drive corners, 40,000 to 60,000 sq. ft. of concrete walks, etc. Howald I. Taylor, member of selectmen.

District of Columbia:

Washington, D. C.—Until 2 p. m., April 5, by District Commissioner, for furnishing and delivering broken stone and for quarrying and crushing trap rock at the District Quarry, Dickerson, Md.

Illinois:

Chicago, Ill.—Until 11 a. m., March 26, by Board of Local Improvements for 26 contracts for street paving.

Swansea (P. O. O'Fallon) Ill.—Until 7 p. m., March 27, by Board Local Improvements, Anton Schroeder, President, for 6,750 sq. yds. vitrified brick paving on 4 in. concrete base; grout filler, wool felt asphaltum expansion joint.

Springfield, Ill.—Until 11 a. m., March 31, by State Highway Commission, W. W. Marr, Chief State Highway Engineer, for four contracts for state aid concrete roads, one contract for brick road, one contract for gravel road and one contract for bridges. Advertisement in this issue.

Vermillion, Ill.—Until 2 p. m., April 9, by Commissioners of Elbridge Township (3 miles south of Vermillion) for 3,800 lin. ft. gravel on Nevins Road and 6,454 lin. ft. of gravel on Sandford Road, contract to include 2,800 cu. yds. of earthwork and several concrete culverts. Plans with Karl J. Barr, County Superintendent of Highways, Paris, Ill.

Indiana:

Frankfort, Ind.—Until 10 a. m., April 1, by City, for improvement of two streets and one alley with brick, concrete, asphaltic macadam or bituminous concrete involving 13,690 sq. yds. roadway, 41,000 sq. ft. cement sidewalk, 10,000 ft. curb, 3,200 ft. 10-in. and 12-in. tile sewer and other work. Estimated cost $38,170. R. H. Boynton, City Engineer.

Iowa:

Red Oak, Iowa.—Until 10 a. m., March 31, by City Clerk, for paving on portions of 5th and 8 other streets with brick, concrete, asphaltic concrete or sheet asphalt.

Keokuk, Ia.—Until March 30 by City for 8,000 sq. yds. 7 in. concrete pavement, 1½ miles 6-in. by 18-in. concrete curb, and 7,200 cu. yds. excavation. J. F. Winters, City Engineer.

Forest City, Ia.—Until April 16, by Town Clerk, for paving with concrete, asphaltic concrete or brick.

Eagle Grove, Ia.—Until 7:30 p. m. March 30, by Sam. Middleton, City Clerk, for 52,625 sq. yds. of paving, asphaltic concrete, sheet asphalt or concrete.

Kansas:

Atchison, Kans.—Until March 25, by Victor King, City Clerk, for paving the intersection of 14th St. and Utah Ave., in front of the new viaduct.

Junction City, Kan.—Until 5 p. m., March 29, by T. W. Dorn, City Clerk, for the paving of Pine St., Washington to Adams Sts., with Portland cement concrete; 2,760 sq. yds, pavement; 1,840 lin. ft. combined 8-in. curb and 18-in. gutter; 80 lin. ft. combined curb and gutter to be reset; 1,000 cu. yds. earth excavation; 100 lin. ft. 18-in. vitrified sewer tile, and 4 catch basins. W. Van Buck, City Engineer.

Maryland:

Cumberland, Md.—Until 9:30 a. m., April 5, by James P. Gaffney, City Engineer, for 57,000 sq. yds. brick paving on concrete base.

Baltimore, Md.—Until 11 a. m. March 31, by R. Keith Compton, Chairman Paving Commission, for paving on German St.; 1,700 sq. yds. wood block; 1,000 sq. yds. granite block, 12,110 sq. yds. redressed granite block.

Michigan:

Port Huron, Mich.—Until April 1, by County Road Commissioners, Albert P. Ryan, Clerk, for the construction of 3 miles, more or less, of State Trunk Line, class "E" road, on the Port Huron and Yale State Trunk Line.

Minnesota:

St. Paul, Minn.—Until 10 a. m., March 29, by Aug. Hohenstein, City Purchasing Agent, for furnishing 700 sq. yds. 4-in. yellow pine creosoted wood blocks.

Duluth, Minn.—Board of Public Works has called for bids for the improvement of Highland St., 59th to 66th Aves. west, and for the construction of approaches to the new D. M. & N. subway to be erected this spring under Highland St. The estimated cost of the latter is $14,000. Date of opening bids, March 26.

Duluth, Minn.—Until April 3, by O. Halben, County Auditor, for 3¼ miles of gravel road.

New Jersey:

Belleville, N. J.—Until March 30, by Robert G. Minion, Town Clerk, for furnishing crushed trap rock and for concrete work during present year.

Newark, N. J.—Until 3:15 p. m., April 1, by Street and Water Commissioners, M. R. Sherrerd, Chief Engineer, for 3,000 sq. yds. wood block on Central Ave., 2,200 sq. yds. granite block on Margarette St. and 2,800 sq. yds. granite block on Niagara St.

Somerville, N. J.—Until 10 a. m., April 2, by L. E. Opie, Director County Freeholders, for 1 mile waterbound macadam in Bridgewater Township (10,086 sq. yds. surface; 9,562 cu. yds. excavation). Joshua Doughty, Jr., County Engineer, Somerville.

Chesterfield, N. J.—Until April 3, by Township Clerk, for about 2⅓ miles of macadam. Jas. Logan, County Engineer, Mt. Holly, N. J.

Mt. Holly, N. J.—Until March 31, by Joseph S. Bright, Chairman Freeholders Committee, for supplying road oil for County for 1915. Jas. Logan, City Engineer.

Phillipsburg, N. J.—Until 2 p. m. April 3, by Robert P. Howell, Commissioner of Streets, for repaving South Main St. upon present concrete foundation. Schedule A, 10,500 sq. yds. vitrified block; Schedule B, 20,800 sq. yds. vitrified block; Schedule C, 10,500 sq. yds. wood block; Schedule D, 20,800 sq. yds. wood block.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

Volume XLIII. CHICAGO, ILL., MARCH 31, 1915. Number 13.

Public Service Publications.

Small periodicals issued locally by public service corporations have become quite numerous. These little journals perform a service as a preventive of and an antidote for captious criticism. As examples there have come to us two issues of the "trolley talks," an edition of 50,000 of which is issued each Monday and distributed to the patrons of the Portland (Oregon) Railway, Light & Power Co. One of these "talks" can be read in five minutes and it is bright and chatty enough to be read and thus a page or a paragraph dealing with "investments, interest, taxes, operation and in a general way with what the company has done and is doing in the way of maintaining reliable service" is conveyed to the patron to the improvement of his attitude toward the street railway services.

Some Possibilities of Popular Educational Work by the Larger Water Works Associations.

What appeal for intelligent co-operation do the larger associations of water works managers make by publicity literature addressed directly to consumers? The answer is: They make no attempt by this means to instruct or otherwise to concern the consumer in matters in which his aid and support will contribute greatly toward perfect service in public water supply. To be able to make this answer authoritatively the following inquiries were made of officials of the American Water Works Association and of the New England Water Works Association:

> Can you tell me whether the Association has ever had a Publicity Committee whose function it was to prepare matter, pertaining to the water works business, for publication in newspapers or lay magazines? Has any work of this kind ever been done by any individual acting for the Association?
>
> More specifically, I should be glad to have you advise me if the Association has ever made a direct effort to educate the public with reference to the water works business in any of its phases. I am familiar, of course, with the educational work carried on among water works men by the Association, but I have reference in the foregoing only to the education of the public by direct means. What, if anything, has been done by your Association along this line?

What were the answers? The New England Water Works Association has never done any work along the lines mentioned; and the American Water Works Association has never had a Publicity Committee, nor has it ever made any direct effort to educate the public. The official of the latter organization also stated that, "Our endeavor has been to educate ourselves more than the public."

With the basic facts thus established we may profitably consider some of the possibilities of organized efforts, on the part of the two Associations named, to educate the general public on certain broad matters in which the members of the Associations have expert knowledge and in which the public is uninformed and indifferent.

As suggested in the quoted paragraphs we believe Publicity Committees should be appointed to carry out the educational work. It is unnecessary to enumerate all the subjects upon which publicity matter should be prepared. Any reader interested in water supply matters will readily see the possibilities offered by this plan. We shall, for the sake of illustration, discuss but a single topic, namely, better operation of water works systems.

Many readers will doubtless recall the article entitled: "The Faulty Operation of the Average Public Utility with Special Reference to Water Works," which was published in our issue of Feb. 24, 1915. The article showed clearly the difference, to all interests, between competent and incompetent water works operation. That even small towns can be made to see that the operator of a public water supply should have special knowledge of his business is shown by the cited cases of several Kansas towns. This is the sort of thing which the suggested Publicity Committees should work upon by preparing suitable matter for publication in local papers.

This suggestion is not offered as a criticism of the Associations but is meant to show how their great influence can be extended to every city at a small outlay of time and money. Results will not be immediate but they will be sure to come. The chain of influence will be practically endless. Local editors will be the first ones converted and they can be depended upon to bring up at opportune times, in their editorial writing, the facts and arguments disseminated by the Committees. This suggestion also carries with it a way for greatly increasing the membership of the Associations.

The "Jitney" vs. the Street Car.

The writer was invited by a Bell telephone official to talk across the continent. Sitting in New York the writer asked the man at the 'Frisco end whether he had used a street car or a "jitney" to reach his office that morning. The reply came—and it was as distinct as if it had traveled only across the street:

> I rode down in a trolley this morning, but yesterday I used a jitney. It may interest you to know, however, that if you were injured on one of those conveyances you could probably recover nothing in the way of damages for the injury.

So many irresponsible individuals own and operate the "jitney buses" that it has already become a serious question as to their right to run upon the streets of a city unless they furnish bonds that will protect both their patrons and the public. Also it is apparent that these conveyances should pay a substantial tax for the privilege of using the streets.

When liability insurance premiums and taxes are paid, there is reason to believe that many of the "jitneys" will either cease to operate as such or will raise their rates of fare from 5 cts. to a considerably higher price. However, it should not be too hastily assumed that a higher fare will drive these buses out of business.

One very significant aspect of the "jitney" development is the ever present risk that even a well established public utility company runs. It has often been said that although gas companies were financially injured by the development of electric lighting companies, no similar danger confronted electric street railways. And behold the result, even before the breath of the prophets has cooled! Still this same tribe of prophets will probably continue to talk of the safety of investment in a monopoly, and to urge the sufficiency of a 6 or 7 per cent return as the maximum allowable.

The autobus, we may rest assured, has come to stay. Each year has witnessed a decrease in the first cost of motor cars, until now they can become successful competitors of electric traction under certain conditions. Let the cost of automobile tires be substantially reduced and there will inevitably follow a great increase in the use of autobuses. Much the same effect will follow the more extensive laying of continuous smooth pavements.

That the trolley car will not be entirely displaced, is evident, but it seems equally evident that the revenues of many trolley lines are likely to suffer, for a time at least The public has a habit of eventually growing up to every added means of transportation, but the growth is often sufficiently slow to result in reduced earnings for the older transportation agencies.

Effective Cost Keeping by The Philadelphia Bureau of Highways.

Complete costs of all street maintenance work are recorded by the Philadelphia Bureau of Highways. In another column of this issue the method of ascertaining and recording these costs is described. A week ago we published an example of actual cost records. Neither in the method nor in the results is there any technical novelty; the method is practical and serviceable and the records are commendable. The value of both the cost keeping and the cost data lies in the service that they are rendering the Bureau administration. A similarly good and honestly operated cost keeping system will render just such valuable service to any public works department of any city.

Costs in themselves have no great value. It is interesting for Philadelphians to know that they are paying no more for street maintenance than are Bostonians, but it is not of vital significance whether they are or are not. Cost records whose only service is demonstration that a city is not spendthrift in its street maintenance are worth while, perhaps, but they are not of exceeding value. This last value comes only when the costs of one year or one street division are made to serve as a means of reducing costs the next year or in another street division. This is the kind of service that the Philadelphia Bureau of Highways is securing from its cost keeping. It is doing this by two main ways.

By publication of costs recorded by individual repair gangs and by individual city districts competition is created. This is one of the oldest of uses of cost records, and perhaps the one that first suggests itself to the tyro in cost keeping, but it is none the less an effective use. The desire to excel is fundamental in man. To keep this desire excited, under control, is one of the oldest devices of the manager. Cost keeping is a means of measuring excellence and recording results in terms—dollars and cents—understood by the dullest of wage earners. In Philadelphia Mr. William H. Connell, Chief of the Bureau of Highways, finds that: "The moral effect on the organization is alone a justification for keeping unit cost records."

It is in cost analysis, however, that the Bureau discovers the greatest service of its cost records. In bituminous surface treatment, for example, the cost in 1914 was 1½ cts. per square yard less than it was in 1913. Of this total saving, 1 ct. per square yard, or 14 per cent of the entire cost of the work, was entirely due to increased efficiency in the organization handling the work. Analysis in detail of the costs recorded in 1913 showed high cost points which by attention in 1914 were leveled down to the general standard of economy. In the office of the Bureau this winter the costs of 1914 have in turn been analyzed with the purpose of making further economies. This leveling down process has, of course, its limit, but the lowest plane becomes then a datum above which a cost attracts investigation.

A very common objection offered to cost keeping systems which make the foreman on the work the record keeper is that either the foreman neglects his duty as director of the men or he neglects or confuses the records. The experience of the Philadelphia Bureaus of Highways is emphatically recorded as disproving this objection. Instead of being a disadvantage to the foreman's work it is a great advantage to it. As stated in the report of the Bureau Chief, "It tends to develop the foreman, awaken his interest, and in many instances make a new man of him, simply because he is placed on his mettle, taken in to a certain extent on the financial and business end and made a more important factor in the organization.

Whether or not the cost keeping system of the Philadelphia Bureau of Highways is the best, in form and method, for its purposes, it has proved its value. It alone is credited by the Bureau officials with having given them both the information disclosing needed reforms and the tool by which reforms could be worked out.

"The Engineer's Idea of Values Is Usually Confused."—Prof. John R. Commons.

It will be recalled that when the question of railway valuation was before Congress two years ago, Senator La Follette strongly championed having the appraisals conducted by a board of "economists" rather than by a board of engineers. He brought witnesses before the senate committee on interstate commerce, to convince that committee of the importance of keeping engineers in their place as the recipients of orders from a board of professional "economists." His star witness on this point was Prof. John R. Commons, professor of political economics in the University of Wisconsin.

After indicating that his own experience had been mainly as a teacher of political economy, Prof. Commons undertook to show that engineers do not understand the theory of value as applied to public utility property. We think all engineers will be interested in his criticism, so we quote it in full:

> These questions of valuation, I think, have a very important bearing on the personnel of the staff that is to do the valuing. It appears to me that this is much greater than a problem for engineers. It has been suggested here that there should be created a board of engineers, partly appointed by the commission and partly by the railroads—partly by the engineering associations, possibly by the War Department, etc.
>
> The engineer is essential in making this valuation. It can not be made without his assistance, but all that he can make is a physical inventory. As engineer it is not his province to go into the constitutional question of reasonable value. For that purpose the valuing board would need a constitutional lawyer, a person familiar with the decisions of the court and the principles of reasonable valuation as against market valuation.
>
> **The engineer's idea of values is usually confused.** He does not distinguish between what you might call the engineering use, or engineering value of the property, and its valuation as a charge against the public. For example, an engineer would value property according to its operating efficiency, and if there had been a depreciation account so calculated that it would wipe out the value of a piece of property in thirty years, the public would pay in the form of depreciation as operating expenses an amount which would eliminate the value of that piece of property in that period. But if the engineer finds that that piece of property nevertheless has an operating value that will turn out, not value to the public, but turn out products or service to the public, he gives it what he calls a "minimum service value"; that is, it is still valuable as a piece of mechanism to turn out service, even though from the standpoint of the public its value as a charge against them has been entirely eliminated through a depreciation account. **In that way the engineer, not understanding that in making an inventory of physical property he is setting up a charge against the public in doing so, confuses his idea of operating value, or operating efficiency, with this other entirely different idea of a credit and debit relation between the investor and the public.** Now, to correct the engineer in that computation, it is necessary to have an accountant. An accountant is just as essential to this valuation as an engineer, **and the engineer's value should be made under the direction of others who have the idea which is involved in this case of reasonable value.**
>
> I should say also that there should be needed an economist, because the court is really acting as a kind of faculty of political economy. They are working out a theory of value which economists are also working out; the two theories do not always gibe. **But there ought to be somebody there who knows the literature and the theories of value,** so that he can properly weigh the different theories and properly distinguish between them, and also between this reasonable value, which economists do not usually take into account, and these market values which are the dominant ideas in the minds of economists. That is to say, this valuation staff should be more than engineers. It should include experts in all of the elements involved in the valuation.

"The engineer's idea of values is usually confused," says Prof. Commons. But when he proceeds to show the nature of the confusion we find that he himself is confused as to the meaning of the word "value," for the "credit and debit relation between the (public utility) investor and the public is not a matter of values but of costs. And this very "credit and debit relation," as Prof. Commons terms it, is one that had been discussed by engineers prior to any mention of it by Prof. Commons or any other political economist. In ENGINEERING AND CONTRACTING, Dec. 11, 1912, there is an article by Halbert P. Gillette, entitled, "Two Conflicting Theories of Valuation of Public Service Companies." In that article Mr. Gillette discussed at length two theories of "valuation," the "agency theory," and the "competitive theory," as he termed them. The "agency theory" gives the "credit and debit relation" that Prof. Commons mentions. The "competitive theory" gives the ordinary commercial value of property.

Prof. Commons, in the course of establishing his qualifications as a witness, laid stress on the study he had made of court decisions relative to rate making and appraisals. He undertook to convince the Senate Committee that the courts are leaning toward the "credit and debit relation" in arriving at property values. How superficial his study of court decisions must have been is indicated by all the Supreme Court decisions of the last 17 years, as given in an anticle that appears elsewhere in this issue.

What most professors of political economy fail to appreciate is the fact that engineers are primarily economists—real economists and not would-be economists. The training of engineers is aimed to produce men capable of designing, locating, and operating with economy. Many engineers, particularly those who have been in charge of appraisals and rate studies, have read all the important works on political economy from Adam Smith to F. W. Taussig and Irving Fisher. They have, in fact, qualified as being "somebody who knows the literature and the theories of value," and, in addition to knowing "theories of value," they know values.

This brings us to the prime object of these editorial remarks. While many engineers are well acquainted with the theories of political economists, it is desirable that every engineer should be well informed on the subject. To be well informed it is necessary to do more than review one's college text book on political economy. Books and articles advocating extreme theories, such as the single tax theory of Henry George, should be studied. Incidentally, it may be added, George's "Progress and Poverty" is, perhaps, the most fascinatingly written of all works on political economics.

In the course of such study, it is well to read critically, making passages and terms that should be reverted to for further consideration. Looseness of reasoning and failure to define terms properly, if at all, characterize most of the writers on "economics." Even the careful John Stuart Mill is often careless in the use of words. Thus he repeatedly says "law of nature," when he really means "force." Taussig says rent is not a part of *cost* of production, when he means that rent does not affect the *price* of products. Fisher excludes interest as a part of cost, on the ground that, taking society as a whole, the interest credits exactly balance the interest debits! He fails to see that for "society as a whole" there can be no such thing as cost, since cost implies a transaction between *two* parties. "Society as a whole" being *one* party, none of the reasoning as to costs and values applicable to individuals can be applied to "society as a whole."

To an engineer, accustomed as he is to precision in the use of data and terms, it is astounding to see the mass of ill digested theories and poorly defined terms that make such bulk in the literature of political economy. Nevertheless, in spite of all the errors and crudities of political economists, it repays an engineer to master their doctrines. In the very act of doing so, an engineer receives valuable training in the science of logic, more especially in that part of logic that teaches how to avoid fallacies of confusion.

We leave the subject of political economy with three inter-related queries:

How can any man successfully teach true national economics, until he has become an expert at engineering economics?

Is not the science of engineering economics the foundation of all public utilities, all economic geology and mining, all manufacture and transportation, all agriculture?

Can a man who has never had to solve a simple unit cost equation be a safe teacher of the infinitely more complex economic phenomena of exchange relations between classes of men and nations?

The Danger of Incomplete Costs of Motor Truck Haulage.

Recognition of the utility of motor trucks in construction work is certain to increase. A thing which will delay progress, however, is untruthful records of economy of motor truck haulage. As pointed out in our issue of March 10, the falsity in most instances is the omission of some item of indirect expense. Generally the omission is due to ignorance or oversight but it is harmful. Exaggerated records of motor truck economy have no useful place in any campaign to increase the use of motor trucks in engineering construction. Error in the opposite direction will serve better. Our belief that these things are true and which encouraged us to write the editorial of March 10, is confirmed by a letter, received from a prominent engineer, commenting on that editorial.

The writer states that as a result of testimony recently given in a water works rating case in the West, he had a very careful investigation made of the cost of motor trucking to a number of concerns: contractors, coal companies, public works and others. These data indicated that the cost per ton mile of hauling, with four or five-ton motor trucks, was much higher than were given by some published data. When proper allowances were made for depreciation and overhead costs, by the owners of the trucks, the records seemed to indicate that figures of less than 20 cts. per ton mile were rarely attained, and, under suburban conditions, that from 25 to 30 cts. per ton mile was undoubtedly a safer figure to use. He states that his investigations, made with a great deal of care, indicate that most of the published results are grossly inadequate in their assumptions.

Our correspondent expects soon to make public the full results of the studies mentioned in a discussion of experience in motor trucking before a prominent engineering society. In this we hope he will be joined by many others. Numerous actual cost data should now be available and should be given publicity. From the standpoint of engineers and contractors the subject of motor trucking cost is now old enough to render unwarranted further reasoning from assumptions and by inference. Contractors and engineers of public works departments who have actual motor trucking costs should make them public at this time.

WATER WORKS

Design, Construction and Cost of New Water Works Reservoir at Regina, Sask.

Contributed by R. O. Wynne-Roberts, Consulting Civil Engineer.

The part of Boggy Creek watershed from which the city of Regina obtains its main supply of water, is about 72 square miles in area, and the nearest point to the city is about six miles distant by skyline, or eight miles by road. The watershed has a pear-shaped boundary, the narrowest and lowest point being at the southwest corner where the city owns land. On this land about 45 artesian wells have been sunk, under the writer's advice; the water in all cases overflows the surface and is collected and conveyed by underground pipes to Barton pump-well, which has a capacity of 270,000 gals. In a pump house adjacent to the well there are two 80-HP. Crossley oil engines, and two 2,000,000-g.p.d. turbine pumps to raise the water to Tor Hill reservoir, which was described in ENGINEERING AND CONTRACTING of Dec. 10, 1913. This reservoir has a capacity of 5,000,000 gals. is built of reinforced concrete, circular in plan, 202 ft. in diameter and 25 ft. deep, and stands about 90 ft. above the pumps and about 120 ft. above the city street level. The water is conveyed from this reservoir to the city by an 18-in. steel main, which has a maximum delivering capacity of about 3,500,000 gals. per diem.

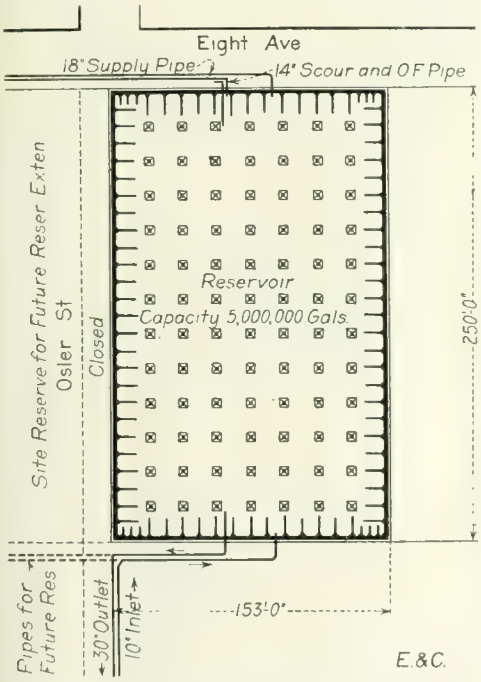


Fig. 1. Plan of New Water Works Reservoir at Regina, Sask.

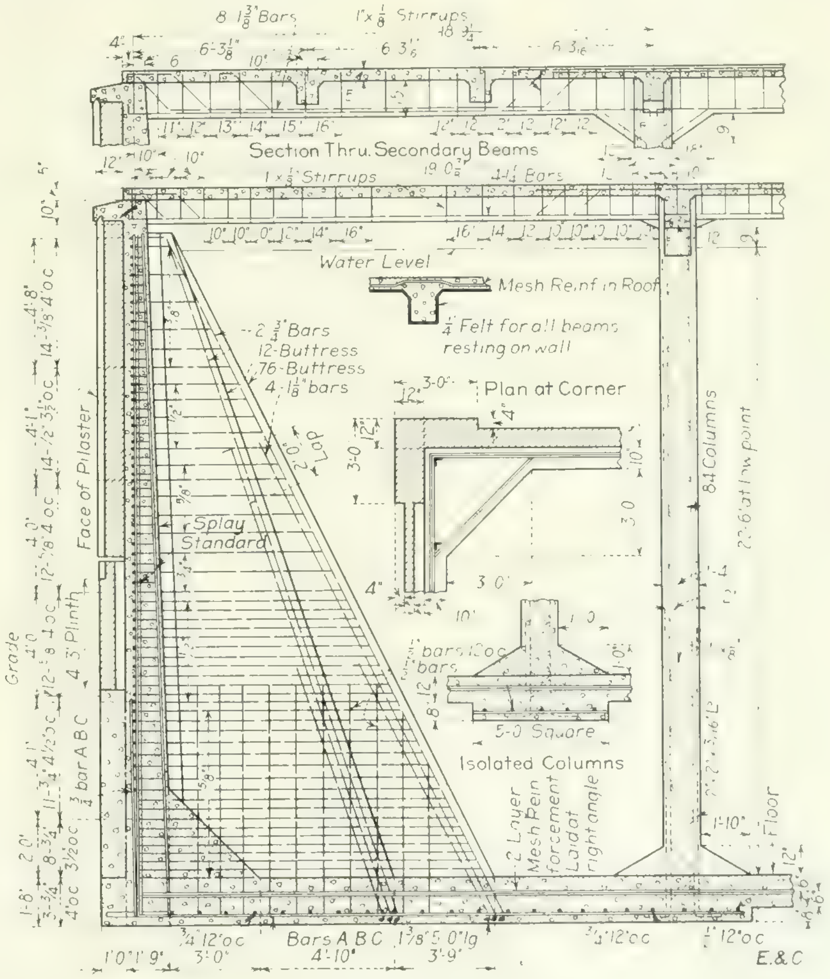


Fig. 2. Typical Sections Through Wall, Roof and Floor of New Water Works Reservoir at Regina, Sask.

In an adjoining section are located a number of springs, yielding from 400,000 gals. upwards, according to the season. This constituted the only source of supply for the city until 1911, and was quite inadequate. This water is conveyed by 15-in. vitrified pipes to a basin half way to Regina, and thence by a cast iron main partly 12 ins. but principally 10 ins. in diameter. The present total yield is from 2,500,000 to 3,000,000 gals. per day, but it is estimated that Boggy Creek area will yield up to 4,000,000 or 5,000,000 gals. per day, by extending the collecting lines and sinking additional wells.

The 10-in. supply is pumped into the city main by an electrically driven turbine pump, but the 18-in. ordinarily affords a gravity pressure of 45 lbs. per square inch. When the demand is great and the pressure is diminished, then the water is pumped by 5,000,000-g.p.d. Escher Wyss turbine pumps, driven by Bellis & Morcom high speed steam engine.

ADDITIONAL SUPPLY.

The writer some time ago reported to the city council on the question of additional water supply, and recommended the adoption of a scheme which involved the taking of water from five watersheds contiguous to Boggy Creek, making a total area of about 200 square miles and estimated to yield about 10,000,000 gals. per day. This scheme can be carried out piecemeal, provided the initial works are properly laid out. A part of the scheme was a 27-in. steel main to tap the Silver Stream area, with a branch to Tor Hill reservoir. As the existing mains from Boggy Creek were delivering the maximum quantity on gravitation pressure system, it was deemed desirable to lay the part of the 27-in. main from Tor Hill reservoir to the city so as to supplement the quantity and pressure. The cost of the pipe line was estimated at about $508,000, which was a large amount to incur under the prevailing financial conditions. As a city reservoir would be necessary even with such a main, City Works Commissioner Thornton considered that the reservoir would suffice for the time being. The supply to the reservoir is from the 10-in. line and the night surplus from the 18-in. main.

Having considered all points of the scheme, it was decided to build such a reservoir. There were two sites available, one near the cemetery on which a duplicate of the Tor Hill circular reservoir could be constructed, and the other a piece of land near the power house. Having regard to the convenience of a reservoir near to the power house and the obviation of the cost of laying a large main from the other site, the power house site was selected. This land, however, was limited and did not permit of embankments, consequently the writer designed a rectangular basin covering the entire site and part of a closed street, the length being 250 ft., width 153 ft., water depth 22 ft., and a capacity of 5,000,000 gals., which was estimated to cost about $125,000, exclusive of the land. The plan of the reservoir is shown in Fig. 1. Reservation was made for a duplicate reservoir to be built in the future.

DESIGN AND CONSTRUCTION OF NEW (POWER HOUSE) RESERVOIR.

The site was practically level, and as it was advisable to assure a constant head on the turbine pumps, most of the reservoir had to be built above ground. The floor level is 6 ft. below the ground surface, and the top water line about 16 ft. above. The work will be described in the order of construction.

Excavation.—It was intended to excavate the ground by machine, but to afford more employment, it was done entirely by manual labor. The excavation extended about 1 ft. beyond the wall lines, and to an average depth of 7 ft. 4 ins. The actual cost of labor was 46 cts. and team work 30 cts. per cubic yard. The material was entirely gumbo clay.

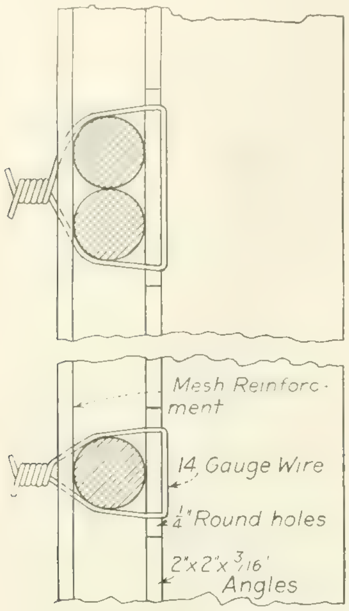


Fig. 3. Section Showing Method of Fastening Horizontal Reinforcing Rods in New "Power House" Reservoir at Regina.

Floor.—The floor for a distance of 22 ft. inwards from the walls is 20 ins. thick, the central portion is 12 ins. thick and under each column 20 ins. thick. The reinforcement consists of ¾-in. rounds at 12-in. centers in the lower part of the thicker concrete near the walls, and these bars extend 8 ft. up the walls to form the necessary tie. Half-inch round bars are also laid within 6 ins. of the surface at 6-in. centers in two directions. These bars are tied with wire at every fifth intersection in one direction, and at every intersection in the other. The column bases have an extra layer of ½-in. bars at 12-in. centers in the lower portion. The concrete was laid to the level of the bars, and when these were placed the next portion of concrete was poured on, and finally a 2-in. finishing coat of fine concrete was laid and trowelled to a close textured surface. There is a fall of 1 ft. from one end to the other of the floor, and a small fall from the sides to the major axis.

Walls and Counterforts.—The walls are 33 ins. thick at the base, with an addition of a splay on the inside of 36 ins. There is a set back on the outside of the wall at the ground surface, and here the concrete is 14 ins. thick, and at the top 10 ins. thick, as shown in Fig. 2. The external faces are vertical, but on the inside there is a batter of 11 ins. in a height of 23 ft. There is an overhanging coping on top with a sloping surface to shed the water. The set back and overhanging coping of 12 ins. will be the base and finish, respectively, of a cellular tile wall which will be explained further. The counterforts are 14 ins. thick, and are located on the line of beams and intermediately, and their bases extend into the reservoir for 11 ft. 6 ins. and finish at 9 ins. above topwater level, the projection there being 12 ins. The counterforts at the corners are smaller to admit of circulation of the water. The extreme corners were filled in solid to avoid complicated form work, etc. At the connections of counterforts with the wall 6-in. splays are provided. Spaces were left in top of walls to receive beams, etc.

Fig. 4. View of Concreting Plant for Regina Reservoir.

The reinforcements were calculated on the assumption that the walls between the counterforts were acting as simple beams, having depths equal to the thickness of the walls, and a uniform load equivalent to the varying depths of water. The horizontal reinforcements are round bars varying in diameters and spacing to correspond approximately to the area of steel required, at the base there are ¾-in. bars at 3½-in. centers, and at the top ⅜-in. bars at 4-in. centers. These bars were cranked at the necessary distances and the ends bent. As it was too troublesome a work to frequently change the cranking, owing to the reduced thickness of the wall, the changes were made at six points. The counterforts were calculated as cantilevers hinged at the base of the wall and tied to the floor at the toe, and are horizontally reinforced at the same spacing or multiples thereof as the wall, but the diameters are less. The tension bars connecting the toe to the floor consist of nine 1⅛-in. rounds linked round bars of the same diameter, inserted crossways in the floor concrete. These bars extend upward for one-third the height; there the number is reduced to four, and from two-thirds height to the top there are two ¾-in. rounds. The overlaps are 2 ft., and the ends of the bars are all bent. The horizontal bars connecting the tension bar to the wall are bent into horizontal hooks to slip over the tension bar and vertical bends to fall over the wall bars. There are ½-in. rounds at 12-in. centers vertically connecting the counterforts with the floor. To provide for temperature stresses, continuous triangle steel mesh reinforcements are inserted within about 3 ins. of the outside face.

As it was most important that the horizontal wall reinforcements should be placed where designed and held there during the process of concreting, the writer adopted practically the same method as on Tor Hill reservoir. Vertical standards consisting of 2x2x3/16-in. angles are located one at each buttress and two between. Two holes were drilled in one web to receive each bar, and a soft wire inserted through the two holes to bend the bar in place at the required distances apart, see Fig. 3. This method fixed the bars permanently, and although men climbed up and down, no movement took place. The reinforcements and supports gave the impression of a secure steel basket work. All overlaps of wall reinforcements took place at junction of the counterforts with the wall.

Columns.—The 84 columns are 18 ft. 9 ins. apart in one direction and 19 ft. ⅜ in. in the other, and are 16 ins. square, resting on pyramidical bases, and the height from the top of the base to the underside of the beams is 21 ft. 9 ins., or slightly over 16 times the least dimension. It is somewhat difficult to assure true alignment and perpendicularity for a vertically cast column of this height, and to prevent any bending, the reinforcement consisted of 2x2x3/16-in. steel angles tied together by 1x⅛-in. flat iron riveted at 24-in. centers, which proved to be very satisfactory.

Roof.—It was intended to construct the roof entirely of reinforced concrete to carry a live load of 200 lbs. per square foot, and careful designs were prepared for this purpose, but owing to a suspension of the work caused by financial disturbances due to the European political situation, much time was lost and it was necessary to adopt a quicker method of construction. Consequently steel joists were substituted for the reinforced concrete beams. The primary beams run across the reservoir, and the secondary beams lengthwise. The primary beams are 18 ft. 9 ins. long and rest on the columns, and the secondary are 19 ft. ⅜ in. less thickness of primary web and are secured together by standard angle connections. The secondary beams are 6 ft. 4 ins. apart. The roof concrete floor is 5 ins. thick, rests on the steel beams and is reinforced with No. 31-A continuous triangle steel mesh 54 ins. wide, with overlaps of 4 ins. The work of concreteing has had to be suspended owing to the frost, and will be completed in the spring. Manhole covers at each end and four ventilators were inserted in the roof. The roof has a fall of 12 ins. from the middle to the ends and rainwater outlets are provided to carry off the surface water. The roof beams and concrete are disconnected from the walls by a thick layer of felt, so as to obviate any stress induced by temperature contraction or expansion being applied to the walls.

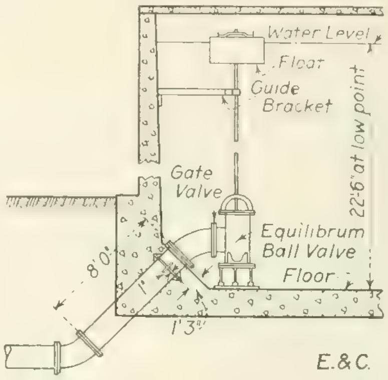


Fig. 5. Sectional Elevation Through 18-in. Inlet of New Water Works Reservoir at Regina.

Water Proofing.—No waterproofing compound was used with the concrete, but when the walls were dry a thick layer of hot liquid bitumen was painted on, and this was afterwards coated with neat cement cream. This process was found to be effectual in the Tor Hill reservoir and was again applied in this case. The roof will be coated in a similar manner.

Concrete Mixtures.—The cement was supplied by the Canada Cement Co. and the gravel was obtained from the city gravel pits, supplemented by some screened gravel from the neighborhood. The pit gravel was tested before the work was started and found to be fairly uniform. No screening was done. There are railway spur tracks at each end of the reservoir, which were found to be very convenient, for the gravel was shovelled into the hopper, cement added and the whole mixed by Ransome mixers. Five bags of cement per

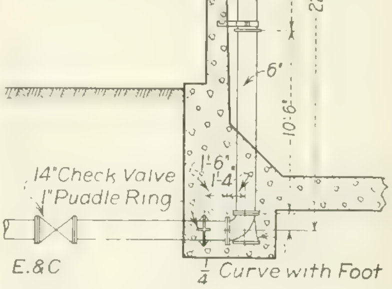


Fig. 6. Sectional Elevation Through 14-in. Overflow, Regina Reservoir.

cubic yard of gravel were used in the floor; 6 bags in the walls, 8½ bags in the columns, 8 bags in the roof, and 6.3 bags per cubic yard in the floor finish.

Drawings.—The drawings were so prepared that the nature of the reinforcements in every part of the work could be seen, that is, the position of the cranks, bends, overlaps, etc., were shown, and the number of bars, diameters, lengths, and weights were given. When the work was being carried out, the cranked bars fell into their allotted places and then were fastened by wire. The work proceeded methodically from start to finish, and doubtless this contributed considerably to the economies effected, for there was very little loss of labor and materials, the work having been prearranged.

Placing Concrete.—As the concrete was mixed it was conveyed in ordinary two wheel tipping concrete carts over runways erected from time to time in the most convenient positions. Men were employed in slicing the concrete in place, and care was taken to assure that the steel was properly covered. Figure 4 is a view of the concreting plant.

Drains.—An 8-in. sewer pipe was laid outside the base of the walls to remove any water that may collect there, and also to conduct the rainwater to the sewer.

Tile Facing.—As the land occupied by the reservoir was limited and expensive, it was essential that the fullest possible use should be made of it. Consequently embankments had to be eliminated and the walls supported internally, hence the reason for using counterforts. Owing to the absence of external protection such as would be obtained by embankments, steps were taken to insulate the wall against temperature in another manner. After due consideration, the method that was deemed expedient was the construction of an external cellular tile facing. Ties have been left on the outside of the concrete walls to bind the tile facing to it. The facing has been designed to produce a pleasing effect, by providing pilasters and recessed panels. The winter arrived before this work could be undertaken, and consequently it was held over until the coming spring weather.

Inlets.—There are two inlets, one at each end, one 18-in. and one 10-in.; this is because of local conditions. Each inlet is provided with a sluice valve on the outside of the reservoir, and a Glenfield & Kennedy equilibrium ball valve which will control the height of water at any predetermined level. As previously mentioned, the 18-in. inlet will discharge the surplus night flow, and to assure the city a pressure, a Glenfield & Kennedy loaded equilibrium valve with by pass, has been inserted on this main, and so adjusted that no water will discharge into the reservoir until the main pressure has exceeded a fixed point. In other words, the equilibrium valve will act as a relief, and when the water level has reached a definite position, then the ball valve will shut off the supply. The 18-in. inlet is shown in elevation in Fig. 5.

Outlet.—There is one 30-in. bell mouthed outlet at the upper end of the reservoir, and this is connected to the pumping plant in the Power House close by. All valves on this line are 24-in., with taper pipes at each end.

Overflow and Scour.—These are located at the lower end of the reservoir. The overflow pipe has a bell mouth top, and is 22 ft. 6 ins. above the floor at that point. It is secured to the wall by 4x½-in. steel stays. The scour pipe, also 14-in. diameter, is situated in a sump 3 ft. deep. The overflow and scour run into one pipe outside the reservoir where the valves are located. An elevation of the overflow is shown in Fig. 6.

All external valves are provided with chambers. Ladders are constructed of 4x½-in. steel stringers and ¾-in. rings 15 ins. apart, and 18 ins. long.

Puddle Rings.—All cast iron pipes, bends, etc., inserted in the concrete work were provided with 6x1-in. puddle rings cast on with brackets, with the view to preventing water seeping along the pipework.

Power House Connections.—Inasmuch as it was important to provide adequately for fire extinction, the writer advised that the connections between this city reservoir and the pump should be made as large as possible, to suffice for some years, and in the interval the additional 27-in. main from Tor Hill reservoir, already referred to, would doubtless be constructed.

The basis of the calculation in connection with computing the quantity of water required for fire extinction purposes, was the formula suggested by the American National Board of Fire Underwriters, which is: $Y = 850 \sqrt{X} (1 - 0.01 \sqrt{X})$, in which Y represents imperial gallons per minute, and X represents the population in thousands.

The pipe arrangement at the power house consists of one 36-in. supply main fed by the 18-in. main from Tor Hill reservoir and 30-in. pipe from the city reservoir, and one 36-in. delivery main; these are parallel and only a few feet apart. When the gravity supply and pressure from the 18-in. main is ample (supplemented by the 10-in. supply which hitherto had to be pumped), then the water passes direct into the 36-in. delivery main; otherwise all water is conducted to the supply main and pumped at city pressure into the 36-in. delivery main. There is an outlet from the 36-in. delivery leading into a warmed underground chamber under the footway, and there it is divided into three distributing mains, 24-in. to southeast district, 24-in. to southwest district and an 18-in. to the north district. Each of these distributing mains is so arranged that the connections in the chamber will allow one, two or three of the branches to be used simultaneously. On each branch there is a Glenfield & Kennedy pressure regulating valve, which can be adjusted to any pressure, and each main has a Simplex Venturi meter. The pressure regulating valves are normally out of commission, but when a fire occurs in any district, two of the pressure regulators are put into action by simply opening small taps near the pump, and thus the fire pressure produced by the pumps is thereby concentrated on the district from which the alarm was received. These regulators have lever arms carrying the weights which fix the outlet pressure, and the piston connected to the free end of the lever is operated by the outlet pressure, causing it to rise or fall, and in doing so an indicator in the power house is moved correspondingly, and thus the operating engineer can see at a glance what is taking place.

Each Venturi meter is connected to the power house by two wrought iron pipes, which conduct the main pressure and the throat pressure to the recorder which indicates the rate of flow, records on a chart the varying flows and also shows by a counter the total quantity discharged.

The credit for the neat and simple contrivance installed in connection with the regulator valves and Simplex Venturi meters is due to Mr. T. H. Smallwood.

Forms.—The wall forms consisted of 1x8-in. sheeting supported by 2x4-in. uprights at 24-in. centers, tied and strutted to forms on the opposite face by soft wire. The counterforts were formed in a similar manner, except that the sloping face had 2x8-in. and splays 2x10-in.

The runways were built of 6x6-in. verticals, 4x6-in. horizontals, and 2x12-in. surface boards.

COST OF RESERVOIR.

As already stated, the estimated cost of the reservoir and connection was $125,000; the reservoir alone was estimated to cost $110,000, and the connection the balance. The total actual cost of the reservoir was $78,514.86, and the pipe connections $14,951.72, making a total of $93,466.58, or $94,657.00 inclusive of sundry expenses, so that a saving of at least $30,343, which is equal to 23.2 per cent on the estimate, was effected by carrying out the work under the direct control of the waterworks department.

Itemized Cost.—Following are a few of the itemized costs:

Labor	
Excavation, per cu. yd.	$[illegible]
Concrete mixing for floor, per cu. yd.	.47½
Concrete placing, for floor, per cu. yd.	.21½
Concrete mixing, for walls, per cu. yd.	.54
Concrete placing, for walls, per cu. yd.	.50
Concrete mixing, floor finish, per cu. yd.	.51½
Concrete laying, floor finish, per cu. yd.	2.03
Concrete mixing, columns, per cu. yd.	.46
Concrete placing, columns, per cu. yd.	1.22½
Concrete mixing, roof, per cu. yd.	.49½
Concrete placing, roof, per cu. yd.	.44½
Steel reinforcement in floor, per 100 lbs.	.16
Steel reinforcement in walls, per 100 lbs.	.59½
Steel angle standards, per 100 lbs.	.77
Steel bending for walls, per 100 lbs.	.44½
Steel mesh in roof, per 100 lbs.	.20¾
Formwork wall, per sq. ft.	.05
Stripping formwork from walls, per sq. ft.	¾
Formwork for columns, per sq. ft.	.05¼
Stripping formwork from columns, per sq. ft.	.01½
Formwork for roof, per sq. ft.	.03
Waterproofing walls, per sq. ft.	½
Cement washing walls, per 100 sq. ft.	.70
Structural steel in roof, per ton	2.94
Placing column reinforcement, per 100 sq. ft.	.70½

The walls cost for labor in placing concrete:

$0.30½	per cu. yd. for the first 9 ft. in height.
.47	per cu. yd. for the second 9 ft. in height.
1.05	per cu. yd. for the third 9 ft. in height.

ACKNOWLEDGEMENTS.

The City Works Commissioner (Mr. L. A. Thornton) took an active interest in the work, which was managed by Mr. J. M. MacKay, the Water Works Superintendent. Mr. H. Gibson had charge of the execution of the work, and Mr. I. Ormond Riddell was the Resident Engineer. Mr. Theo. Brockmann checked the design.

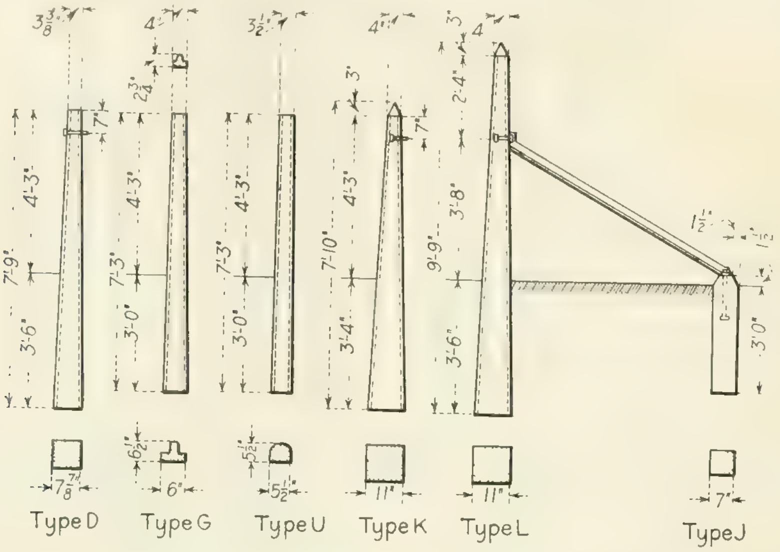
Design and Cost of Concrete Posts Used Along Catskill Aqueduct.

The Board of Water Supply of the City of New York has used about 150 miles of reinforced concrete fencing around the Ashokan reservoir, spoil banks, borrow pits, gate houses and other locations along the Catskill aqueduct.

In enclosing the Ashokan reservoir property, over 14,000 concrete posts were used by Mr. Honness, Department Engineer of the Reservoir Department, in constructing about 43 miles of fencing, the posts being placed at intervals of 16 ft. Straining or anchor posts were used on straight lines at intervals of about 300 ft. and at all abrupt angles. These posts were 3½ ins. square at the top and 8 ins. square at the bottom and 7 ft. 9 ins. long. They were reinforced with four ¼-in. square twisted steel bars, held in position by five hoops made of the same material. The line posts were "U" shaped, 5½ ins. over all at the bottom and 3½ ins. at the top, reinforced with four No. 5 U. S. steel wire gage rods. All posts were made on the site by the contractor for the fencing, the concrete consisting of one part cement to four parts aggregate in which the sand was limited to ¼-in. maximum size and the stone to such size as would pass through a ¾-in. screen and be retained on a ¼-in. screen.

The specifications required the posts to be kept moist for two weeks. Occasional sprinkling was not satisfactory and it was necessary to cover the posts with something that would retain the moisture. After being cured from 15 to 30 days, the posts were hauled to the site on wagons equipped with platforms on which the posts lay flat, no packing of any kind being used. The number of posts damaged in handling did not exceed 1.5 per cent. The posts in general have been satisfactory, but would perhaps have been more satisfactory had the square posts used as end or anchor posts been made with a heavier section, as an unbalanced strain occasionally broke them off at the surface of the ground.

These posts were furnished under a contract which included the manufacture, delivery and setting, but not the excavation of the hole or the cement and reinforcement used in their manufacture. At the contract prices, the cost of the line posts in place was $1.47 each, distributed as follows: Post, 90 cts.; cement, 14.5 cts.; reinforcement, 17.5 cts.; excavation and



Types of Reinforced Concrete Fence Posts Built Along Catskill Aqueduct.

Type D—4 pieces ¼ in. square by 7 ft. 8 ins. long, corrugated; weight 6.75 lbs.; 0.60 bag cement; volume 1.792 cu. ft. Type G—3 pieces No. 5 wire 7 ft. 2 ins. long; weight 2.45 lbs.; 0.20 bag cement, volume 0.595 cu. ft. Type U—4 pieces No. 5 rods 7 ft. 2 ins. long; weight 3.26 lbs.; 0.32 bag of cement; volume 0.9063 cu. ft. Type K—4 pieces ½ in. square by 7 ft. 6 ins. long, twisted; weight 26.35 lbs.; 1.05 bags of cement; volume 3.185 cu. ft. Type L—4 pieces ½ in. square by 9 ft. 6 ins. long, twisted; weight 32.3 lbs.; 1.14 bags of cement; volume 4.025 cu. ft. Type J—0.31 bag of cement, volume 1.045 cu. ft.

backfilling, 25 cts. The corner and anchor posts, set in concrete with one brace and thrust block, complete in place, cost $13.81, made up of the following items: Post $1.30, cement 32 cts., reinforcement 43 cts., earth excavation 50 cts., concrete to refill post hole $6, galvanized angle iron brace $3.02, excavation for thrust block, earth, 14 cts., concrete for thrust block $2.10. Post holes for line posts in rock cost 40 cts. each additional and for corner and anchor posts and thrust blocks $1.02 additional.

In the Southern Aqueduct Department, Mr. F. E. Winsor, Department Engineer, used approximately 7,500 posts in building about 23 miles of fencing along highways, property lines and right-of-way. These posts were manufactured by the contractor at three points, from which they were distributed over a length of line of about 30 miles. As a rule, the posts were not delivered and set in less than 30 days after being cast.

Complete data are not available, but it is estimated that in handling not over 3 per cent of the type "G" post were damaged and not over 1 per cent of the heavier types. In general the posts were delivered by automobile trucks. Type "D" posts were found rather light for anchor posts, but type "K" was found very satisfactory.

To obtain satisfactory bond in type "G" posts, it was necessary to rust the reinforcing wires by diluted solution of salammoniac; it is believed that more satisfactory results would have been obtained by using twisted rods for reinforcement. Some crazing has developed on the surface of these posts, and it is feared that, due to the thin section of concrete, this may shorten the life of the posts. It was also noted that the strength of the posts was materially decreased when the reinforcement was too near the neutral axis.

Tests were made on 19 posts. They were tested as cantilever beams 4 ft. long, with a gradually increasing load concentrated at the end.

The average breaking load (four tests) for posts made of run-of-bank was 180 lbs. Posts made of crushed trap rock, in which clean, smooth rods were used, developed a breaking load (three tests) of 185 lbs., while the average for posts slightly rusted (five tests) was 324 lbs. By substituting three ¼-in. deformed bars for No. 5 gage wire, the average breaking load obtained in five tests was increased to nearly 500 lbs. The types of posts described above with their reinforcement are illustrated by the accompanying drawings, Fig. 1.

ACKNOWLEDGMENT.

The foregoing information is from the 1915 report of the Committee on Signs, Fences and Crossings of the American Railway Engineering Association as published in the Bulletin of the Association for December, 1914. The committee acknowledges its indebtedness for this information to Mr. J. Waldo Smith, Chief Engineer of the Board of Water Supply of the City of New York and to Department Engineers George G. Honness and Frank E. Winsor.

Pumping Capacity in Pennsylvania Coal Mines.—The quantity of water that must be pumped and hoisted out of the anthracite mines of Pennsylvania has increased nearly 10 per cent in the last ten years, and will continue to increase, making the mining of anthracite constantly more expensive. It has been computed that every ton of coal removed from the mines involves the removal of a ton of water every year thereafter until the mine and all workings connected with it are worked out and abandoned.

In 1904 there were 846 pumps below ground and ten years later there were 929 pumps, many of them of greater capacity than the old ones they replaced, besides the huge water hoists. In 1904 the capacity of these pumps was 745,690 gals. per minute as against the 1,037,009 gals. per minute recorded as their capacity in the last annual report of the Pennsylvania Department of Mines.

All of this pumping capacity, necessary to meet periods of "heavy water," is not in use all the time. The quantity of water actually delivered at the surface in 1904 was 446,120 gals. per minute. Ten years later it was 489,600 gals. per minute, or about 250,000,000,000 gals. a year. This is equal to approximately 950,000,000 tons a year, or thirteen and a half times as many tons as the total output of coal.

ROADS AND STREETS

The Economic Design of Culverts for Various Depths of Fills.

The economical length of culverts for use on highways and the design of headwalls for various depths of fills were discussed in a paper before the Ohio Engineering Society by P. K. Sheidler, a division engineer of the Ohio Highway Department, as follows:

Under ordinary conditions the headwalls of highway culverts should have the same length and height, irrespective of depth of fill over them—unless some special condition exists, as mentioned later. This design allows the use of standard plans in the construction of culverts. To use a standard plan one has only to determine the proper length of barrel for the given depth of fill at a certain location. In getting out a set of plans where standards are used, one blue print of a certain type of structure can be used for more than one structure, if the necessary length of barrel be indicated for each particular structure.

It is a fact that there are cases where headwalls must be designed higher and necessarily longer than ordinary circumstances would demand. These are: (1) Where the end or ends of the culvert would come outside of the right-of-way line, and it would either be impractical or impossible to procure additional right-of-way.

(2) Where the additional filling material would cost more than the extra masonry in the larger walls. While this case is rare, it is possible—such as in rock cut, or where filling material would have to be hauled an excessive distance, and materials for masonry construction easily obtained.

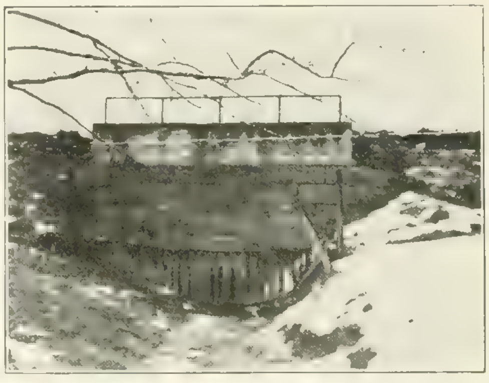


Fig. 1. A Stone Arch Culvert of 4 ft. Span With High Head Walls.

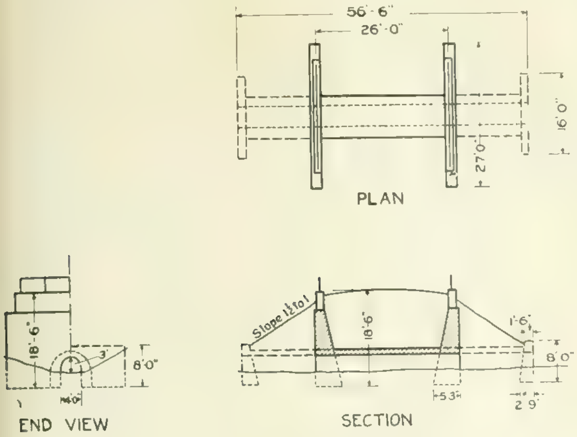
(3) On side hill slopes where the grade of flow line is as great or greater than the side slopes of the road improvement, calling for a wall to be built as close to roadway as clearance will allow.

(4) Where the structure occurs in a V-shaped ravine of practically constant width, in which the grade of flow line is very steep.

It is a common practice to design headwalls of a sufficient length to keep the opening clear when earth is assumed to fall around the ends of the headwalls on a 1½ to 1 slope. Some soils require designing for flatter slopes than this, while perhaps in some cases a steeper slope could be assumed without obstructing the opening.

When culverts are to be constructed in connection with new road work, it is very essential that attention be given to this feature, as freshly excavated material will be brought against the headwalls in finishing the bermes or dressing the slopes. In building structures on a road not being improved, this is nearly as important from the standpoint of future improvement, but the need of it is not so apparent at the time, as the earth surrounding the headwalls has become settled, and will, from several causes, stand at a steeper slope.

In planning culverts another important feature must be kept in mind. I refer to the necessity in future years of providing more roadway for increased traffic. Today we are replacing bridges of 12 and 14-ft. roadway with those of 16, 18 or even 24 ft. If a culvert had been constructed 25 years ago with a high, massive headwall, instead of a long barrel and low headwall, today it becomes necessary for us to destroy all of this large wall—or at least to remove part of it and cover it over—in order to carry a wider roadway across. Extending a culvert that has been built with long barrel and low headwall can be done at a much less cost.



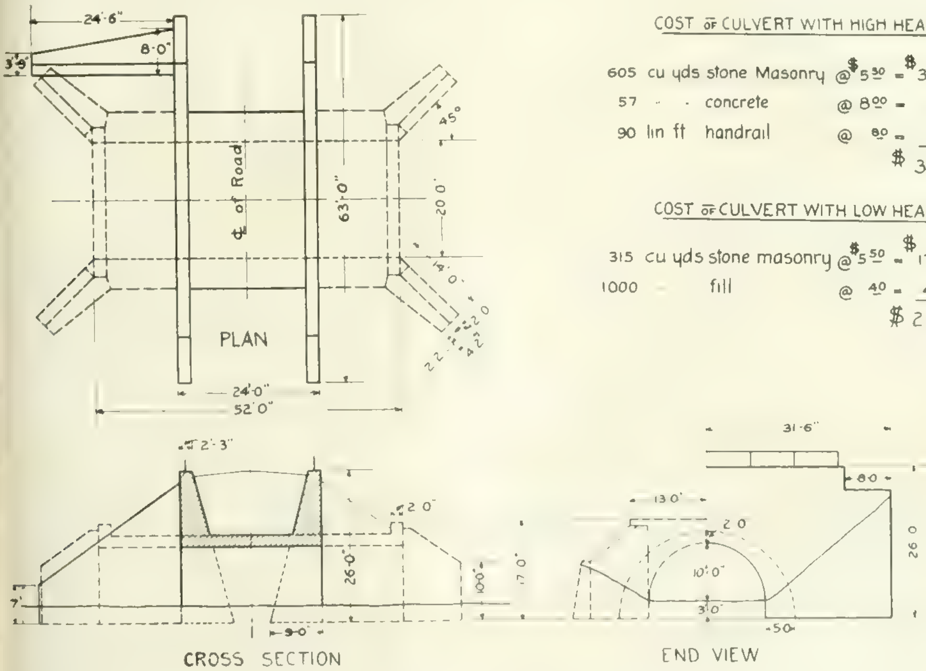
COST OF CULVERT WITH HIGH HEADWALLS		
120 cu yds stone masonry	@ 5.50	= $660.00
9 " " concrete	@ 8.00	- 72.00
50 lin ft handrail	@ .80	- 40.00
		$772.00

COST OF CULVERT WITH LOW HEADWALLS		
70 cu yds stone masonry	@ 5.50	$385.00
200 " " fill	@ .40	80.00
		$465.00

Fig. 2. Comparative Design With Long and Short Barrels of the Culvert Shown in Fig. 1.

Figure 1 shows a small stone arch culvert of 4-ft. span. The height of wall above flow line is 15½ ft., but the length of wall is only 27 ft. The grade of the roadway is level with the top of the headwalls, which are 24 ft. apart.

Being able to measure only the length and width of the wall at the top, it was necessary to assume a bottom width of the walls in order to compute quantities. The assumption made for this bottom width was 35/100 of the total height of wall. This may be slightly less than the practice of some designers would permit, while on the other hand we find walls that have thus far performed their duty with a base of less than 3/10 of the height. However, for these comparisons, we have universally used 35/100 of the total height for the base of all headwalls. Using this basis, the quantities computed as being in this structure are: 120 cu. yds. stone masonry; 9 cu. yds. concrete, and 50 lin. ft. handrail.



COST OF CULVERT WITH HIGH HEADWALLS		
605 cu yds stone Masonry	@ $5.50	= $3327.50
57 " " concrete	@ 8.00	= 456.00
90 lin ft handrail	@ .80	= 72.00
		$3855.50

COST OF CULVERT WITH LOW HEADWALLS		
315 cu yds stone masonry	@ $5.50	= $1732.50
1000 fill	@ .40	= 400.00
		$2132.50

Fig. 4. Comparative Design With Long and Short Barrels of the Culvert Shown in Fig. 3.

In all of these examples, the cost of excavation for the wall is assumed to be included in the yard price of the masonry, which is a common practice in the counties in this state, and owing to the difficulty of our making any rational assumption as to the probable contour of the original road section at the time these structures were built. We must treat the cost of excavation in this manner. This, no doubt, gives the original structure an advantage in these comparisons of costs, for excavating for the large walls shown, located as they are, up against the roadway, would result in larger quantities than we would get for small headwalls.

To effectively show the difference in quantities obtained by designing a structure of the same waterway as the present one, and fitting the road section also, but with a long barrel and small headwall, a design, Fig. 2, has been prepared portraying the new design superimposed on the old. The new design being shown in dotted lines where it extends beyond the limits of the old.

The same assumptions were used in obtaining the small headwall dimensions except the length is designed for a 1½ to 1 slope, while the old wall would have to be 44 ft. long to carry a 1½ to 1 slope.

The quantities contained in the new design complete are: 70 cu. yds. stone masonry, 200 cu. yds. earth fill.

The comparisons of cost using unit prices prevailing at the time the structure was built are shown in Fig. 2. The price of $5.50 per cu. yd. was the actual cost of stone masonry on one of the structures used as an illustration. This cost is not for merely building extensions to the present culvert, but represents the cost of an entirely new culvert. There would have been a saving of $307 in the cost, had the new design been used.

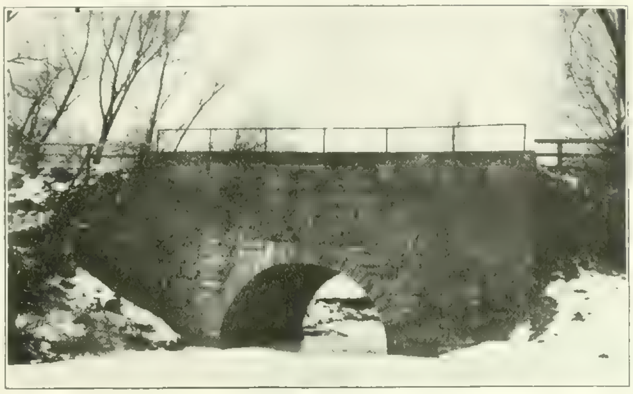


Fig. 3. A Stone Arch of 20-ft. Span.

The structure shown in Fig. 3 is a stone arch of 20-ft. span. This culvert is located in a fill across a valley perhaps 800 ft. wide, and the road grade is practically 18 ft. above the adjoining fields.

The side walls are not designed for 1½ to 1 slopes. Had they been, the side walls would be 86 ft. long instead of 63 ft. Old willow trees on both sides of this fill help considerably in keeping the fill in place. However, it was necessary to build the large concrete wall shown in Fig. 4 to keep the fill back when a subsequent widening of the fill was made. Also the bank at the other end of the same wall was riprapped for the same purpose. Using the same assumption for width of walls at bottom, the quantities and estimated cost of structure, not including riprap, are shown in Fig. 4.

The other type of structure designed for this cross section is shown by the dotted lines, and quantities and estimated cost also given in Fig. 4 show a saving of $1,723.

The third structure shown in Fig. 5 is a stone arch of 4-ft. span. The plan shows a stone wall 49 ft. 6 ins. long and 17 ft. 3 ins. high above the flow line. At each end is a short concrete wall evidently built at a later date to intersect the sides of the ravine shown in the photograph, to keep the road fill entirely behind the wall.

The upper end of the culvert, Fig. 6, is not shown for the reason that it extends under the railway fill, and takes care of underground drainage which does not require a headwall.

The cost of the high wall is estimated to have been as follows:

169 cu. yds. stone masonry at $5.50	$ 929.50
22 cu. yds. concrete at $8.00	176.00
Total	$1,105.50

while the cost of construction shown in dotted lines is:

30 cu. yds. stone masonry at $5.50	$165.00
300 cu. yds. fill at 40 cts	120.00
Total	$285.00

The smaller headwall design in this case would have cost about one-fourth that of the design used—a saving of $820.50.

To show graphically the difference in cost between the two kinds of designs, a curve has been drawn for each. In the upper left-hand corner of Fig. 7 (see p. 291) is shown in full lines the culvert used as a base—30 lin. ft. of 18-in. cast iron pipe with gravity headwalls designed to hold a 1½ to 1 slope. Superimposed on this section is shown in dotted lines the two methods discussed of increasing the structure to provide for the increased depth of fill above flow line.

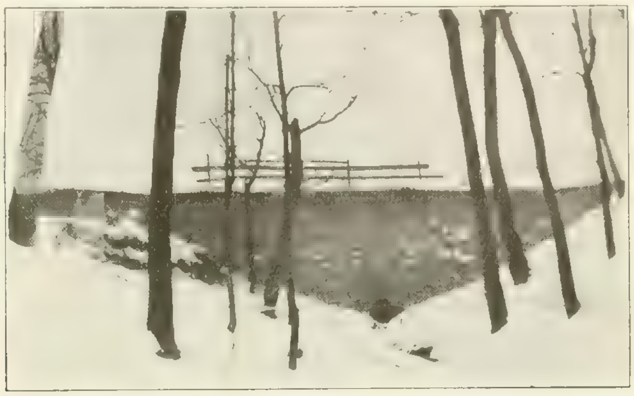


Fig. 5. A Stone Arch of 4-ft. Span.

Two tables were computed to obtain data for plotting the curves and are also shown. The table marked "A" (see p. 291) gives total costs of culverts whose barrels are kept a constant length of 30 ft. and whose headwalls are raised and lengthened for different depths of fill varying by 1 ft.

Table "B" shows the cost of culverts whose headwalls are kept of constant dimension, and whose barrels vary in length to fit the road section.

The curve "C" was plotted to show the cost of fill that would be necessary to cover the barrel of the long culverts and to occupy the space taken up by the high headwalls, if they were to be removed. The area between the curves "B" and "C" represents this cost—the ordinates being plotted from the curve "B."

The sudden jump in the upper curve is caused by adding the cost of handrail to this type of culvert at the point where top of the wall is five feet above flow line in order to comply with the state law governing this. The assumed prices used are:

Concrete, cu. yd	$8.00
18-in. cast iron pipe, lin. ft	2.00
Handrail, lin. ft	1.00
Earth fill, cu. yd	.40

In order to show a specific example from these tables, we have selected the two types of culverts that would be necessary for a fill of ten feet above the flow line—the two types are superimposed to make the comparison more striking. This is shown in Fig. 7. The cost of the culvert with the high walls is $607.60, while that of the other is only $162.80, representing a saving of $444.80.

To summarize, the following points should be considered in culvert design: (1) The design of drainage structures requires as careful attention as any other part of a road improvement. (2) The primary object of a culvert is to conduct water under the roadway. (3) Where a large amount of culvert work is to be handled, a design with the length of barrel as the only variable, enables one plan to be used for many culverts. (4) Ordinarily, for a given depth of fill, a culvert with a long barrel and small headwalls, can be built at less cost than one with a short barrel and large headwalls.

The Equipment and Maintenance of Convict Gangs in Georgia.

To secure accurate data to form a basis for the investigation of road work for misdemeanor convicts a questionaire was prepared to be submitted to persons actually engaged in working misdemeanor convicts on the roads. This questionaire has been sent to every county in Georgia and the results obtained are presented here in a condensed form. They give the viewpoint of citizens and officials in Georgia and are uncolored by outside influence. These data were presented in a paper before the Philadelphia Convention of the American Association for the Advancement of Science, by Jas. Leland Stanford.

NUMBER OF CONVICTS EMPLOYED.

The Georgia Prison Commission reports that practically all of the misdemeanor and felony convicts with the exception of the women and those in poor health are employed in some phase of highway work. A total of 2,441 misdemeanor and 2,740 felony convicts were worked by 124 counties during 1914.

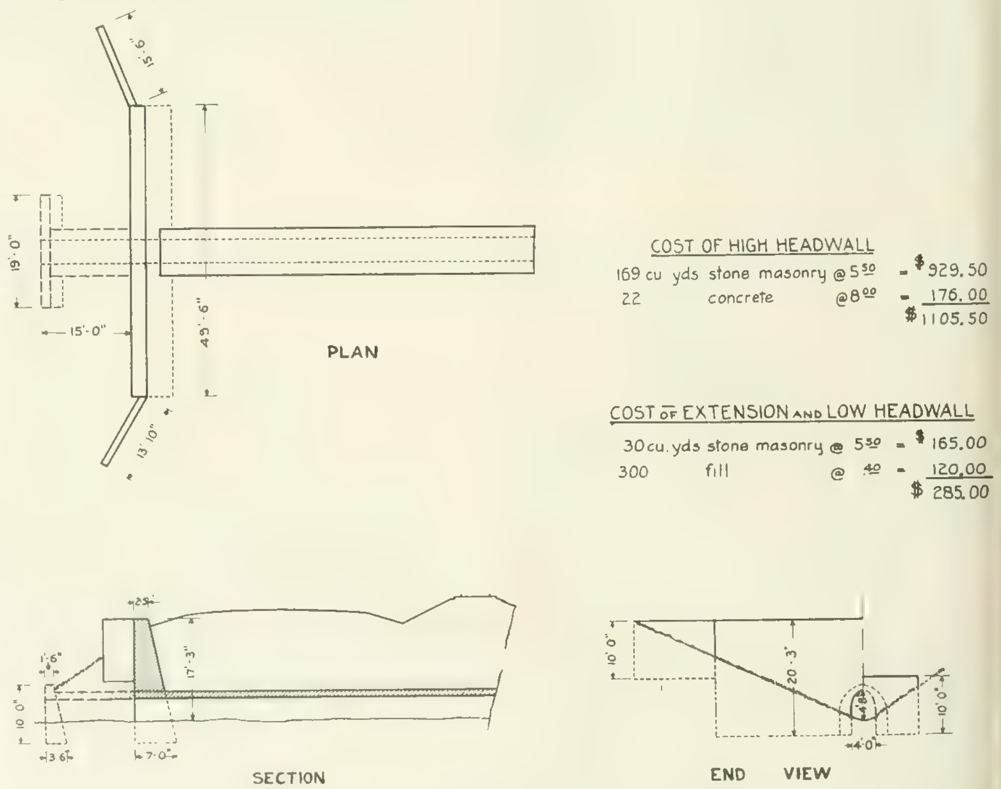


Fig. 6. Comparative Designs With Long and Short Barrels of the Culvert Shown in Fig. 5.

SIZE OF A ROAD GANG UNDER ORDINARY CONDITIONS.

Regardless of the kind of work undertaken by a convict gang the factors noted in Table I will be involved. The annual interest on the first cost and depreciation of the equipment are included in the annual expense of maintaining the convicts. The economical solution is to so adjust the size of road gang as to render the sum of these factors a minimum.

According to reports received and actual experience, which may be said to have passed the experimental stage, a guard can most economically and advantageously handle 15 men. Fifteen men per guard under ordinary local conditions in the southeastern states has, therefore, been chosen as a unit. And it is suggested to the engineer that in planning a county gang, to make the gang some multiple of fifteen, if he would secure the greatest efficiency per guard and the greatest efficiency per gang. The size of a gang varies in numbers according to the wealth and population of the county, as each county works its own misdemeanor convicts. In exceptional instances only should a road gang be less than two units or 30 men, as the expense per man has been found to increase rapidly when the number is smaller.

The number of units comprising a gang should be proportionately determined by such factors as the expense per man; mileage of roads to be constructed and repaired; the character of the work to be done; the class of men in the gang; and the equipment provided.

Mr. John C. Koch, Athens, Ga., reports that in heavy cuts and fills gangs work efficiently up to seven units. For ordinary construction work on county roads some distance from a base of supplies, experience has proved it more economical to divide a gang when it exceeds appreciably six units.

The expense per man both as to food and guarding at night increases rapidly as the number of men in a gang falls below 30 and decreases just as rapidly as the gang increases by units up to a certain limit. One night guard can handle a camp of 90 convicts quite easily since the day guards sleep nearby and are ready to give him assistance at any time.

Moreover, men who worked on the roads all day hardly need a guard at night. When

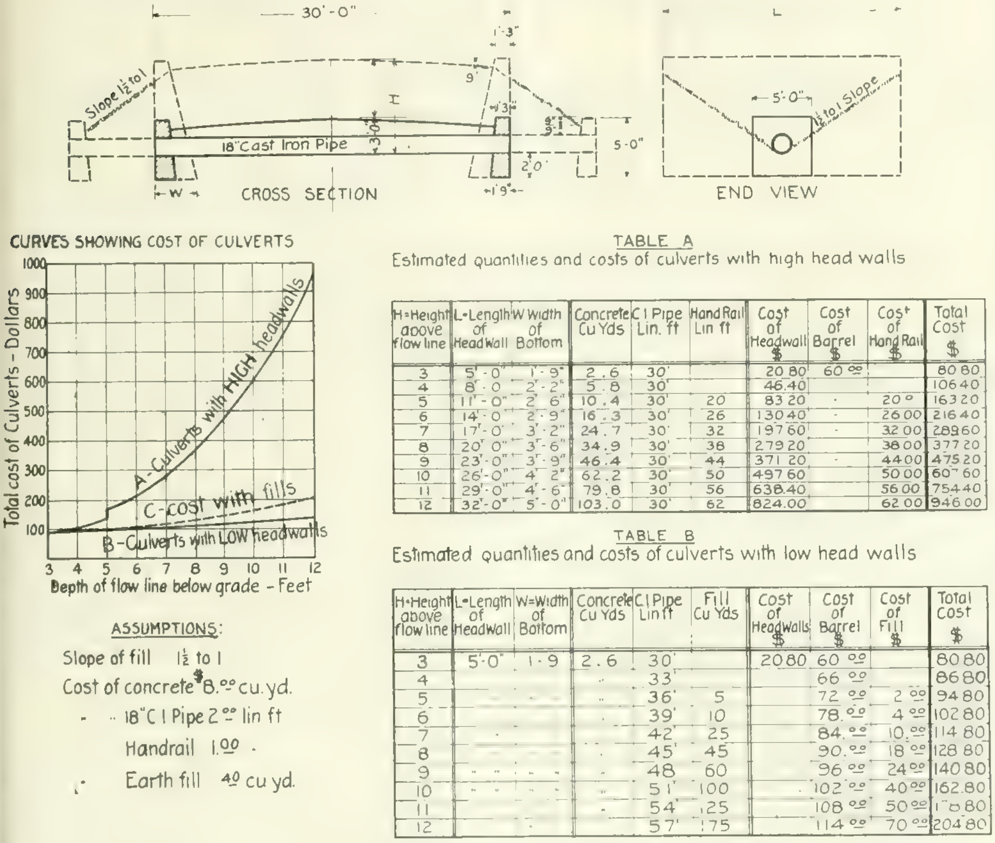
TABLE I.—COST OF MAINTENANCE PER CONVICT PER DAY.

	One unit.	Two units.	Four units.	Six units.
1 physician	0.111	0.055	0.027	0.019
1 warden	0.133	0.066	0.066	0.022
1 day guard per unit[1]	0.066	0.066	0.066	0.066
1 night guard per camp	0.066	0.033	0.016	0.011
	A	B	C	D
Food	0.250	0.230	0.204	0.168
Clothing	0.106	0.100	0.095	0.091
Depreciation	0.075	0.028	0.025	0.021
Interest on first cost, all kinds of equipment	0.058	0.022	0.020	0.016
Total cost per day	0.865	0.600	0.519	0.414
Actual practice plus interest	0.850	0.559	0.446	0.396
	E	B	C	E

Report of official.
(A) F. F. Hill, Homer, Ga.
(B) J. C. Redman, Butts County.
(C) E. H. Myers, Ware County.
(D) V. O. Morgan, DeKalb County.
(E) Av. of several similar reports.

*Compiled from report of J. E. Levorn, Supt. of State Reformatory.
*Compared with Searles' Field Engineering, page 25.
Based on salaries for month: Physician, $50; warden, $60; each guard, $30.
Rate of interest, 6 per cent.

[1] The maximum amount allowed a guard by the convict act of 1908 is $50 a month.



ASSUMPTIONS:

Slope of fill 1½ to 1
Cost of concrete $8.00 cu. yd.
" " 18" C I Pipe 2.00 lin ft
" Handrail 1.00 "
" Earth fill .40 cu yd.

TABLE A
Estimated quantities and costs of culverts with high head walls

H=Height above flow line	L=Length of HeadWall	W Width of Bottom	Concrete Cu Yds	C I Pipe Lin. ft	Hand Rail Lin ft	Cost of Headwall $	Cost of Barrel $	Cost of Hand Rail $	Total Cost $
3	5'-0"	1'-9"	2.6	30'		20 80	60 00		80 80
4	8'-0	2'-2"	5.8	30'		46.40			106 40
5	11'-0"	2' 6"	10.4	30'	20	83 20	"	20 00	163 20
6	14'-0	2'-9"	16.3	30'	26	130 40	"	26 00	216 40
7	17'-0'	3'-2"	24.7	30'	32	197 60	"	32 00	289 60
8	20' 0"	3'-6"	34.9	30'	38	279 20		38 00	377 20
9	23'-0"	3'-9"	46.4	30'	44	371 20	"	44 00	475 20
10	26'-0"	4' 2"	62.2	30'	50	497 60		50 00	607 60
11	29'-0"	4'-6"	79.8	30'	56	638.40		56 00	754 40
12	32'-0"	5'-0"	103.0	30'	62	824.00		62 00	946.00

TABLE B
Estimated quantities and costs of culverts with low head walls

H=Height above flow line	L=Length of HeadWall	W=Width of Bottom	Concrete Cu Yds	C I Pipe Lin ft	Fill Cu Yds	Cost of Headwalls $	Cost of Barrel $	Cost of Fill $	Total Cost $
3	5'-0"	1-9	2.6	30'		20 80	60 00		80 80
4			"	33'			66 00		86 80
5	"	"	"	36'	5		72 00	2 00	94 80
6			"	39'	10		78.00	4 00	102 80
7	"			42'	25		84.00	10.00	114 80
8			"	45'	45		90.00	18 00	128 80
9	" "	" "	"	48	60		96 00	24 00	140 80
10	" "	" "	"	51'	100		102 00	40 00	162.80
11			"	54'	125		108 00	50 00	168 80
12		"		57'	175		114 00	70 00	204 80

Fig. 7. Curves and Tables Showing the Difference in Cost Under Various Depths of Fill of a Typical Road Culvert.

a four-unit camp is divided into two camps of two units each, an extra night guard and an additional warden must be employed since the law requires a warden to each camp.

TABLE IV.—ROAD MACHINERY AND ROAD WORKING EQUIPMENT FOR A TWO-UNIT GANG, EARTH AND SAND-CLAY CONSTRUCTION.

Item.	Cost.
Large 6-horse grader	$ 255.00
Two-horse grader	110.00
Large rock or rooter plow	35.00
Rock plow	20.00
5 drag scrapers	36.00
4 wheel scrapers	240.00
4 2-horse wagons	260.00
10 large mules	2,250.00
5 sets of double harness	100.00
Hammers, shovels, picks and axes	74.00
Total cost of machinery and equipment	$3,350.00

Note.—Table from "Good Roads for Georgia," Jan, 1909. by Dr. C. M. Strahan, dean of civil engineering, University of Georgia.

The guards act as road foremen, hence the expense of employing foremen is obviated and balanced by guard hire. The guards should be hired at a stipulated amount and their wages gradually raised as they become more efficient foremen.

MULES FOR ROAD WORK.

In a great many instances it has been found economical to use certain mechanical appliances as labor saving devices. Mules are generally used for traction in the construction of sand-clay roads, because they can be utilized in places which would make other forms of motive power impracticable.

As yet very little evidence has been presented as to the economic use of mules for road work and a policy will merely be outlined, which may be considerably modified before a conclusion is reached in the matter. Not only the use of mules, but other forms of traction will each be considered in the final report on this subject. It is evident that the cost of hauling on the ten-mile basis bears a fixed relation to the cost of running a convict camp economically.

The efficiency of a gang in constructing sand-clay roads depends upon the number of mules per gang, without certain limits, states T. E. Patterson of the Georgia Prison Commission. "One mule per man is best usage" and secures the greatest amount of efficiency per gang. The mules are usually worked in teams and are hitched to the various appliances used in road work. A great deal of hard labor and valuable time is saved thereby.

When the number of mules drops appreciably below half the number of convicts composing a gang the efficiency of the gang will become so low that convict labor ceases to be economical and the county will lose money on the job.

When the number of mules appreciably exceeds the number of convicts composing the gang, the number of trusties and the mules operating the machines will be exhausted. It is not a good policy to hire free labor to operate the machines, because of the increased expense and the likelihood of friction with the convicts.

W. F. Ferguson, Lenoir City, Tenn., says "Good first-class mules can be worked with profit from eight to ten years, while a horse, under similar conditions, can be worked with profit only from six to eight years. Mules will last longer, as they are more moderate on heavy draft."

E. H. Myres, Waycross, Ga., states, "We have ten mules we have worked from eight to nine years with good care. They are good today. Just a little slower than the new ones. We have made no particular study of single or double effect, as all of our stock works double and sometimes in fours. When using wheel scrapers we figure on the haul of each mule at 1,200 to 1,500 pounds on a sandy road—new construction on unfinished roads. We use heavy Studebaker wagons without body, only floor boards. Barring accident in five years the country would realize almost the original cost of the mule."

TABLE II.—EQUIPMENT FOR A ROAD GANG.

Camp equipment.	One unit.	*Two units.	Four units.	Six units.
[1]Winter barracks, including guard room	$140	$200	$240	$ 300
Cook room	25	25	25	25
Large range, cooking utensils and dishes	125	125	130	150
Hospital and furnishings	50	50	75	75
Tents for summer camps	50	70	140	200
Stable sheds	60	75	125	170
Bath house, equipped to wash clothes	25	25	30	40
Commissary tent and fixtures	25	30	35	40
	$500	$600	$800	$1,000

TABLE III.—COMPARISON OF INCREASED COST OF DIVIDING GANGS.

Camp Equipment.

	One unit.	Two units.	Four units.	Six units.
One-unit gang	$ 500	$1,000	$2,000	$3,000
Two-unit gangs	600	1,200	2,400	3,600
Four-unit gangs	800	1,600	3,200	4,800
Six-unit gangs	1,000	2,000	4,000	6,000

[1] Rule Book of Georgia State Penitentiary.

The first six items for two units were reported by W. S. Holman, County Road Commissioner of Clark County, in charge of the work. See "Good Roads for Georgia," page 5, January, 1909.

Note.—Each unit is composed of one guard and fifteen convicts.

ACKNOWLEDGMENT.

This report has been prepared in co-operation with the Committee on Honor Men of the National Committee on Prisons and Prison Labor, Columbia University, and will be included in a final thesis for the graduate highway department at Columbia University. It is the second in the series of monographs on the work of convicts in road construction which has been prepared jointly by the committee and the graduate highway department.

Municipal Exhibit at Mayors' Meeting.—A municipal exhibit, the first of its kind in New York State, will be one of the features of the sixth annual meeting of the New York State Conference of Mayors and Other City Officials to be held at Troy on June 1, 2 and 3.

The exhibit will consist of implements and manufactured wares most commonly used and purchased by municipalities. Mayor Cornelius F. Burns of Troy has appointed a local committee to have charge of the exhibit and act for the Conference. The exhibit will be held in the large drill shed of the Armory. Plans are being made so that the large apparatus may be easily removed to the street for demonstration purposes. All of the cities in the state have been asked to send motion pictures of their principal municipal activities. C. R. Metzger, General Secretary of the Troy Chamber of Commerce, is secretary of the committee.

Cost Keeping System for Work Performed by Municipal Forces of the Philadelphia Bureau of Highways.

Since 1912 systematic cost keeping has prevailed for all work done by the forces of the Philadelphia Bureau of Highways. The system as at present is described in the last report of the Bureau and from advance sheets we abstract the data that follows.

MNEMONIC SYMBOLS FOR WORK PERFORMED BY MUNICIPAL FORCES.

B S—Brick on sand
B C Brick on concrete
G S—Granite block on sand
G C—Granite block on concrete
S S—Slag block on sand
S C—Slag block on concrete
C —Cobble

M P—Waterbound macadam patching
M R—Waterbound macadam resurfacing
M S—Waterbound macadam surfacing
B G—Brickgutters

R —Rubble.
G L —Granolithic.
A B S Asphalt block on sand.
A B C—Asphalt block on concrete.
A C —Asphalt on concrete.
A B —Asphalt on bituminous base
A S —Asphalt on broken stone.

B B G—Belgian block gutters, which includes granite and blue stone.
R G —Rubble gutters.
C G —Concrete gutters.

Surface treatment and bituminous patching work.	Treating waterbound macadam roads.	Treating bituminous macadam roads.	Patching waterbound macadam roads.	Patching bituminous macadam roads.
With tarvia A..............	T A M	T A B	P A M	P A B
With tarvia B..............	T B M	T B B	P B M	P B B
With tarvia X..............			P X M	P X B
With Ugite No. 1 (cold)....	T U-1		P U-1	
With Ugite No. 2 (hot).....	T U-2		P U-2	
With asphalt cut back......	T C M	T C B	P C M	P C B
With calcium chloride......	T C C			
With road oil..............	T R O			
With glutrin	T G			

	Dirt roads.	Macadam roads.
Cleaning gutters	C G D	C G M
Cleaning roads............	C R D	C R M
Cleaning and shaping shoulders............	C S D	C S M
Cleaning trunks, drains and inlets............	C T D	C T M
Repairing trunks and drains............	R T D	R T M
Building, constructing or placing trunks and drains..	B T D	B T M
Water sprinkling—W S C (cinder roads)............	W S D	W S M

G R—Repairs to guard rails, fences and other safety devices.
X —Any miscellaneous work not described above which should be further described under miscellaneous work on the progress and material sheet.

FIG. I.

The maximum possibilities of a unit cost system naturally vary with the conditions existing in the organization in which it is operated. In installing the unit cost system in the Philadelphia Bureau of Highways, however, the following objects were sought:

(a) To ascertain the quantity, and total and unit cost of each class of work performed which will provide data to facilitate the preparation of budget and prospective work estimates and also afford a basis from which may be determined the fairness of unit prices bid on contract work.

(b) To provide data to assist in the determination of the time beyond which it would be undesirable for economic reasons to continue maintenance work on existing pavements, or in other words, the time when replacements must be contemplated.

(c) To secure by interpretation of the data knowledge as to the efficiency of performance of the Bureau's forces, and to assist in showing the adequacy of the service rendered to the public.

(d) To show the quantity and cost of each class of work performed within the bundaries of any district, or unit length, of highway, or on any specific structure or job.

(e) To show separately the varying and principal elements of expense, such as labor, hauling and materials, entering into the cost of each class of work.

(f) To produce in the subordinate employes the beneficial moral effect resulting from a realization that records of their performances are brought to the attention of their superiors.

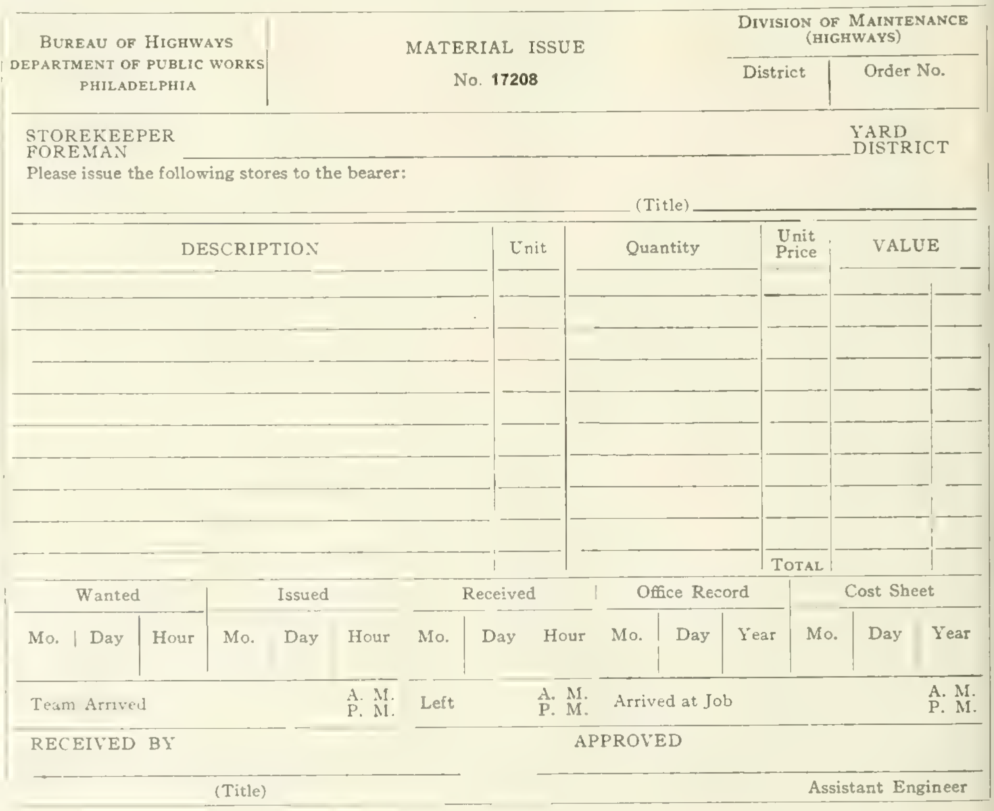
(g) To promote friendly competition between similar units of the organization and establish a sort of esprit de corps among the men.

As all the work performed by the municipal forces is that of maintenance, it was possible to design a standard unit cost system which would be sufficiently flexible to permit its application to any class of maintenance work. The general classifications into which the maintenance work performed by municipal forces are divided, and for each of which complete distinctive unit cost systems have been provided, are as follows: (a) Highways; (b) Sewers; (c) Bridges; (d) Meadow Banks.

Except in minor details the procedure for each of these systems is similar. Considering this and also the fact that while the procedure for the highway maintenance repair unit cost system includes greater variations from the standard, but at the same time also embodies all of the standard principles governing the systems for the remaining three classifications, an explanation of the procedure governing these later three classifications is omitted in favor of a description of the general conditions and considerations governing the highway maintenance repair unit cost system. This work is sub-divided into two general sub-classifications as follows:

(a) Restoration work, which includes the replacement of highway pavements opened by individuals or public utilities, for which the city receives remuneration, and the replacement of pavements opened by the several municipal bureaus.

(b) General maintenance work, which includes all work done on the highways and not included under (a).



BUREAU OF HIGHWAYS
DEPARTMENT OF PUBLIC WORKS
PHILADELPHIA

MATERIAL ISSUE
No. 17208

DIVISION OF MAINTENANCE
(HIGHWAYS)

District | Order No.

STOREKEEPER
FOREMAN ________________ YARD
DISTRICT

Please issue the following stores to the bearer:

________________ (Title) ________________

DESCRIPTION	Unit	Quantity	Unit Price	VALUE
			TOTAL	

Wanted			Issued			Received			Office Record			Cost Sheet		
Mo.	Day	Hour	Mo.	Day	Hour	Mo.	Day	Hour	Mo.	Day	Year	Mo.	Day	Year

Team Arrived A. M. P. M. Left A. M. P. M. Arrived at Job A. M. P. M.

RECEIVED BY ________________ (Title)

APPROVED ________________ Assistant Engineer

Fig. 2.

To facilitate the reporting of field data, the work included in the two preceding general sub-classifications has been divided into the three following divisions: (a) City street pavement restoration and maintenance. (b) Country road pavement restoration and maintenance. (c) Bituminous surface treatment and sprinkling.

To provide for the operation of the unit cost system and the attainment of the objects for which it was instituted, the following set of forms were provided:

(a) A schedule of mnemonic symbols representing each and every class of work likely to be encountered. Fig. 1.

(b) Daily route sheets, one each for restoration work and maintenance work respectively. Fig. 3.

(c) Material issue orders. Fig. 2.

(d) Composite labor, material, hauling and progress record forms, one each for city street pavement restoration and maintenance; country road restoration and maintenance; and, surface treatments and sprinkling, respectively. Figure 4 shows one of these sheets, which is typical of all.

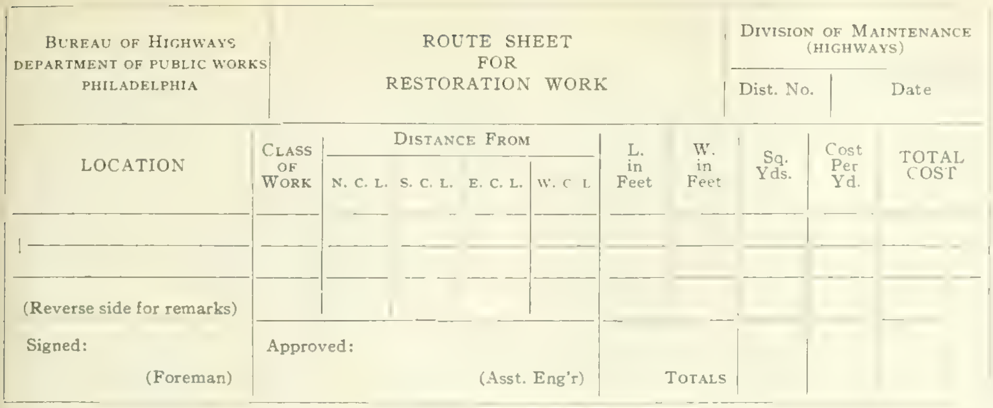
(e) Cost record forms. Fig 5.

(f) Highway maintenance record forms, one each for blocks and intersections respectively. Fig. 6.

(g) Printed instructions, enclosed in a pocket folder, explaining in detail the use of the forms and the general operation of the system. Fig. 7.

To insure universal and definite knowledge concerning the operation of the unit cost system, every employe having to do with the system is provided with a schedule of work symbols and a set of written instructions.

On all of the forms, two colors of ink have been used in column headings, red indicating



BUREAU OF HIGHWAYS DEPARTMENT OF PUBLIC WORKS PHILADELPHIA	ROUTE SHEET FOR RESTORATION WORK	DIVISION OF MAINTENANCE (HIGHWAYS) Dist. No. Date

LOCATION	CLASS OF WORK	DISTANCE FROM				L. in Feet	W. in Feet	Sq. Yds.	Cost Per Yd.	TOTAL COST
		N. C. L.	S. C. L.	E. C. L.	W. C. L.					
(Reverse side for remarks)										
Signed: (Foreman)	Approved: (Asst. Eng'r)					TOTALS				

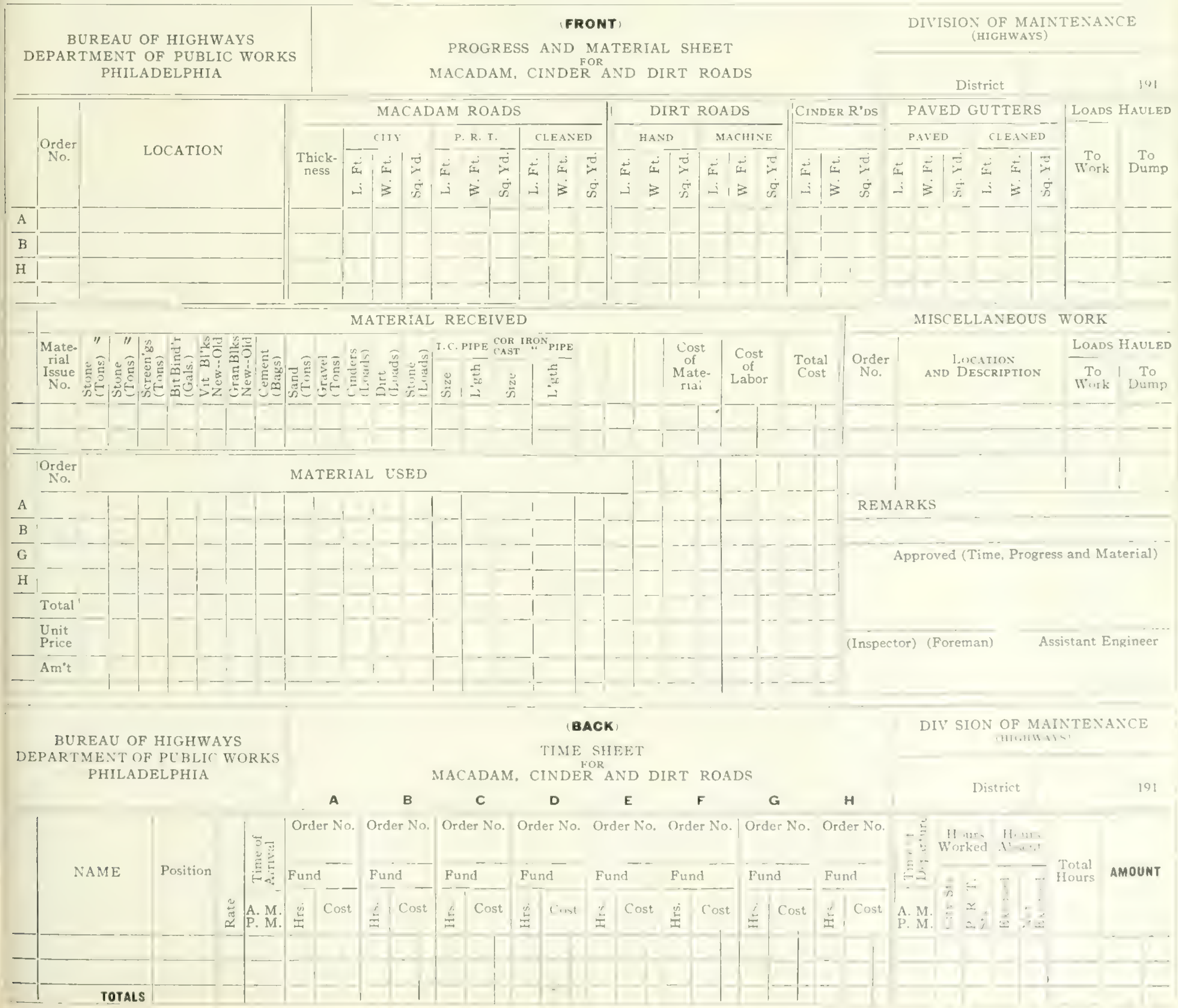
Fig. 3.

that the data will be supplied by the office and black indicating that it should be supplied by the gang foreman. Wherever practicable the data supplied by the office is typewritten. Gang foremen are not permitted to make or keep any records concerning the work except on the indicated forms and these entries must be made while actually engaged on the work.

Except when a longer period of time is required to finish a specific parcel of work, the gang foreman is each day provided by the district office with a route sheet, indicating the location and order in which the work is to be performed that day, separate forms being used for restoration work and maintenance work respectively. For each class of work the gang foreman enters the work symbol and the length, width and area of the work performed. Upon completion of the work, he signs and transmits this report to the district office for approval by the district engineer, who forwards it to the main office.

On the first day of each week each gang foreman is furnished by the district office with enough copies of the time and progress and material sheet for that week. These forms contain the district number and date, the name, position and rate of pay of each employe in the gang. During the progress of each day's work the following data is recorded on these forms by the gang foreman: the work symbol (placed in the spaces headed "Order No."), the fund, the time of arrival and departure on the job of each workman and team, location of the work indicated by block or intersection, the length, width and area or thickness of work performed, the quantity and character of materials received and used, and the number of hauling trips made. After being signed by the gang foreman this report is transmitted to the district office for the approval of the district engineer, after which it is forwarded to the main office.

When it is necessary to use materials from stock the gang foreman originates a Material Issue Order prepared in triplicate, upon which is printed "Please issue the following stores to bearer" and in addition each copy contains the following data, the district number, the date, the serial number, the name of storekeeper, the work symbol, the quantity, unit and description of material and the day and hour that the material is wanted, which is the time the team or agent leaves the job for the storeyard. The duplicate copy of the material issue order is retained by the gang foreman and the original and triplicate copies are presented by the driver or agent to the store-



(FRONT)

BUREAU OF HIGHWAYS DEPARTMENT OF PUBLIC WORKS PHILADELPHIA	PROGRESS AND MATERIAL SHEET FOR MACADAM, CINDER AND DIRT ROADS	DIVISION OF MAINTENANCE (HIGHWAYS) District 191

	Order No.	LOCATION	Thickness	MACADAM ROADS									DIRT ROADS						CINDER R'DS			PAVED GUTTERS						LOADS HAULED	
				CITY			P. R. T.			CLEANED			HAND			MACHINE						PAVED			CLEANED			To Work	To Dump
				L. Ft.	W. Ft.	Sq. Yd.	L. Ft.	W. Ft.	Sq. Yd.	L. Ft.	W. Ft.	Sq. Yd.	L. Ft.	W. Ft.	Sq. Yd.	L. Ft.	W. Ft.	Sq. Yd	L. Ft.	W. Ft.	Sq. Yd.	L. Ft	W. Ft.	Sq. Yd.	L. Ft.	W. Ft.	Sq. Yd		
A																													
B																													
H																													

	MATERIAL RECEIVED																				
	Material Issue No.	Stone " (Tons)	Stone " (Tons)	Screen'gs (Tons)	Bit Bind'r (Gals.)	Vit Bl'ks New--Old	Gran Blks New--Old	Cement (Bags)	Sand (Tons)	Gravel (Tons)	Cinders (Loads)	Dirt (Loads)	Stone (Loads)	T. C. PIPE Size	T. C. PIPE L'gth	COR IRON / CAST " PIPE Size	COR IRON / CAST " PIPE L'gth			Cost of Material	Cost of Labor	Total Cost
	Order No.	MATERIAL USED																				
A																						
B																						
G																						
H																						
	Total																					
	Unit Price																					
	Am't																					

MISCELLANEOUS WORK

Order No.	LOCATION AND DESCRIPTION	LOADS HAULED	
		To Work	To Dump

REMARKS

Approved (Time, Progress and Material)

(Inspector) (Foreman) Assistant Engineer

(BACK)

BUREAU OF HIGHWAYS DEPARTMENT OF PUBLIC WORKS PHILADELPHIA	TIME SHEET FOR MACADAM, CINDER AND DIRT ROADS	DIVISION OF MAINTENANCE (HIGHWAYS) District 191

NAME	Position	Rate	Time of Arrival	A		B		C		D		E		F		G		H		Time of Departure	Hours Worked		Hours Absent		Total Hours	AMOUNT
				Order No.		Order No.		Order No.		Order No.		Order No.		Order No.		Order No.		Order No.								
				Fund		Fund		Fund		Fund		Fund		Fund		Fund		Fund								
			A. M. P. M.	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	Hrs.	Cost	A. M. P. M.	City St.	P. R. T.	[illegible]	[illegible]		
TOTALS																										

Fig. 4.

keeper who records the time the team arrives, the time of issue of material to driver and the time the team departed, and retains the original and returns the triplicate to the driver for transmittal to the gang foreman, who then records the time of the receipt of the material and time of the hauling vehicle's arrival at the job. After being signed by the gang foreman the material issue order is transmitted to the district office where it is approved by the district engineer, and then forwarded to the main office. Whenever possible, however, the material issue order is approved by the district engineer prior to its being sent to the storekeeper. The original copy of the material issue order which is retained by the storekeeper is used in the posting of the balance of stores records.

BUREAU OF HIGHWAYS
DEPARTMENT OF PUBLIC WORKS
PHILADELPHIA

COST CARD

DIVISION OF MAINTENANCE
(HIGHWAYS)

District	Order No.

LOCATION

DESCRIPTION

Date	Sq. Yards	Labor	Teams	Material	TOTAL	FOREMAN	REMARKS
For'd							
TOTAL							
COST PER SQ. YD.							

Fig. 5.

Upon the receipt of the record forms at the main office the entries on the time and progress and material sheets and on the material issue orders are extended and totaled by the cost clerk, and after being forwarded to the paymaster for his record of the employes' time and returned, the following data is entered on the Cost Record cards, one of which is originated for each highway intersection and block: the district number, the work symbol, the fund, the date, the location, character and quantity of work performed, the foreman's name and the costs of labor, material and hauling. At the termination of any desired period of time there can be readily compiled from these cost records the unit costs of any class of work performed in any geographical division, or the unit costs of the performances of any unit of the organization.

From the data contained on the Route Sheets received at the main office there is made on the reverse side of the Highway Maintenance Record cards (which contain a detailed sketch, drawn to a standard scale, of each block or intersection) a record of the character, area, and a graphical sketch of all pavement restoration and maintenance work performed on streets that have not outlived their economical life. This makes it a simple matter to determine how the repairs are wearing as a repair over a previous repair would be brought out in the plotting. Where it is decided that it would be more economical to repave instead of repair a pavement, the repairing done pending the appropriation of funds for repaving is not plotted as the plotting is intended to serve only as a guide until the pavement has outlived its economical life.

HIGHWAY BLOCK RECORD

HIGHWAY FROM TO

PAVING: SURFACE BASE UNIT COST: SURFACE BASE

PAVED BY ADDRESS

FINISHED GUARANTEE PERIOD YEARS. EXPIRES

MAINTENANCE DATA

Year	Yardage Repaved	Total Cost	Unit Cost	Unit Cost Per Year per Sq.Yd of Pavement	Yardage Repaired Over Cuts	REMARKS

Fig. 6.

A separate card is provided for each block and each intersection of highway pavement. These records contain on their face side a record of the character and unit costs of the base and surface courses of the original pavement, and the name and address of the contractor, the dates of completion and guarantee expiration and length of guarantee. At the close of each year from the data shown on the Cost Record cards for each highway block and intersection there is recorded on the corresponding Highway Maintenance Record the following data: the year, the total area repaired, the total and unit costs of pavement replacements made necessary for both restoration and maintenance, the total area of restoration work only and the unit replacement cost per year per square yard of pavement covered by the record. These maintenance records will eventually serve as a basis upon which the discontinuance of maintenance and the need of entire pavement replacements will be determined.

HIGHWAY INTERSECTION RECORD

INTERSECTION OF AND

PAVING: SURFACE BASE UNIT COST: SURFACE BASE

PAVED BY ADDRESS

FINISHED GUARANTEE PERIOD YEARS. EXPIRES

MAINTENANCE DATA

Year	Yardage Repaved	Total Cost	Unit Cost	Unit Cost Per Year per Sq.Yd of Pavement	Yardage Repaired Over Cuts	REMARKS

Fig. 7.

For the purpose of the maintenance records a block is considered to be a length of highway lying between the near curb lines of the two nearest main intersecting highways, and an intersection is considered to be that portion of the main intersecting highways lying outside of the curb lines.

Testing Aggregates for Concrete Roads Built by the New York Highway Commission.

The methods of testing and handling aggregates for concrete roads built under the supervision of the New York Highway Commission were described by H. S. Mattimore, first assistant engineer, in a paper before the last meeting of the Association of Portland Cement Manufacturers.

It is absolutely essential that a good quality of cement should be used in concrete, but we should constantly keep in mind that cement, although the important ingredient in concrete, is only one of several ingredients used in mixing this product, and in order to secure a first-class concrete the other ingredients must also be of a good quality.

To insure a fine aggregate of high grade our department has drawn up the following definite specifications:

> Fine aggregate shall consist of sand, free from organic matter; that which shows a coating on the grains shall not be used until satisfactorily washed. No. 1 sand for use in concrete pavement shall be of the following gradation: 100 per cent shall pass a ¼-inch screen; not more than 20 per cent shall pass a No. 50 sieve and not more than 6 per cent shall pass a No. 100 sieve. Sand may be rejected for this class if it contains more than 5 per cent of loam and silt. Mortar in the proportion of one part of cement to three parts of sand to be tested, shall develop a compressive strength at least equal to the strength of a similar mortar of the same age composed of the same cement and standard Ottawa sand.
>
> Screenings when approved in writing by the chief engineer, may be substituted for a portion of No. 1, 2 and 3 sand under the following conditions: The screenings shall be free from dust coating and other dirt, 100 per cent shall pass a ¼-inch screen and not more than 6 per cent shall pass a No. 100 sieve. The compressive strength of a mortar, in which the screenings and sand are in the proportions intended for use, shall be at least equal to the standard strength obtained with sand of the given class.

You will notice from the specifications quoted that the only allowable use for stone screenings as fine aggregate is when mixed with a proportion of sand. We have had some field tests made on using all screenings for fine aggregate and these have shown such doubtful results that it was not thought advisable to replace all of the sand by screenings. It is possible to get good concrete with screenings in laboratory test, but when tried on a large scale in the field it is extremely difficult to get a uniform well-graded material. The proper proportion of screenings from the hard variety of stone will improve a fine-grained sand, but the high costs for careful inspection and proper mixing is likely to make their use prohibitive, except in instances where a good quality of sand is very expensive.

The specification for stone as coarse aggregate in concrete requires that samples shall be tested before being used in the work. It must be free from dirt and coating of any kind. As a tentative specification we require that stone for use in concrete pavement shall show a "French coefficient" of at least nine when tested in the standard abrasion test for stone.

TABLE I. — COMPRESSION TESTS ON THE 1 : 1½ : 3 CONCRETE CUBES, MADE FROM MATERIAL BEING PLACED ON ONE OF THE BEST HIGHWAYS.

Date made.	Age.	Break lbs., per sq. in., average of 2 cubes.	Sand used.
June 5, 1914	30	5480+	No. 1 sand.
June 7, 1914	34	4365	
June 12, 1914	45	4815	
June 21, 1914	36	3980	
July 6, 1914	28	4810	
July 12, 1914	29	4925	
July 14, 1914	30	4675	
July 20, 1914	28	4625	
July 23, 1914	28	4875+	
July 31, 1914	33	5555+	No. 2 sand.
Aug. 5, 1914	28	4500	
Aug. 11, 1914	28	4680	
Aug. 15, 1914	28	4050	
Aug. 19, 1914	30	4665	
Sept. 4, 1914	30	4420	
Sept. 8, 1914	28	5030	
Sept. 12, 1914	28	4450	
Sept. 17, 1914	32	4450	
Sept. 30, 1914	33	1945*	

*The concrete represented by the last two cubes was made of stone and screenings substituted for sand. It was made for experiment, not used on highway.

Tests of sand used in above concrete:

No. 1— Voids = 31.2%; Loam = 1.5%

gradation.		compression break.
Passing ¼-in.,	100.0%	1 : 3 mortar
Passing No. 6,	93.3	
Passing No. 20,	41.7	Ottawa, 1420
Passing No. 50,	10.5	Natural, 1987
Passing No. 100,	1.8	
Passing No. 200,	0.9	Washed, 1802

No. 2— Voids = 28.6%; Loam = 2.5%

gradation.		compression break.
Passing ¼-in.,	100.0%	1 : 3 mortar
Passing No. 6,	94.0	
Passing No. 20,	28.7	Ottawa, 1520
Passing No. 50,	9.1	Natural, 1750
Passing No. 100,	1.6	
Passing No. 200,	1.1	Washed, 1685

Some few miles of concrete pavement have been built with gravel used as coarse aggregate. These were in sections where a very high grade was available. Such material was all tested and had to meet the requirements of being composed of all sound, durable stone, and to be absolutely clean and free from coating. We have found the gravel banks in a large part of the state to run so non-uniform that it was not thought advisable to use this product in concrete pavements except in limited areas where we have assured ourselves from past experiences that a uniform product can be obtained.

An endeavor is made to use local materials as far as possible in all our work, and the above specifications were written after a careful study of several hundred sand tests from widly scattered portions of the state. Availability was considered, with the idea of quality paramount.

TESTS EMPLOYED.

During the routine of the physical laboratory within the past year the work included the examination and testing of samples representing 1,080,580 barrels of cement, 909 samples of sand and 857 samples of stone.' The cements were tested according to the standard methods of the American Society for Testing Materials. There being no standard tests for sands, the following is a brief outline of the tests and methods employed in our laboratory:

Gradation.—1,000 grams of the sand to be tested, after a careful weighing, is screened through the ¼-in. No. 6, No. 20, No. 50, No. 100 and No. 200 mesh sieves. After weighing the residue on these sieves, the proportions passing are readily computed. We found from past experiences that these are the essential sieves for an intelligent judgment of the gradation.

Voids.—For the determination of the voids the sand is placed and loosely compact into a graduated cylinder. This latter has a hole drilled in the bottom in which a tube is connected leading from a burette filled with water. This apparatus is placed and worked so that gravity causes the water to rise slowly through the sand, forcing the air ahead. By reading from the burette the amount of water which has flowed out the voids can be computed within a practical degree of accuracy. This method of allowing the water to flow in from the bottom rather from the top of the sand eliminates the forming of air pockets, which are extremely difficult to avoid by the latter method.

Loam.—For the determination of the amount of loam a portion of the sand sample is placed in a graduated cylinder and well covered with water. This is thoroughly agitated and then allowed to settle from 10 to 24 hours. The loam and silt which readily separates from the sand is deposited on top of the sand, and the proportions can easily be computed. This method of loam determination by volume we believe is as refined a determination as necessary to fit all practical requirements. It also allows an easy method of checking in the field.

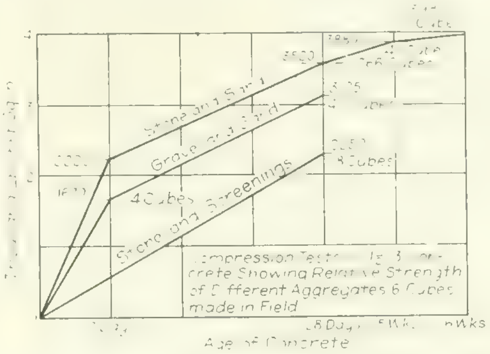


Fig. 1. Curves Showing the Relative Compressive Strength of 1:1½:3 Concrete Using Different Aggregates.

These cubes were made in the field and stored in the field for 21 days.

Compression Tests.—The majority of our compression tests are made on 3-in. cubes, mixed 1 part of cement to 3 parts of the sand. These are stored in moist air and broken in 14 days; 4 cubes are made from each sand, 2 from the natural product and 2 from the washed. For a comparison of the compression 4 cubes of the same size, mixed with standard Ottawa sand and the same cement are made, stored and broken under the same condition and at the same age. The cement used for this purpose is a blend mixed in the laboratory from cements which show similar characteristics under tests. The cement and sand in the cubes are proportioned by volume rather than weight to avoid the variation of the latter in sands of different character. The cement, although measured by volume, is carefully checked by weight to eliminate different degrees of compactness in measuring.

At present time we are running a series of sand compressions on both 2 and 3-in. cubes for the ultimate purpose of using the smaller size cube. These latter will be made up in lots of four, two of which will be broken at 7 days and two at 28 days. This in many cases will decrease the time necessary for a sand test and also enable us to observe the relations of the strengths at the different ages.

Of our tests we consider the compression strength of the sand in mortar of major importance, but as this depends more or less on other determinations, especially gradation and per cent of loam, silt or organic matter, it is advisable to run a full test in order to properly judge the material.

Occasionally sands are tested for tensile strength, but our experience on the relation between tension and compression strengths of sand mortars has verified the results obtained by other investigators in the fact that this relation is so non-uniform that it is absolutely unreliable, and as we build plain concrete to withstand compression rather than tension we should test it from that standpoint.

During the course of construction the concrete highways are under constant supervicion of competent engineers. Their duties not only include ordinary highway engineering work, but they are required to closely inspect all concrete aggregates. This especially refers to sand and gravel supplies, and when such material shows any great change in character, this being determined by field tests for gradation and loam, such conditions are immediately reported to their superior engineer, who takes steps to rectify them and compel the contractor to secure suitable materials.

One of the important checks instituted within the past year on our concrete work was in the testing of the finished product. Engineers in charge of concrete work are required to make 6-in. cubes from the mixed concrete as deposited in the work. Two cubes are taken from every 500 cu. yds. of concrete laid. This in the case of a concrete highway 16 ft. wide and of our standard thickness represents about 1,700 lin. ft. of roadway. These specimens are stored in moist sand near the highway for 21 days, at which time they are sent to the laboratory, where at 28 days they are tested for compressive strength. The engi-

TABLE II.—TABLE SHOWING RELATION OF THE COMPRESSION TEST ON SAND TO THE COMPRESSION TEST ON CONCRETE MADE FROM THIS SAND.

Made.	Mix.	Comp. lbs. per sq. in. Average 2 cubes.	Sand test compression.
July 11, 1914	1 : 2 : 4	1735	97% of Ottawa
Aug. 12, 1914	1 : 2 : 4	2405	150% of Ottawa

This concrete is from one road.

Below Are Shown Results From Two Different Roads.

Made.	Mix.	Comp. lbs. per sq. in. Average.	Sand test compression.
From Sept. 14, 1914, to Oct. 16, 1914	1 : 1½ : 3	2235 (18 cubes)	100% of Ottawa
From Aug. 24, 1914, to Sept. 26, 1914	1 : 1½ : 3	3870 (14 cubes)	115% of Ottawa

TABLE III.—TABLE TO SHOW EFFECT OF LOAM AND FINE SAND ON CONCRETE AND ON MORTAR.

Made.	Break, lbs. per sq. in.	Gradation of sand.	Compressive strength.
Sept. 20, 1914	3,100 2,850	Passing ¼-in., 100.0% Passing No. 6, 96.0 Passing No. 20, 79.2 Passing No. 50, 15.6 Passing No. 100, 6.2 Passing No. 200, 4.4 Voids, 36.3% Loam, 9.2%	1 : 3 mortar Ottawa, 1,360 lbs. per sq. in. Natural, 2015 Washed, 1455
Oct. 1, 1914	4,580 1,100	Passing ¼-in., 100.0% Passing No. 6, 92.8 Passing No. 20, 29.0 Passing No. 50, 6.4 Passing No. 100, 3.1 Passing No. 200, 2.1 Voids, 30.4% Loam, 4.8%	Ottawa, 1,520 lbs. per sq. in. Natural, 2260 Washed, 1550
Oct. 5, 1914	4,030 4,730		
Oct. 12, 1914	5,000 5,220		

neers on the highways are notified of the results of such tests, and this seems to have promoted a friendly rivalry between them to endeavor to obtain the best possible concrete. This pride in accomplishment certainly tends toward obtaining desired results. The chiefs of the department do all in their power to build an excellent type of highway, but in the end much depends on the engineers directly in charge.

By means of the above described tests I know we obtain a good quality of aggregates, and the final tests on the field cubes give us an excellent check on both material and workmanship, but we also realize that the using of concrete for highway surfacing introduces the factor of making a concrete to resist impact and abrasion. This at present is well taken care of by using a rich mixture, but at the same time we are studying both concrete and mortars from this standpoint, and hope in the near future to be able to devise some method of testing the abrasive and impact resistance of various aggregates.

NOTES ON TABLES.

Table I shows some very high compression breaks obtained on 6-in. cubes made in the field from material being placed on the highway. There is some slight variation in the age of the different cubes, due to delay in shipping, but a large proportion of the material is from 28 to 30 days old. This is not an average highway—in fact, it is one of the best. The two interesting features of these tests are the consistent uniformity of the breaks and the fact that the compressions are the highest I have ever seen recorded on plain concrete. I wish to call your attention to the tests on the two sands from different banks, used in this concrete. Both are coarse sands with voids slightly below the average, they are comparatively clean and show a good compressive strength in mortar. They would not be called a sharp sand, as many of the grains are rounded. This material is from an old lake deposit and unfortunately rather limited. You will note the last two cubes made Sept. 30 were mixed with stone screenings substituted for sand. This concrete was not used in the highway, but was made for experimental purposes only. It may be rather an unfair comparison, as only two cubes were made from this material, but there is such a great difference in compressive strength that we do feel thankful that sand rather than stone screenings was used in the concrete placed in the highway.

The curves shown in Fig. 1, I believe, are self-explanatory. Their main value is that they are the results of field tests, thus giving a good illustration of the concrete obtained in actual practice. I believe this is a good, fair comparison of stone and gravel concrete, as both of these aggregates were of high grade, particular attention being paid to obtain a clean, uniform product, passing all requirements for this class of concrete.

You will notice the material made with screenings, although showing a fair compression strength, is much below that obtained with a good sand. These latter cubes were made from concrete placed on highways previous to the adoption of the specifications quoted above.

Table II. shows comparisons of compressive strength of concrete and mortar. This table illustrates mainly the effect of different sands on the concrete.

Table III. is given to also show the comparison of two different sands and results obtained by using them in concrete. The cubes made Sept. 20 were mixed with sand which had been rejected for use in natural condition in concrete pavement. About 100 lin. ft. of roadway was laid with concrete made from this sand through error. The second sand, which differs mainly from the other in containing less loam, was the sand used on the work. The mixture used was 1:1½:3.

TABLE IV.—TABLE TO SHOW THE EFFECT OF SAND GRADATION ON THE COMPRESSIVE STRENGTH.

Gradation.	No. 1.	No. 2.
Passing ¼-in.	100.0%	100.0%
Passing No. 6	94.1	74.5
Passing No. 20	38.4	30.4
Passing No. 50	14.4	26.7
Passing No. 100	2.0	8.4
Passing No. 200	1.4	4.5
Voids, %	30.9	25.5
Loam, %	3.6	4.0
Compressive strength:		
Ottawa	1445	1975
Natural	2275	875
Ottawa in %	157.5	44.2

These two tests are on sand taken from the same bank at two different times by two different engineers.

Table IV is given to show the importance of proper sampling of sand sources. As is noted in the table, both of these sands were from the same bank, being sampled by different engineers. Sand No. 1 is well within our specifications for use in the best grade of concrete, while sand No. 2 is of a poor grade for any concrete. I made an inspection of this bank at a later date and found that this good sand could be economically obtained. In this regard I wish to mention that the department is making a material survey of the state which is well toward completion. Inspection has been made of the various sources of material, samples are taken from these and tested. The locations are plotted on topographic maps and graded according to tests. Check samples are taken and tested from these localities at various intervals.

Table V is mainly given to show the effect of coarse and fine sand on the concrete. The compression would probably show a great difference if it was not, as you will note that the better concrete was tested in 28 days, while the poorer grade was 33 days old.

TABLE V.—EXAMPLE OF EFFECT OF SAND GRADATION ON THE COMPRESSIVE STRENGTH OF CONCRETE.

Test on First Sand.

Gradation.		Compression on 1 : 3 mortar.
Passing ¼-in.	100.0%	Ottawa, 1587
Passing No. 6	98.1	Natural 1722
Passing No. 20	61.5	Washed, 1847
Passing No. 50	22.3	
Passing No. 100	1.0	
Passing No. 200	0.5	
Voids, 34.5% loam	2.4%	

Compressive test on 1 : 1½ : 3 concrete; cubes made between May 25 and July 13; average of 14 cubes 3,320 lbs. per sq. in. at average age of thirty-three days.

Test on Second Sand.

Gradation.		Compression on 1 : 3 mortar.
Passing ¼-in.	100.0%	Ottawa, 1,520
Passing No. 6	99.5	Natural, 1,952
Passing No. 20	41.0	Washed, 1,780
Passing No. 50	4.7	
Passing No. 100	1.4	
Passing No. 200	1.1	
Voids, 31.2% loam	2.7%	

Compressive test on 1 : 1½ : 3 concrete; cubes made between July 18 and September 30; average of 14 cubes, 3,670 lbs. per sq. in. at average age of twenty-eight days.

Table VI is self-explanatory and is interesting as comparative data in using different aggregates.

TABLE VI.—COMPARATIVE TESTS ON 1 : 2½ : 5 CONCRETE USING DIFFERENT AGGREGATES.

Aggregates.	Age, days.	No. cubes.	Compression break, lbs. per sq. in.
Slag and sand	28	16	2,000
Stone and sand	28	134	1,990
Gravel and sand	28	142	1,895
Stone and screenings	28	28	1,740
Coated gravel and sand unwashed	28	48	1,170

BUILDINGS

Equipment and Methods Used in Constructing the Austin Nichols Building in New York.

Economy in the successful erection of reinforced concrete buildings is dependent on the efficiency with which the materials entering into the construction are handled upon delivery at the building site. The comparatively small yardage of concrete in any one building does not justify an elaborate and costly installation of receiving and mixing machinery. Inasmuch as even a large building operation seldom requires the use of the concrete plant for more than four or five months, it is essential that the erection and removal of this plant shall be performed easily, quickly, and cheaply. Its cost must be divided among several contracts, and therefore prompt transfer from one contract to another is of utmost importance.

In order that varying conditions on different buildings may be met it is desirable that simple standards of plant layout be adopted. When a special installation is considered necessary it is desirable before determining on a final layout to reduce the installation to a cost per cubic yard of concrete. This very often shows that the saving in the handling of materials is not sufficient to offset the cost of this special installation. Also, in special layouts, the labor of erection and removal is usually high, and the greater part of the cost of materials entering into this installation should be charged largely to this one contract, as, after using once, it may be some

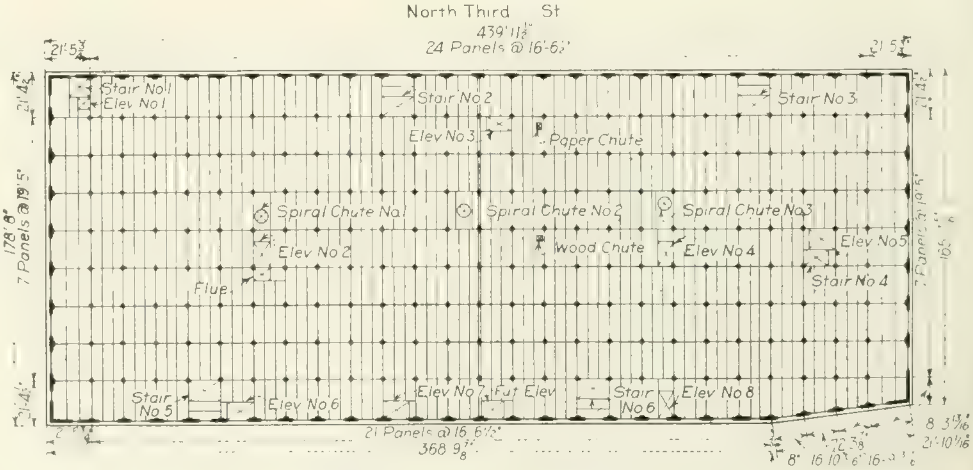


Fig. 1. Typical Floor Plan of Austin Nichols Building, New York, Showing General Dimensions and Type of Construction.

time before a similar installation is required, and a plant depreciates rapidly.

Careful study must be given to the layout of all plants to be sure that it will fulfill all requirements. It must handle the total concrete yardage, without overloading, in the time allowed by the speed schedule, and it should have the capacity for so-called "big days"—days when conditions of the work call for maximum output.

The following article describes and illustrates the methods and equipment used in the construction of the Austin Nichols Building in New York.

LOCATION AND TYPE OF BUILDING.

The Austin Nichols Building is situated at the northwest corner of Kent Ave. and North Third St., Borough of Brooklyn, New York. It extends from Kent Ave. along North Third St. to the bulkhead line of the East River. The Austin Nichols Company, manufacturing wholesale grocers, occupy the entire building. In plan the structure is 439 ft. 11½ ins. x 178 ft. 8 ins., and is six stories high, with basement. It is of reinforced concrete construction throughout, except for the steel column and girder construction inclosing the railroad tracks. The reinforced concrete floors are of the beam-and-girder type. Figure 1 shows a typical floor plan of the building.

CONTRACT PROVISION.

The contract for the erection of the building was awarded Dec. 12, 1913, and it called for the entire completion by Sept. 1, 1914. Failure to deliver the building complete by this date would subject the contractor to a heavy penalty.

QUANTITIES OF MATERIALS AND SUB-CONTRACT WORK.

The following list of materials gives an idea of the scope of this work and is of particular value in connection with a study of the equipment and its arrangement:

Excavation, cu. yds.	24,200
Piles (west half of building supported on piles)	2,520
Cement, bbls.	43,600
Sand, cu. yds.	16,920
Gravel, cu. yds.	21,000
Cinders, cu. yds.	2,800
Reinforcing steel, tons	1,560
Tile for partitions, sq. ft.	128,000
Granolithic finish (placed on 2½-in. cinder concrete base), sq. ft.	447,000
Plaster (office partitions, fifth floor), sq. yds.	7,560

The contract also included all sub-contract work, the main items of which are as follows:

Structural steel (over tracks, first story).
Elevators.
Sprinklers.
Heating.
Plumbing.
Electric wiring.
Pneumatic tubes.
Refrigeration.
Spiral chutes and conveyors.
Roofing and waterproofing.

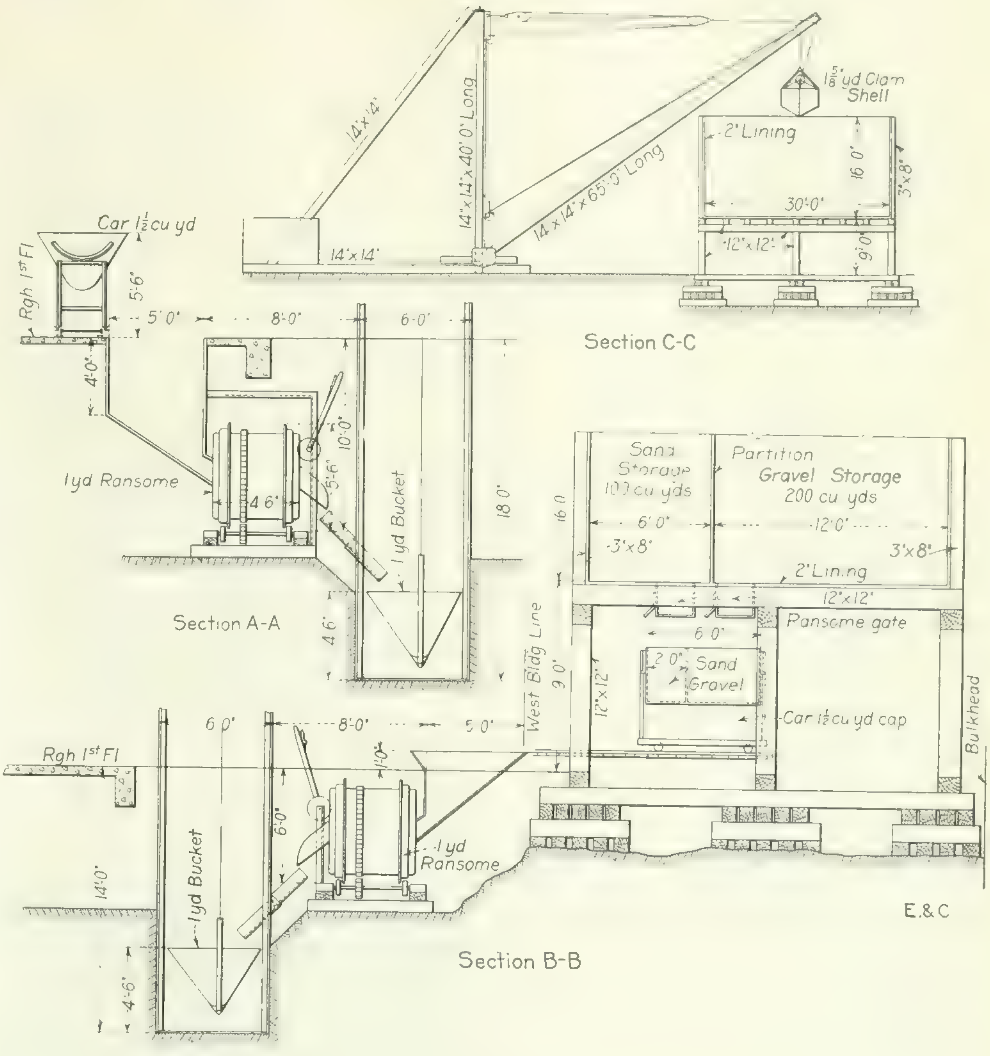


Fig. 3. Cross Sections Showing Details of Equipment for Austin Nichols Building—Also See Fig. 2.

The total cost of all sub-contract work was $340,000.

UNLOADING AND CONCRETING EQUIPMENT.

The layout of the unloading derrick, storage bins, concrete mixers and hoists is shown in detail in Fig. 2 and in sections A-A, B-B, C-C, of Fig. 3. Sand and gravel were delivered alongside the bulkhead, adjacent to the storage bins, on scows of about 400 cu. yds. capacity. A derrick equipped with a clam-shell bucket of 1⅝ cu. yds. capacity unloaded the contents of these scows into storage bins holding 100 cu. yds. of sand and 200 cu. yds. of gravel. This derrick is shown in plan and elevation in Fig. 2 and in Fig. 3, section B-B. It was operated by a Meade-Morrison three-drum standard hoisting engine having 9x10-in. cylinders and a rated capacity of 35 HP. For swinging the derrick a separate engine was installed. Power was supplied by a 50-HP. horizontal boiler.

The sand and gravel were discharged from the bins through "Ransome" gates, into "V" bottom, two-way dump cars for delivery to the mixers. Each car was loaded with 12 cu. ft. of sand and 24 cu. ft. of gravel, a steel partition separating these materials.

One car was used to convey the materials to mixer No. 1, and was pushed by hand from the storage bin to the mixer. For charging mixer No. 2 a 2-ft. 6-in. gage double track was laid from the bin to the mixer, on which two cars were operated, one on each track. These tracks were laid on the first floor, which, in order to follow the grade of North Third St., sloped down 8 ft. from Kent Ave. to the river. A double-drum, motor-driven "Lidgerwood" hoist pulled the cars from the bin to the mixer. These cars were connected by a tail line operating around a sheave at the bin, so that the loaded car going toward the mixer would pull back the empty car to the bin.

Owing to the limited bulkhead space at the building it was necessary to dock the cement

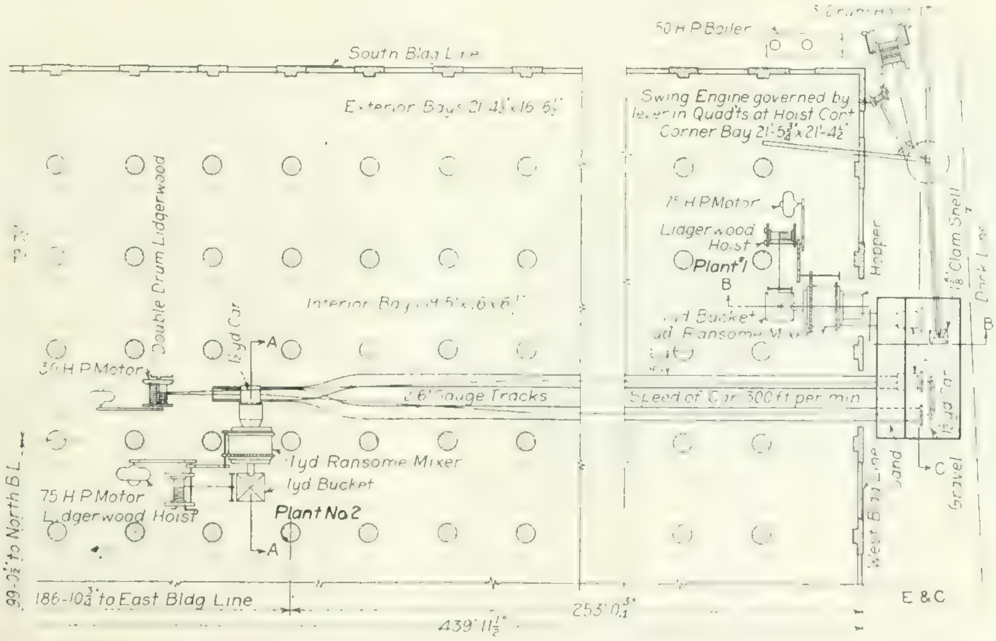


Fig. 2. Plan Showing Unloading, Mixing and Hoisting Equipment—Austin Nichols Building.

lighters one block away and to truck the cement to the building. The cement was stored adjacent to each mixer, six bags being used in each batch.

Two 1-cu. yd. "Ransome" mixers were installed in the locations shown in Fig. 2. Each mixer discharged into a 1-cu. yd. "Ransome" bucket, which was hoisted by a single-drum "Lidgerwood" hoist. Power for the operation of each concrete plant was furnished by a 75-HP. motor. The concrete was dumped from the bucket into a 2-cu. yd. box on each floor, from which it was wheeled in carts.

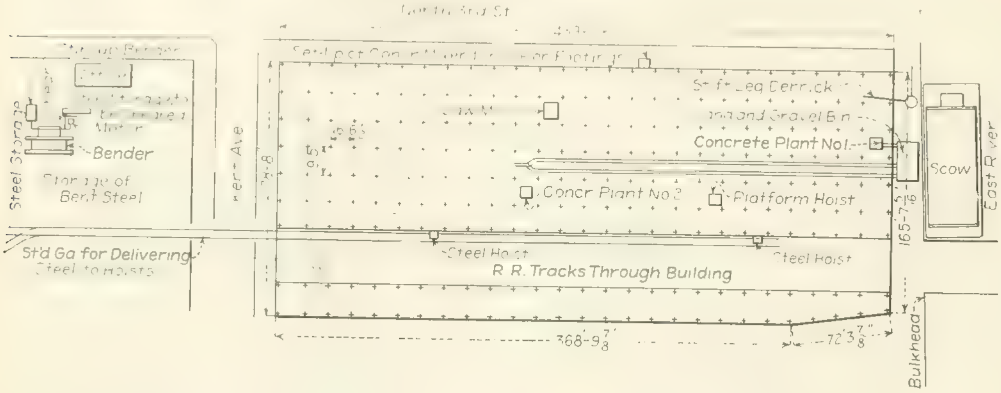


Fig. 4. First Floor Plan of Austin Nichols Building and General Layout of Equipment.

The use of spouts for placing concrete was carefully considered. Records of the cost of wheeling concrete on similar buildings showed that its cost did not exceed 9 cts. per cubic yard, cost being based on labor at 37½ cts. per hour. Assuming that, of a total of 19,620 cu. yds. of concrete to be placed, 16,000 cu. yds. could be placed by spouting, the cost of wheeling would be $0.09 × 16,000 = $1,440. Hence $1,440 would have to cover both the cost of installing two spouting outfits and the following additional installations incidental to placing concrete in this manner: raising tower additional height; guying tower; and moving spouts.

This analysis showed conclusively that, for this building, the cost of the spouting equipments plus the additional installation cost, would materially exceed the cost of wheeling concrete.

EQUIPMENT FOR HANDLING REINFORCING STEEL.

The general layout of the steel yard and equipment is shown in Fig. 4. Steel was delivered in cars on the track adjacent to the steel yard. In unloading, care was taken to place in separate piles all steel to be bent.

The equipment installed in the steel yard consisted of a "Wilson" bender (for bending beam and girder bars), a "Wilson" stirrup bender, and a shear capable of shearing 1-in. square bars, all driven by one 15-HP. motor. As the steel was required at the building it was placed on standard-gage hand cars and pushed to the steel hoists (see Fig. 4). The two hoistways (each 4 ft. 6 ins. x 4 ft. 6 ins.) were placed as shown, being sheathed on all sides with 2-in. plank. Over each hoistway (on the floor in course of construction) there was placed a gin pole 25 ft. long, to which was attached the tackle, in order that the steel could be hoisted vertically. The hoisting was done by single-drum, motor-driven "Mundy" hoists, one located adjacent to each hoistway on first floor.

Fig. 5. View Showing Excavation and Foundation Work in Progress — Austin Nichols Building.

MATERIALS AND MANNER OF HANDLING SAME.

The floors throughout the building consist of a top coat of cement mortar ¾ in. thick, placed on a cinder concrete base 2½ ins. thick.

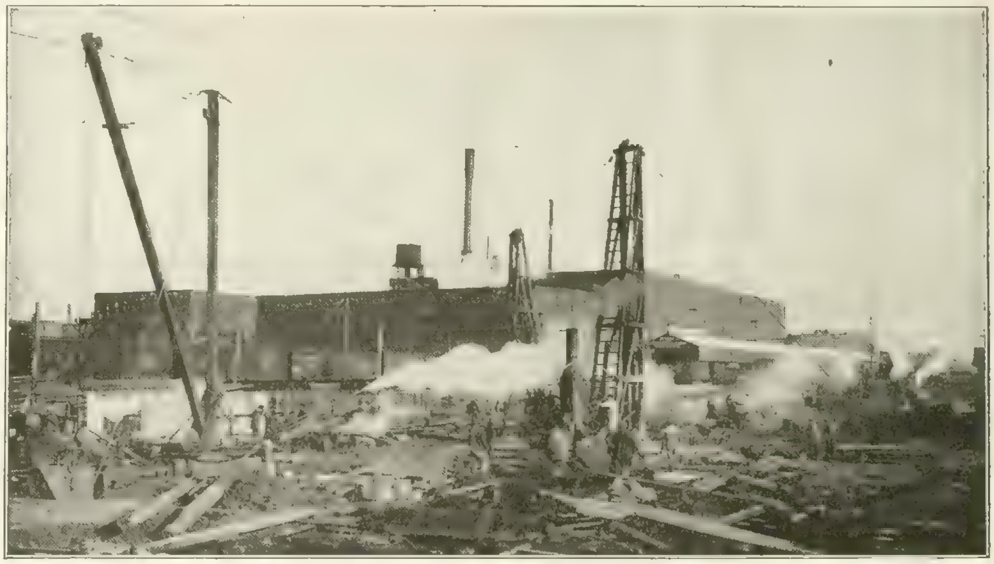


Fig. 6. View Showing Pile Driving Equipment and Derricks Used in Foundation Work of Austin Nichols Building.

The cement mortar and the cinder concrete base were mixed in the following proportions: cement mortar, 1 part cement, ½ part sand, 1½ part grit; cinder concrete, 1 part cement, 2 parts sand, 5 parts cinders.

The grit was delivered on scows at the dock which was used for receiving cement. The cinders were obtained from factories in the neighborhood. These materials were trucked to the building and stored on North Third St. The cinder concrete base and cement top coat were mixed and hoisted in the same manner as the gravel concrete, the cinders and grit being wheeled to the mixers.

The hollow tile, for partition construction, was delivered on lighters, it was unloaded adjacent to the sand and gravel bins, and was piled on the first floor near the platform hoist (see Fig. 4). This hoist was placed in an elevator shaft, and consisted of a platform 5 ft. 6 ins. x 5 ft. 6 ins., operated by a single-drum, motor-driven hoist. The tile was wheeled onto the platform in wheelbarrows, and was elevated to the various floors. The erection of the tile partitions followed closely the completion of the cement floors. The platform hoist was also used for elevating all plaster and the various materials entering into the work of the sub-contractors.

The derrick used was capable of unloading 700 cu. yds. of material per day of eight hours. The average capacity of each concrete plant was 45 cu. yds. of concrete per hour. The largest quantity of concrete placed in one day of 8½ hours was 640 cu. yds.

The efficiency of the equipment for conveying materials from the bins to the mixers was demonstrated when, due to a slight breakdown, the derrick was idle for one day. In order to keep one mixing plant in operation, the sand and gravel were wheeled from emergency storage piles on North Third St. Charging one mixer in this manner required 22 additional men, and reduced the output of the plant to about 30 cu. yds. per hour.

In order not to delay the progress of the work it was necessary that the reinforcing steel be placed immediately after the completion of the forms. This required that work in the steel yard be so systematized that the bending and fabrication of steel would be sufficiently in advance of requirements to prevent any delay in the work.

Beam and girder bars were bent in the "Wilson" bender at an average rate of 125 per hour, while the capacity of the "Wilson" stirrup bender was 4,000 stirrups per day.

The total labor cost for installing all equipment used in the erection of the building was 20 cts. per cubic yard of concrete. It must be borne in mind, however, that this cost does not cover any charge either for materials or for the use of plant, depreciation or interest on equipment investment.

EXCAVATING AND CONCRETING.

The successful erection of this building was due to the efficient operation of the equipment herein described. All foundation work was finished April 11th and the roof was completed July 3rd. Between these dates 17,510 cu. yds. of concrete were placed in 62 working days, an average daily output of 282 cu. yds.

The excavation, piling and concrete foundation work was done during December, 1913, and January, February and March, 1914. The progress views illustrating the equipment and procedure used in this part of the work are shown in Figs. 5 and 6.

For concreting the foundations, a "Ransome" mixer, motor-driven, of ½-cu. yd. capacity, was set up west of the center of the building about 8 ft. above the general excavation level. The concrete was discharged into a box, from which it was wheeled to the footings in concrete carts, of 6 cu. ft. capacity. Adjacent to this mixer there was placed a vertical boiler of 25 HP. capacity, the steam from which was used to heat water for the concrete and to thaw out frozen sand and gravel. Over each footing which was concreted in freezing weather there was placed a collapsible framework, covered with heavy burlap, inside of which was placed a salamander burning coke (see Fig. 5). This method of preventing the concrete from freezing proved entirely satisfactory, and made it possible to carry on concreting operation regardless of the temperature. This mixer above referred to was used while the excavation, piling, pumping, etc., interfered with the erection of the permanent concrete plants.

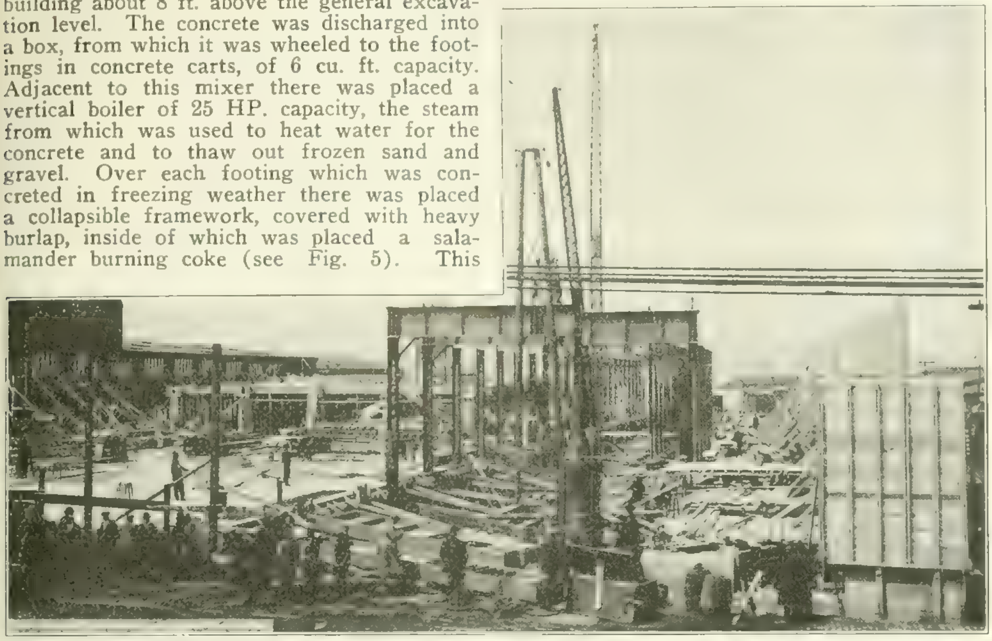


Fig. 7. View Showing Steelwork Over Tracks and Equipment Used in Erecting Same—Austin Nichols Building.

Serious difficulties were encountered in excavating and in driving piles, due to the presence of old brick and concrete foundations, cribs, etc. Moreover, severe cold and heavy snow storms in February materially delayed the progress of the excavation and piling work, and retarded the concreting of the foundations. The piling and excavation work was completed April 7, 1914, and the foundations April 11, 1914.

On account of the long-span construction over the railroad tracks (see Fig. 4), steel girders and columns were used in the first story of this part of the building. Figures 7 is a view showing this steelwork and the equipment used in its erection.

To complete the building by Sept. 1, 1914, required that the roof be finished by July 1st, and that all concrete work, excepting the cement floors, be completed by July 15th. This required the placing of 19,620 cu. yds. prior to July 15th.

Figure 8 shows the form work and equipment used in concreting the exterior walls in the fourth story, and Fig. 9 is a view of the building practically completed, a portion of the form work for the cornice being shown in place.

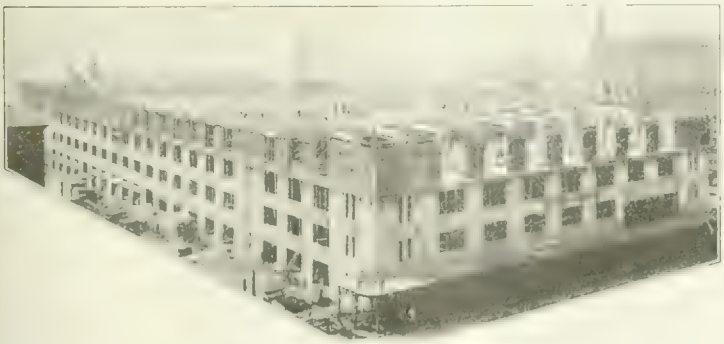


Fig. 8. View Showing Forms and Equipment Used in Concreting Walls of Austin Nichols Building.

Fig. 9. View Showing Austin Nichols Building Practically Completed—Forms for Cornice in Place.

PERSONNEL AND ACKNOWLEDGMENT.

The building was erected for Havemeyers & Elder, and was leased by them to Austin. Nichols & Co. The Turner Construction Co., New York, executed the general contract under the direction of Cass Gilbert, architect. This article is based on data contained in a paper by T. Arthur Smith, presented at the eleventh annual convention of the American Concrete Institute, Philadelphia, Pa. We are indebted to Mr. Smith for the drawings showing plant layout.

Decrease in Steel Earnings.—The annual report of the United States Steel Corporation for 1914 shows a big depression in the steel industry during that year. Earnings of $81,746,518 shows a decrease of $65,421,000, compared with 1913, while the net income of $46,520,408 shows a decrease of $58,800,284.

Net income for 1914 shows a deficit of $16,971,984, against a surplus of $30,582,184 the previous year. The corporation's expenditures of $45,372,594 for maintenance, repairs, and extraordinary replacements were $14,570,376, or 24.31 per cent, under the previous year.

In 1914 the corporation mined only 17,034,981 tons of iron ore, against 28,738,451 tons in 1913, and its total production of rolled and other finished steel products for sale fell off 3,360,326 tons to 9,014,512 tons.

Resolution of Board of Direction of Western Society of Engineers Pertaining to Proposed License Law for Structural Engineers.

In our issue of March 17, 1915, we published the provisions of a proposed license law for structural engineers practicing in Illinois. The proposed act, which was drawn up by the Legislative Committee of the Western Society of Engineers, is entitled, "A Bill for an Act to Provide for the Licensing of Structural Engineers, and to Regulate the Practice of Structural Engineering." In our introductory paragraph we stated that the proposed law had been approved by the Board of Direction of the Western Society of Engineers, which had instructed its Legislative Committee to endeavor to secure its passage at the present session of the Illinois Legislature. As our communication from the Legislative Committee did not contain the complete resolution of the Board of Direction, and as this resolution contains provisions not mentioned in our previous issue, we reprint below the full text of the resolution as adopted March 9, 1915:

Whereas, A law exists in this state commonly known as the Architects' License Law, and,

Whereas, Said law denies to the public the full benefits to be derived from the employment of engineers of their profession, and,

Whereas, The Legislative Committees of the Western Society of Engineers have devoted two years to the study of remedies for this unfavorable condition, and have prepared a bill for passage by the legislature, entitled "An act to provide for the licensing of structural engineers, and to regulate the practice of structural engineering," and have reported the same to this Board, and,

Whereas, This Board seeks no special privileges for engineers and has serious doubts of the wisdom of regulating engineering through state license, as a general proposition, but believes that a special emergency exists in this state that can be met only through additional legislation; therefore, be it

Resolved, That it is the sense of the Board of Direction of the Western Society of Engineers:

(1) That the Architects' License Law as now existing on the statute books of Illinois is detrimental to the practice of engineering, and not in the interests of the people of this state.

(2) That the Board favors the following remedies:

(a) The repeal of the Architects' License Law, or its amendment in such manner as to permit equal privileges to engineers and architects.

(b) The adoption of a State Building Code that will secure the protection of the public without hardship to either architects or engineers, or,

(c) In the event that neither of the above remedies can be brought about, the passage of said bill for the licensing of structural engineers, or a modification of said bill retaining the essential provisions thereof.

(3) That the Legislative Committee of this Society has the approval of this Board of Direction, in urging before the legislature of Illinois, relief from the present intolerable conditions through any one of the measures enumerated above as the Legislative Committee may find most expedient, but preferably in the order named.

Engine Houses: Principles of Design.

The careful study which the American Railway Engineering Association has given to engine house designing in recent years has resulted in definite conclusions, which are embodied in the following report of the Committee on Buildings:

FORM.

(a) The circular form is preferable.

(b) At points where not more than three or four locomotives are housed at one time, and where it is more economical to provide a "Y" track than a turntable, or where it is not necessary to turn locomotives, a rectangular house, either with through tracks, or with switches at one end only, may be desirable.

(c) At shops where a transfer table is used, a rectangular engine house served by the transfer table may be desirable.

TURNTABLE.

(a) The turntable should be long enough to balance the engine when the tender is empty.

(b) A deck turntable is preferable to a through table.

(c) At important terminals, turntables are most economically operated by mechanical means. Where few and light engines are turned, hand operation may be desirable.

Where electric power can be obtained at a reasonable cost, an electric tractor is the most efficient means for operating a turntable, the cost of power is cheaper, and it is superior in continuity of service and maintenance. The first cost is approximately the same as an air motor of equal power and size.

Power wires are brought to table by either the overhead or the underground method. Overhead device has the advantage of accessibility for inspection and repair. Special care must be taken to protect properly collector head from weather and gases and support collector rigidly (framework supporting same should be fastened to steel frame of table and not to ties, and must be securely braced); the wires should be large enough to keep them from breaking from sleet and should be supported to framework supporting collector. Any play at table multiplies at collector head. Wires should be brought to pole, close to curb of turntable, keeping lines as far distant from nearest wall of roundhouse as possible, to minimize the danger of destruction by fire.

When the underground system is properly installed, its advantages are that all exposed non-current carrying parts are permanently grounded, including the circular-track rail (the only part of system to repair is collector head); non-interference from weather if turntable pit is properly drained.

The disadvantages are: The wire is not so easily repaired, and is much more difficult to originally install, as it must be properly protected from water, and cannot be successfully laid in a fill or on ground where settlement or shifting takes place. Where turntable pit cannot be well drained, it cannot be used with success. It has the advantage of protecting power to run table in case of fire to roundhouse, especially in one of a nearly complete circle.

Compressed air tractors are frequently used. Ordinarily the power costs much more than electricity and is not so reliable. At points having no power plant the locomotive to be turned furnishes the compressed air; in this case an auxiliary supply should be maintained by providing small air tank secured to the turntable for operating it before or after the engine is placed.

(d) The deck on turntable should be wide enough to provide a walk on each side and be protected with hand rails.

TURNTABLE PIT.

(a) The turntable pit should be well drained and preferably paved.

(b) The circle wall should be of concrete or brick, with a wood coping not less than 6 ins. thick.

(c) The circle rail should preferably bear directly on concrete base. The use of wood ties and tie plates supported by masonry is desirable under some conditions.

(d) Easy access to the interior of a turntable for the oiling of bearings, painting and inspection should be provided in the design of the turntable pit, unless ample provision is made in the turntable itself.

DOOR OPENINGS.

The clear opening of entrance doors should not be less than 13 ft. in width and 16 ft. in height.

DOORS.

Doors should be easily operated, fit snugly, be easily repaired and maintained, and should admit of the use of small doors.

TRACKS.

(a) Lead tracks to the turntable should line up with tracks of the engine house where possible.

(b) Tracks should be on a level grade and should be provided with stop blocks.

(c) Special fastenings of the track rails at the circle wall and on the turntable are desirable to prevent movement of the rails, to give good bearing, and to lessen the damage from derailed wheels.

POSITION OF LOCOMOTIVE.

In a circular house the locomotive should stand normally with the tender toward the turntable.

LENGTH OF HOUSE.

The length of stall along center line of track should be at least 15 ft. greater than the overall length of the locomotive, to provide a walkway behind the tender, a trucking space in front of the pilot and a certain distance in which to stop the locomotive or to move it to bring side rods or other parts into convenient positions.

MATERIALS.

(a) The material used in construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(b) The additional security against interruption to traffic from fire warrants serious consideration of the use of a fireproof roof, and dividing the engine house into units of approximately ten stalls by the use of division walls built of fireproof material.

(c) When the roof is of reinforced concrete the columns and roofbeams should be of the same material.

(d) Reinforced concrete should be used for the walls only where special conditions reduce its cost below that of brick or plain concrete, and should not be used for that portion of the wall directly in line of track where engine is liable to run into it.

ENGINE PITS.

Engine pits should be not less than 60 ft. in length, with convex floor, with drainage toward the turntable. The walls and floors may be of concrete. Proper provision should be made for the support of the jacking timbers.

SMOKE JACKS.

The smoke jacks should be fixed. The bottom opening should not be less than 42 ins. wide and long enough to receive the smoke from the stack at its limiting positions, due to the adjustment of the driving wheels to bring the side rods in proper position for repairs. The bottom of the jack should be as low as the engines will allow, and it should be furnished with a drip trough. The slope upward should be gradual to the flue. The area of the cross-section of the flue should not be less than 7 sq. ft., and the jack should be made of non-combustible material. (This design of jack applies to all houses where regulations will permit. In some cities, where smoke abatement laws are in force, special design of jacks are necessary.)

FLOORS.

The floor should be of permanent construction. It should be crowned between pits.

DROP PITS.

Drop pits should be provided for handling truck, driving and trailer wheels.

HEATING.

(a) Heat should be concentrated at the pits. The outlets should be fitted with dampers, so that heat can be cut off while men are working in the pit.

(b) The general temperature of the engine house should be kept between 50° and 60°.

(c) The recommended method for heating is by hot air driven by fans through permanent ducts, which should be under the floor, where practicable. The fresh air supply should be taken from the exterior of the building and no recirculation allowed. It should be delivered to the pits under the engine portion of the locomotive. It should be heated as far as possible by exhaust steam, supplemented, as required, by live steam.

WINDOW LIGHTS.

(a) The disadvantages of skylights are so much greater than their advantages as to make them undesirable.

(b) Windows in the outer walls should be made as large as practicable with the largest glass or light area consistent with the requisite strength. In general, the lower sill should be not more than 4 ft. from the floor, and only sufficient space left between pilasters and sides of window frames and girders and window heads to properly secure the window frames. Windows or transoms as large as practicable should be provided over all doors where locomotives enter. Window lights in doors are objectionable on account of difficulty of maintenance.

ELECTRIC LIGHTING.

General distribution of illumination should be provided between pits by arranging a number of lights to avoid shadows and to give good light for workmen at the sides of the locomotives. There should be plugged outlets for incandescent lamps in each alternate space between pits.

PIPING.

(a) The engine house should be equipped with piping for air, steam and water supply, and where desired, piping for a washout and refilling system should be installed. Where this system is installed, the blowoff lines should be led to a central reservoir; where it is not used, the blowoff lines should be led outside the house.

(b) The steam outlet should be located near the front end of the boiler. The blowoff pipe, the air, the washout and refilling water and the cold-water connections should be near the front end of the firebox. Connections need only be provided in alternate space between stalls.

TOOLS.

There should ordinarily be facilities provided for hand tools and for the location of a few machine tools, preferably electrically driven.

HOISTS.

Hoists with differential blocks are generally used for handling heavy repair parts, and suitable provision should be provided for supporting them.

New Bridge in Straits Settlements.—The new $36,000 Victoria Bridge over the Rochore Canal, Singapore, is of reinforced concrete on the Kahn bar system. It has five elliptical arched ribs, the whole of the foundations of abutments and wing walls being inclosed by ferroconcrete sheet piling. The bridge was designed to sustain a superimposed dead load of 80 lbs. per square foot on the footpaths and a rolling load of two tramway trains, each consisting of one motor double-bogie goods van of 20 tons, and drawing 4 goods vans each of 8 tons, or a total of 104 tons of two trains. The test was carried out by stacking steel sheet piling uniformly throughout the entire lengths of the footpaths, and while these were in position two complete trains passed over the bridge at a speed of 12 miles an hour, first in contrary directions and afterwards running abreast in the same direction. The maximum temporary deflection was 0.055 inch; there was no permanent set.

Strength and Other Properties of Typical Cinder Concrete Used in Floor Construction in New York.

The extensive use of cinder concrete in reinforced concrete floor construction in New York and other eastern cities has led to a demand for more definite data on its strength and other properties. To meet this demand the Department of Civil Engineering of Columbia University instituted an investigation, together with a series of experiments, the work being started in 1913 and is now in progress. The investigation includes: (1) The determination of the compressive strength, with elastic and other properties, of typical New York cinder concrete cast under working conditions, as obtained in actual practice; (2) a study of the behavior of typical cinder concrete slabs under load as affected by the character and percentage of reinforcement, span length, age, and local conditions, for the purpose of aiding in theoretical design or in establishing a standard loading test; and (3) an attempt to recommend specifications tending toward an improvement in the product as to greater density, uniformity, etc. The following data pertaining to the strength and other properties of typical cinder concrete were abstracted from a paper by Harold Perrine and George E. Streham, in Proceedings, American Society of Civil Engineers, Vol. XLI, p. 260.

TABLE I.—DATA ON CINDER CONCRETE AS USED IN FIREPROOF FLOORS IN NEW YORK CITY.

Zone	A_1	B_1	B_2	C
Mix	1 : 2 : 5	1 : 1 : 5	1 : 2 : 5	1 : 2 : 5
Method	Continuous mixer. Coltrin.	By hand turned twice.	Batch mixer.	Mixer. Ransome.
Cement	Alsen.	Dragon.	Vulcanite.	Atlas.
Sand	Typical Long Island bank sand, north shore			
Cinders	Anthracite.			
	Ice plant.	Local hotel steam plant.	Local.	Local office building steam plant.
Weight, in lbs. per cu. ft.	107	100	107	109
One-month test:				
Crushing strength, in lbs. per sq. in.	407	507	818	980
Modulus of elasticity, in lbs. per sq. in.	924,600	857,400	1,230,000	1,492,000
Two-month test:				
Crushing strength, in lbs. per sq. in.	701	662	1,254	1,035
Modulus of elasticity, in lbs. per sq. in.	1,134,000	1,030,000	1,740,000	1,428,250
Six-month test:				
Crushing strength, in lbs. per sq. in.	933	754	1,744	1,478
Modulus of elasticity, in lbs. per sq. in.	971,000	1,050,000	1,348,000	1,276,000
One-year test:				
Crushing strength, in lbs. per sq. in.	913	813	1,465	1,475
Modulus of elasticity, in lbs. per sq. in.	993,000	956,000	1,200,000	1,320,000

TYPICAL MATERIAL.

Tests to determine the compressive strength and elastic properties were made on standard cylinders 8 ins. in diameter and 16 ins. high, as recommended by the Joint Committee. Galvanized iron forms having these interior dimensions were taken to buildings in course of construction in various parts of Manhattan, and 40 cylinders were cast at each location. All specimens were made by men familiar with the casting of test cylinders, under the personal supervision of a Building Bureau official. The mixture in the specimens was identical with that going into the floors at the time of arrival, no advance notification having been sent to the contractor of the intention to take samples. The various methods of handling, tamping, etc., were carefully noted. Test pieces were taken from five buildings selected from three arbitrarily chosen zones, the intention being to find local variations, if such existed. Samples of the component materials were selected from the cement, sand, and cinders in each case, and tests and analyses of these were made.

The cylinders were allowed to remain for several days under the atmospheric conditions obtaining on the mixing floors of the buildings in which they were cast, after which time they were removed to the Columbia laboratories and stored in air at ordinary room temperature until tested. During the early aging they were sprinkled occasionally. It was thought that this method of storage duplicated as nearly as possible the conditions under which the floor slabs themselves are cured. In many cases, due to their thinness, the slabs dry out quite rapidly. All cylinders were faced at both ends with plaster of Paris before testing.

RESULTS OF TESTS.

From each of the sets of 40 cylinders 10 were tested respectively, at 1, 2, 6, and 12 months. The results of these tests are shown in Table I. Zone *A* applies to that region of Manhattan which is occupied by apartment houses; zone *C* is the down-town office building district; and zone *B* refers to that large section in New York lying midway between zones *A* and *C*, in which the new construction consists mainly of loft and mercantile buildings.

The arbitrary choice of zones was made, not only for the purpose of obtaining material from different types of buildings in process of construction, but also to study the effect of the conditions occurring at the source from which the cinders were obtained; for, in many cases, the existence of oil, injurious chemicals, certain by-products of manufacture, and other impurities are important factors detrimental to the resulting concrete.

TABLE II.—MECHANICAL ANALYSIS OF SAND AND CINDERS USED IN CASTING TYPICAL NEW YORK PRODUCT.

Zone.	Mix.	Material.	Percentage passing sieve. 1¼-in.	1-in.	¾-in.	½-in.	¼-in.	No. 10.	No. 30.	No. 40.	No. 50.	No. 100.
A	1 : 2 : 5	Sand	....	....	....	100.0	98.8	88.9	58.5	39.5	29.3	7.3
		Cinders	97.8	97.2	93.4	85.9	63.4	38.8	24.4	22.8	21.6	13.7
B_1	1 : 1 : 5	Sand	....	....	....	100.0	96.4	79.0	62.9	41.4	30.3	7.6
		Cinders	100.	98.2	93.4	76.1	34.1	11.1	5.0	3.7	3.5	1.4
B_2	1 : 2 : 5	Sand	....	....	....	100.0	98.3	75.9	56.3	33.4	25.3	6.5
		Cinders	94.4	....	80.3	57.3	24.3	11.7	9.3	6.7	6.2	3.6
C	1 : 2 : 5	Sand	....	....	....	100.0	99.2	80.8	57.0	38.3	25.8	4.2
		Cinders	98.1	96.3	88.3	64.5	25.4	11.1	3.0	1.5	1.3	0.5

Each value in Table I is an average obtained from 10 samples, except in the case of B_2, in which the total number of specimens tested was 30 instead of 40. This was due to the fact that about three-quarters of the material used was mixed under actual working conditions, and the remaining 10 cylinders were cast from a mix prepared by the contractor's foreman, who was aware of the use to which the test specimens were to be put. His evident zeal in the matter resulted in extremely high compressive strengths, and therefore these were excluded from the averages.

The modulus of elasticity was determined at a point on the elastic curve corresponding to one-fourth the ultimate strength.

The writers believe that Table I contains sufficient data to prove conclusively the variableness of cinder concrete as used at present in Manhattan. The strength of sample *A*, 407 lbs. per square inch at an age of 1 month, may be taken as typical of concrete resulting from the use of low-grade cinders, despite the fact that it was machine mixed. Sample B_1 was found to have a strength of 507 lbs. per square inch, after a similar interval of time. In this case the use of good cinders and a richer mix than is required did not offset the poorer results almost always obtained by ordinary hand-mixing. Sample B_2 approaches, and *C* about equals, good practice in cinder concrete construction at the present time.

Samples B_1, B_2 and *C* represent cylinders of approximately the same gradation in size as given in Table II.

The mechanical analysis of sample *A* shows a greater preponderance of fine material in this cinder than in the other three samples. The conclusion that poorer results are obtained with hand mixing appears to be justified in view of the detailed tests of the component materials.

The results of a chemical analysis of the cinders is shown in Table III.

By referring to Table III it will be noted that the quantity of sulphur is in general small and increases with the unburned coal content. The sulphur existing as sulphides probably is inert, while the sulphuric anhydride which is present in the cinders may be an agent of corrosion. The only safeguard is to insure the presence of a protective coating of cement mortar on the steel reinforcement, by the use of a mixture of viscous or wet consistency.

TABLE III. CHEMICAL CONSTITUENTS OF CINDERS

Samples.	Percentage of unburned coal determined by carbon loss on ignition.	Percentage of sulphides.	Percentage of sulphuric anhydride. (SO_3).
A	16.50	0.073	0.21
B_1	28.10	0.091	0.14
B_2	25.75	0.084	0.08
C	26.41	0.107	0.07
Slabs, 1913	15.96	0.063	0.09
Slabs, 1914	10.84	0.056	0.03

Comparative Cost of American and German Cement in Costa Rica.—The following are the itemized costs of placing a barrel of American cement in warehouse at San Jose, which is the capital and chief distributing center of the republic of Costa Rica:

F. o. b. New York cost	$1.46
Ocean freight, New York to Port Limon, Costa Rica, at 27 cts. per cwt.	1.07
Insurance, at 45 cts. per $100	.01
Commission, at 2½%, for cash trading	.06
Cost c. i. f. Limon, Costa Rica	$2.60

The subsequent Costa Rican costs, which are the same on all cement imported, are:

Duty and wharfage	Free
Unloading and dispatching	$0.36
Railroad freight from Limon to San Jose in minimum lots of 100 pounds	2.36
Cartage	.13
Incidentals	.02
Total Costa Rica costs	$2.87
Plus c. i. f. Limon cost	2.60
Cost at San Jose	$5.47

The following are the items of c. i. f. Port Limon cost for German cement in steel barrels:

Hamburg f. o. b. cost	$1.52
Ocean freight, Hamburg to Limon	1.29
Insurance	.03
Commission at 3%, cash trading	.08
Total cost per barrel, c. i. f. Limon	$2.92

GENERAL

Court Decisions Showing "Present Value" to be the Only Value for Rate Making Purposes.

Contributed by H. P. Gillette.

It has been repeatedly asserted that the Supreme Court has fixed no standard toward which appraisers can work in order to arrive at a fair value of public utility properties for rate making purposes. While it is true that the Supreme Court of the United States has not explicitly fixed upon "cost of reproduction," for example, as a standard of present value, it is to be noted that in all rate case decisions since 1898 the Supreme Court *invariably* has used some expression equivalent to "*present value.*" It is also to be noted that in explaining or defining what this "present value" is, every decision makes it clear that *it is not original cost* or the actual investment in the property.

Prior to the Smyth vs. Ames case (decided 1898), there are three noteworthy decisions of Federal Judges in relation to values for rate making. These pioneer decisions marked the path toward the Smyth vs. Ames decision.

Justice Brewer, in the Union-Pacific Railway rate cases, decided in 1894 (64 Fed. 165), said:

> Now, if the public was seeking to take title to the railroad by condemnation, **the present value of the property, and not the cost,** is that which would have to pay. . . .
>
> In the cases before us, however, there is abundant testimony that the cost of reproducing these roads is less than the amount of stock and bond account, or the cost of construction, and that the present value of the property is not actually represented by either the stock and bonds or the original construction account.

Justice Brewer then goes on to indicate that while the securities issued should have weight, it is the present value, and by that he evidently means the reproduction value, that should have the controlling weight in determining a base for rates.

Judge Ross in the San Diego Land and Town Co. v. National City, decided 1896 (74 Fed. 79), says:

> In the solution of that problem many considerations may enter, among them the amount of money actually invested. But that is by no means, of itself controlling, even while the property was at the time fairly worth what it cost. If it has since enhanced in value, those who invested their money in it, like others who invested their money in any other kind of property, are generally entitled to the benefit of the increased cost. . . . In my judgment **it is the actual value of the property at the time the rates are to be fixed** that should form the basis on which to compute just rates.

Judge Thayer in the Kansas City Stock Yards Rate Case, decided 1897, says (82 Fed. 850, 854):

> On the other hand, however, when property is valued for the purpose last stated [rate making] it is clear that **the owner thereof is entitled to the benefit of any appreciation in value above the original cost and the cost of improvements,** which is due to what may be termed natural causes.

Justice Harlan in Smyth vs. Ames, decided in 1898, speaks as follows (169 U. S. 466):

> We hold, however, that the basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative act must be the **fair value** of the property being used by it for the convenience of the public. . . . What the company **is** entitled to ask is a fair return upon the value of that which it employs for the public convenience.

Justice Harlan indicates the various elements that should be considered in arriving upon his *existing* value of the property. It is to be noted that his language when speaking of value is in the present tense, as for example, "property being used." The same justice, Justice Harlan, in deciding the San Diego Land and Town Co. vs. National City, in 1899, makes it still more evident that he had in mind "present value" and not "original cost," for, after reviewing the fact that the *appellant asks that the original cost of the plant be made the base for rates,* he says (174 U. S. 739):

> The basis of calculation suggested by the appellant is, however, defective in not requiring the real value of the property and the fair value in themselves of the services rendered, to be taken into consideration. What the company is entitled to demand in order that it may have just compensation is a **fair return upon the reasonable value of the property at the time it is being used for the public.**

The next important decision by the Supreme Court serves still further to emphasize the interpretation of the Smyth vs. Ames decision as being one that leads to fair *present* value, for Justice Holmes, in the San Diego Land and Town Co. vs. Jasper, decided in 1903, says (189 U. S. 439):

> The main object of attack is the valuation of the plant. **It no longer is open to dispute that under the Constitution "what the company is entitled to demand, in order that it may have just compensation, is a fair return upon the reasonable value of the property at the time it is being used by the public."..........That is decided, and is decided as against the contention that you are to take the actual cost of the plant, annual depreciation, etc., and to allow a** fair profit on that footing over and above expense. . . . No doubt cost may be considered, and will have more or less importance according to circumstances. In the present case it is evident for reasons, some of which will appear in a moment, that it has very little importance indeed.

In the next important Supreme Court decision relating to rate making values, namely, the Wilcox vs. Consolidated Gas Company Case, decided in 1909, Justice Peckham said (192 U. S. 201):

> And we concur with the court below in holding that the value of the property is to be determined as at the time when the inquiry is made regarding the rates. If the property, which legally enters into the question of consideration of rates, has increased in value since it was acquired, **the company is entitled to the benefit of such increase.**

In the most recent rate case decision of the United States Supreme Court, we find a complete affirmation of the principle that *present* value, including all the increments in value that have occurred since construction of plant, should be taken as a basis for rate making, Justice Hughes, in the Minnesota Rate Cases, decided in 1913, says (230 U. S. 352):

> It is clear in ascertaining the present value we are not limited to the consideration of the amount of the actual investment. If that has been reckless or improvident, losses may be sustained which the community does not underwrite. As the company may not be protected in its actual investment, if the value of property be plainly less, so the making of a just return for the use of the property **involves the recognition of its fair value if it be more than its cost. The property is held in private ownership and it is that property, and not the original cost of it, of which the owner may not be deprived without due process of law.**

It is evident from these Supreme Court decisions that while various matters may be considered in appraising the present value of property for rate cases, the proper consideration of all elements, such as original cost, simply implies that those elements shall be used to guide toward the *present fair value.*

Results of Study Made to Indicate Economic Choice of Shovels for Handling Different Classes of Material.

Contributed by C. W. Hartley, Civil Engineer, Empire City Subway Co., New York City.

It has recently been the writer's privilege to make some experiments in shoveling, with the view of determining the most efficient size of shovel to be used in handling different classes of materials, and to collect as many data as possible along these lines, the study of which might lead to the adoption of the methods of greatest efficiency.

In almost all branches and classes of construction work, some materials are handled with shovels, whether it be in excavating, mixing concrete, or shoveling sand and crushed stone, and the shovel is an implement of such universal and common use that it would appear, on the surface, that little might be learned in this connection which would be of value to the contractor.

However, it has been shown by the late F. W. Taylor, and by others who have followed in his footsteps, that great increases in output may be accomplished through the proper selection of shovels of different sizes for handling materials of different classes, basing the selection on a shovel that will hold 21 lbs. of material.

Taylor found that a first class shoveler will accomplish the most when using a shovel selected with this in view and, further, that no undue fatigue will result if certain periods of work and rest are properly apportioned. I mention these facts here for the reason that the experiments described later on, and the conclusions derived from them, are based thereon.

It is the custom, or has been in the past, among many large contracting firms and companies in New York City employing a great number of laborers on trench work, to require the men to furnish their own shovels. The principal reason for this is claimed to be that shovels furnished by the employers are very rapidly lost or stolen. While this may be true, it would appear that such procedure is a false economy, as I shall endeavor to show.

Frank B. Gilbreth, in his work on "Motion Study" (page 59) says:

> No worker should ever be obliged to furnish his own tools, if large output is expected. When workmen are obliged to furnish their own tools (due to their having too much thrift, lack of money, or fear of having them stolen) they usually use one size only of the same kind of tool. On many kinds of work, greater output can be obtained by using two or more sizes of a tool.
>
> Again, where workmen furnish their own tools, they use them after they are too much worn. A shovel with a worn blade will require several motions to push it into the material to fill it. It is cheaper in this case to cut off the handle of the shovel, so that the men cannot use it. Where no records are kept of their individual outputs, the men always choose the shovel with the small blade.

The statements contained in the last paragraph quoted have been most strikingly forced upon the writer's attention by reason of the following discovery:

In a gang of 38 men, at work in a trench, with shovels furnished by themselves, it was found that 92 per cent were using the smallest size shovel on the market, a No. 2, while the remaining 8 per cent were using the next size larger, a No. 3. These shovels, as will be shown later, are incapable of holding near the amount of material (if it be earth) that should constitute a shovelful. It was further observed that 50 per cent of these men were using shovels, the blades of which were worn down approximately 3 ins. from the point, or until but little over half the original blade remained, and it is interesting to figure out the probable loss due to the use of these worn shovels.

By critical time observations it was demonstrated that the men using the worn shovels worked no faster than those using the good; further, that men will shovel at approximately the same speed whether they are working with a No. 2 shovel, or a No. 4, and, as a general rule, will fill the blade full, whenever possible to do so. This being the case, it is self-evident that the use of small or worn shovels will entail the handling of less material, as follows:

A No. 2 shovel, in good condition, was found by many trials to hold, as an average load, 13 lbs., the material being common loam or earth, loose and dry. This same size shovel worn down, as were half of those in use by this aforementioned gang, was found to hold but 7 lbs. of earth or loam, which is, as will be noted, only one-third the amount Taylor has shown to be productive of the greatest shoveling efficiency.

Now let us assume that these 38 men were paid at the rate of 20 cts. per hour, or $1.80 per day, and that 13 lbs. represents the unit base from which their output is figured. Fifty per cent, or 19 of the men, were using worn shovels, and were therefore doing but 7/13 the amount of work done by the remainder. Figured in terms of money lost, this would give a loss of 83 cts. per day per man, or $15.77 per day for the entire gang, or 41½ cts. per day for each shoveler in the gang of 38 men. It is easily seen how these figures would be increased if figured with 21 lbs. as the unit. For instance, a man is shoveling with a shovel holding but 7 lbs. of earth, when he might be using one holding 21 lbs. He is, therefore, performing but one-third the amount of work that might be accomplished by him, were he provided with the proper tool. If he be a $1.80 man engaged in shoveling all day, this means a monetary loss to his employer of $1.20 per day.

These same data were obtained for shovels of other sizes, namely No. 3, No. 4, and No. 5, and Table I gives the results of the tests made to determine the average amount of earth, sand, and stone that constitutes a shovelful.

TABLE I. — SHOVEL LOADS OF VARIOUS MATERIALS IN POUNDS FOR SHOVELS OF DIFFERENT SIZES.

		—Worn—			—New—		
Number.	Dimensions of blade (inches).	Earth	Sand	¾-in. stone	Earth	Sand	¾ in. stone
2.....	9¼ by 12¾	7.0	9.0	7.0	13.0	14.5	9.5
3......	9½ by 13¼				15.5	17.0	11.0
4......	9¾ by 13¾				18.0	19.0	12.0
5......	10½ by 14¼		.	.	22.0	22.5	15.5

There is no reason to believe that anything presented herein may bear any claims to originality, but the thought that prompts the writing of this article is based on the following:

It has been my observation that the shovel most used in general contracting work is a No. 2, whether it is supplied by the employer, or by the laborer. That this is the fact is due, probably (in the case of the employer), to lack of consideration of the subject, and also to the fact that the use of this particular size is sanctioned by custom.

There has been much written on this subject, in the last few years, and much attention given to efficiency work on construction, though possibly not such a great deal in connection with shoveling. At the same time there is undoubtedly much to be accomplished along these lines, and it is unfortunate to think of the many shoveling operations being carried on with great loss of efficiency when, with a little experimenting to fit the particular case, the old order of things might be changed.

It will be noted, from Table I that the No. 4 and No. 5 shovels approach most nearly, in the amount of material handled, the 21-lb. load. For trench and general shoveling work, however, the No. 5 is a trifle wide and cumbersome, while the No. 4, though appearing large and heavy in comparison with a No. 2, we found to be well adapted to use in the trench. Fortified, therefore, with the data presented at the beginning of this paper, it was decided to equip the laborers in the construction department with the No. 4 shovels, and at the beginning of the season, in April, 1914, this was done.

To quote from a report presented to the chief engineer:

> I find that we started the season, on April 15, 1914, with 606 round-pointed No. 4 shovels, and 150 square-pointed No. 4 shovels, or a total of 756.
>
> At the present time, Nov. 10, 1914, there are at the storeyard 311 round and 92 square shovels, leaving 295 round and 58 square, or a total of 353 shovels used during the season. Of these 353 shovels, 57 have been returned as worn out, and there are at present 251 in use on the work. The majority of these shovels now in use show considerable signs of wear, and might well be classed as worn out, so we have a total of 308 shovels worn out during the season. This leaves 45 shovels to be accounted for as lost, stolen, broken, etc.
>
> In a season of 168 working days (up to the first of November) therefore, we have used 353 shovels, or an average of 2.10 per day. These shovels were of two different grades, costing $8.60 and $5.25 per dozen, respectively. The fact that the higher priced shovels outwear the lower has not been apparent, however, at least, not sufficiently so as to warrant the difference in cost.
>
> Assuming, for sake of argument, that all the shovels cost us 72 cts. apiece (or at the rate of $8.60 per doz.) we find that it has cost $1.51 per day to supply our laborers with these No. 4 shovels. The daily average number of laborers at work during the season was 178, and the cost of the shovels per man per day was therefore .85 cts.
>
> It was shown, by my previous reports, that the use of a No. 4 shovel, in place of a No. 2, increased the efficiency, and consequently the output of the shoveler, approximately 27 per cent. While it is practically impossible, on our work, to figure the actual increase in yardage shoveled, the balance seems to be unquestionably in favor of the No. 4 shovel. The cost of these shovels, as shown above, was less than 1 ct. per man per day, and there can be no doubt but that their use effected an increase in output far greater than that amount.

The item of 45 shovels lost, stolen, or unaccounted for is worthy of note. As remarked before, the statement has been made that shovels furnished by the employer are lost and stolen in great numbers. The fact that out of a total of 353 shovels used by 178 men through a season of over five months, only 45, or a percentage of 12.7, were unaccounted for, would tend to refute the argument.

There may be some who might question the practicability of equipping with the No. 4 shovel a number of men who have never used any other than a No. 2. This was done, however, and without the offering of any explanation, or a bonus for increased output. Such a step quite naturally created a great deal of comment and discussion among the men, for a few days, but after that time they apparently forgot that they were using a shovel which would hold half as much again as the one to which they had been accustomed.

Money and time have been expended, and brains and inventive genius have been applied to the developing and perfecting of excavating machinery of various kinds, and all to good purpose. Excavation on a large scale is thereby accomplished with the utmost expedition and efficiency. But by contrast, what do we find on the small jobs, or, perhaps I should say, the ones on which, for various reasons, the excavation must be handled with shovels? As a general rule, we find conditions similar to those which I have described. We find laborers supplied with tools which in themselves effectually prevent a man from developing to the point of his greatest efficiency. We find men, in many cases, applying themselves incorrectly, and without method, to the work before them; and not infrequently we find slight disposition on the part of those in immediate authority to interest themselves in the cause of increased production through the selection and use of the proper tools.

It might almost be said that the foundation of construction work, in more ways than one, lies in shoveling. There is scarcely a contract undertaken, during the course of which the handling of excavation with shovels does not play some part, however small; and yet I would venture the opinion that there are very few instances in which this subject is given complete and thorough consideration from an efficiency standpoint.

Motor Buses and Passenger Traffic in Cities.

To THE EDITORS: In the March 3 number of your excellent publication there is an editorial on Motor Buses and Passenger Traffic in Cities, which can only have been written in a misunderstanding of the attitude of the electric railways of the country towards motor bus competition. In the first place, there is an assumption that the motor bus lines running on regular schedules, and operated over regulation routes, are identical with the so-called "Jitney" Bus. This is not the case. The "Jitney" Bus is a recent evolution, having sprung up within the last few months. In most cases it consists of a second-hand automobile, holding four or five passengers, as the case may be, and operated at will through the streets, picking up passengers where they are to be found, with no set route and no schedule whatever. It operates when weather conditions are favorable, and in such sections as pay the best return. In a large part of the cases, the owners are irresponsible, are under no regulation by either city or state, and give a service designated, not to furnish the city with a complete transportation system, but to secure the most profitable haul only.

In view of the obligations that are placed upon street car lines, by reason of state regulation, by reason of the taxes that are paid, by reason of their obligations to furnish service to sections of the community which are unprofitable, by reason of the requirements as to paving, and by reason of the many other services which they perform for the cities, it is evident that the "Jitney" Bus in no way performs an equal service, or is of the same value to the community, or bears the same burdens.

It is also to be borne in mind that by the extension of their lines to newly developed sections, which furnish no adequate return, the electric railways contribute largely to civic growth and prosperity and that the "Jitney" does not, nor will not furnish this service. The unfair nature of the competition is seen when it is considered that "Jitney" Buses take the cream of the business and leave the skim milk to the railroad companies.

Electric railways are operated on a very close margin. By reason of the flat fare in vogue throughout this country, they must depend upon the profit of the short haul passenger to make up for the loss experienced because of the transportation of the long haul passenger. If, then, they are to be deprived of the profitable part of their business, it is certain that they cannot long continue to exist on the unprofitable part. So that, if the "Jitney" is to continue its operations unrestricted, communities will, sooner or later, face the proposition of being deprived of the comprehensive service, including the elaborate transfer system, and must fall back on a system which serves only part of the community and that at the will of the owner, who will operate it only when weather conditions are favorable and when a profit is to be derived, and which pays a negligible part of the city's taxes. The situation is, then, as serious to the communities as it is to the companies.

Again, a misapprehension seems to have crept into your article when you say, "but, from the standpoint of the street railway companies, many of which have frankly admitted that they depend upon crowded cars and strap hangers for their profits," the case is serious. An examination of the accounts of any street railway company will show that the rush hour service, when "strap hanging" is prevalent, is the least profitable of all the company's business.

This statement may seem anomalous, but its truth will be evident, when the fact is considered that, in order to provide this rush hour service during a few hours only of the day, it is necessary to have greatly increased power house capacity, greatly increased equipment, to arrange for labor, which must be paid for more time than it is employed, and to assume numerous other overhead costs, which eat up any profits which might accrue from the crowds transported during the rush hours.

I have not the slightest doubt but that you intend to be entirely fair to the electric railways in your editorial comment, but it seems to me that if, as you say, certain street railway companies have "frankly admitted" that they depend upon crowded conditions for their profits that such companies have a very poor understanding of their own business.

Yours very truly,
HARLOW C. CLARK,
Editor, "Aera."

New York, N. Y., March 9, 1915.

A Method of Obtaining Volumes in Railroad or Ditch Work by Diagrams.

Contributed by F. C. Snow, Bozeman, Mont.

A diagram for obtaining cubic yards direct, of the prism between stations in canal or railroad work as described herein is as accurate as the usual field methods of setting slope stakes and obtaining the earth work notes on such surveys warrants and is much shorter than the usual calculations for obtaining such volumes.

Figure 1 of the accompanying cuts shows the general method of constructing such a diagram after the base and side slopes of the prism have been determined, based on the following formula for section areas, so used that the volumes are figured by the average end area method.

A_1 equals the area of one end of the section, A_2 the area of the other end and L, the side slope of the banks, equals tan. ∝ in Fig. 1a, then,

$$A_1 = \left(\frac{m_1+n_1}{2}\right)\left(\frac{b}{2L}+d_1\right)-\frac{b^2}{4L} \qquad Equ.\ 1.$$

and

$$A_2 = \left(\frac{m_2+n_2}{2}\right)\left(\frac{b}{2L}+d_2\right)-\frac{b^2}{4L} \qquad Equ.\ 2.$$

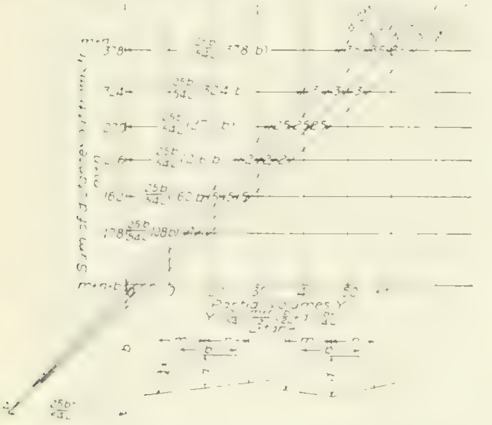


Fig. 1. Profile and Mass Diagram Showing Method of Computing Overhaul by Method of Trapezoids.

If these sections are 100 ft apart the volume in cubic yards equals,

$$\left(\frac{A_1+A_2}{2}\right)\left(\frac{100}{27}\right)=\frac{100}{54}(A_1)+\frac{100}{54}(A_2)=$$
$$\frac{100}{54}\left\{\left(\frac{m_1+n_1}{2}\right)\left(\frac{b}{2L}+d_1\right)-\frac{b^2}{4L}\right\}+$$
$$\frac{100}{54}\left\{\left(\frac{m_2+n_2}{2}\right)\left(\frac{b}{2L}+d_2\right)-\frac{b^2}{4L}\right\} \qquad Equ.\ 3.$$

Now diagrams can be constructed on either half of this equation using m, n and d in place of either m_1, n_1 and d_1 or m_2, n_2 and d_2.

Let this partial volume equal Y, then,

$$Y=\frac{100}{54}\left\{\left(\frac{m+n}{2}\right)\left(\frac{b}{2L}+d\right)-\frac{b^2}{4L}\right\} \ldots Equ.\ 4.$$

and the total volume between stations can be obtained by picking the value of Y for the station at each end of the prism 100 ft. long and adding these partial volumes.

In Fig. 1 the diagonal lines represent center cuts or fills, the Y, or horizontal scale, partial volumes and the X, or vertical scale, the sum of the distances out from the center to the side slope stakes, represented by m plus n.

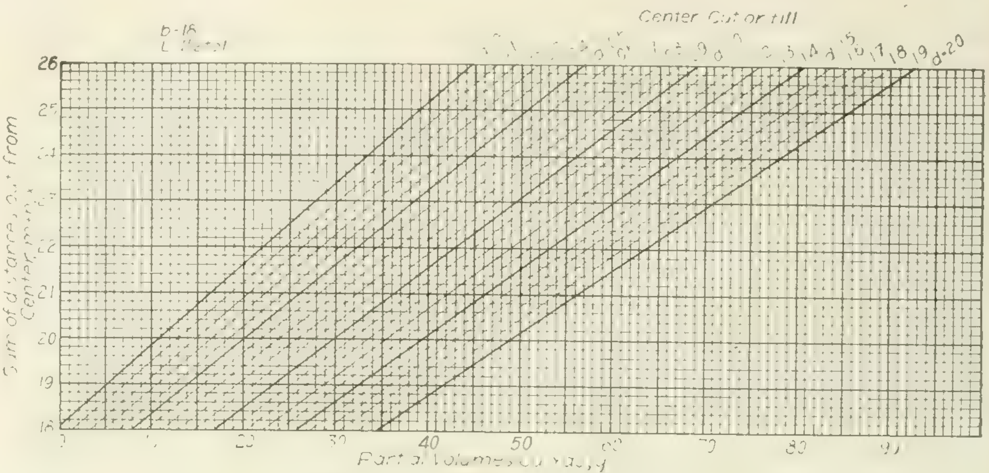


Fig. 2. Profile and Mass Diagram Showing Method of Computing Overhaul from the Overhaul Area of Mass Diagram.

The point A in Fig. 1 is found by making $(m+n)$ equal 0 in Equ. 4, then

$$Y=-\frac{100}{54}\left(\frac{b^2}{4L}\right)$$

The center cut, or d lines, are located as follows, when d equals zero, from Equ. 4.

$$Y=\left(\frac{25\,b}{54L}\right)(m+n-b) \qquad Equ.\ 5.$$

and differentiating Equ. 4,

$$\frac{d\,(Y)}{d\,(d)}=\left(\frac{25}{27}\right)(m+n)$$

so that

$$d\,(Y)=\left(\frac{25}{27}\right)(m+n)\Big(d\,(d)\Big) \ldots\ldots Equ.\ 6.$$

or for any change in d the corresponding change in Y equals

$\left(\frac{25}{27}\right)(m+n)$ times the change in d.

If the change in d is taken as 0.1 of a foot then the change in Y equals $\left(\frac{2.5}{27}\right)$ $(m+n)$, and if 2.5 $(m+n)$ is taken as some multiple of 27, the change in Y becomes a number that is easily plotted, such as 1, 2, 3, etc. For this reason in determining the position of the (d equals zero) line as shown in Fig. 1, $(m+n)$ is taken as 10.8, 16.2, 21.6, etc., the increase being 5.4 each time. The corresponding values of the change in Y are then 1.0, 1.5, 2.0, etc., from Equ. 6.

The d equals zero line can be located from Equ. 5 by substituting the above values for $(m+n)$, as

$m+n$ equals b, d equals 0, Y equals 0.

$$m+n=10.8,\ d=0,\ y=\left(\frac{25\,b}{54L}\right)(10.8-b)$$

$$m+n=16.2,\ d=0,\ y=\left(\frac{25\,b}{54L}\right)(16.2-b)$$

etc.

Each of the other d lines can now be located by plotting the value of the change in Y for 0.1, change in d on the proper $(m+n)$ line and drawing the diagonals through the points thus determined and through the point A as a check.

Fig. 2 shows an example of these diagrams for a base of 18 feet and slopes of banks of 1.5 to 1.0. Its use is as follows:

Station 1	$\frac{9.7}{0.5}$	$\frac{0}{0.9}$	$\frac{10.3}{0.9}$	
$(m+n)$	20.0	$d=0.9$		$Y=$ 28.0
Station 2	$\frac{12.9}{2.6}$	$\frac{0}{2.0}$	$\frac{10.4}{0.9}$	
$(m+n)=$	23.3	$d=2.0$		$Y=$ 72.8

Total volume equals the sum of Ys 100.8 cu. yds.

If the volume of a prism having a number of stations 100 ft. apart is required, add to the partial volumes of the stations at each end of the prism in consideration twice the sum of the partial volumes of the intermediate stations, thus,

Station.	Field notes.			m + n	d	Partial volumes.	
1	$\frac{9.6}{0.4}$	$\frac{0}{0.3}$	$\frac{9.6}{0.4}$	19.2	0.3	....	11.9
2	$\frac{10.1}{0.7}$	$\frac{0}{0.7}$	$\frac{10.1}{0.7}$	20.2	0.7	25.4	
3	$\frac{9.7}{0.5}$	$\frac{0}{0.9}$	$\frac{10.3}{0.9}$	20.0	0.9	28.0	
4	$\frac{10.2}{0.8}$	$\frac{0}{0.9}$	$\frac{10.5}{1.0}$	20.7	0.9	32.6	
5	$\frac{9.4}{0.3}$	$\frac{0}{0.7}$	$\frac{10.2}{0.8}$	19.6	0.7	....	[illegible]
						86.0×2	172.0
							21.6
							205.5 cu. yds.

If the volume for sub-station (that is, a station less than 100 feet) is required, if the length of the sub-station is called (P), then 100 : (P) :: Volume obtained from diagram :Actual volume, thus

Station.		Field notes			m + n	d	Partial volumes.
1		$\frac{12.4}{2.3}$	$\frac{0}{1.7}$	$\frac{11.0}{1.4}$	23.4	1.7	67.3
1	38.3	$\frac{13.1}{2.7}$	$\frac{0}{2.0}$	$\frac{11.1}{1.4}$	24.2	2.0	79.6
							146.9

100 : 38.3 :: 146.9 : X

X equals 56.3 cu. yds., the actual volume.

In the diagram Fig. 2 the scales are such that the partial volume can be read to cubic yards directly and tenths of cubic yards must be estimated, but the scales can be so arranged that closer readings can be obtained if desired.

Engineering and Contracting

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FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the branch offices at 337 Custom House, New York; 629 Federal Bldg., Chicago, Ill.; 76 Appraiser's Stores Bldg., San Francisco, Cal., and Room 1020, Hibernia Bank Bldg., New Orleans, La. In applying for addresses reference should be made to the file numbers.

Locomotives, Road Machinery, Etc.—European Government is contemplating a considerable amount of construction work which will require locomotives, stone crushers, concrete mixers, road-making machinery, steam rollers, etc. No. 16088. [For address see first paragraph.]

Electrical Machinery, Tramway Equipment.—There is a possible opportunity in South America for sale of machinery for an electric light plant and equipment for a tramway. No. 16092. [For address see first paragraph.]

Steel Rope, Pipe, Engines.—Commission merchant in Russia wishes to get in communication with manufacturers of steel ropes for drilling, camel-hair belting, oil and gas pipes, iron and steel products, oil engines. No. 16096. [For address see first paragraph.]

Pipes.—Firm in Switzerland wishes to represent American firms which are in a position to supply lead, tin and malleable iron pipes for gas and water conduits. No. 16098. [For address see first paragraph.]

Steam Rollers.—Contractor in East Indies wishes to get in touch with American exporters of steam rollers. No. 16100. [For address see first paragraph.]

Sewer and Water Pipe, Etc.—A concession for installing the house connections for a new water works and sewage system in Latin American city has been awarded to an American contractor; the concessioner will be in the market for about $50,000 worth of material. No. 16050. [For address see first paragraph.]

Cast Iron Pipe and Fittings.—Firm in South America wishes to receive price lists, etc., from American manufacturers which are in a position to make prompt shipments of 2½, 4 and 6 in. cast-iron pipes, cast-iron fittings, brass and lead fittings. Prices should be quoted f. o. b. New York or, if possible, c. i. f. destination. It is stated that the firm is prepared to pay cash. Correspondence may be in English. No. 16066. [For address see first paragraph.]

Railway Supplies.—Firm in East Indies desires to be placed in communication with American manufacturers of light railway materials, such as light engines, rails, switches, and all accessories for building, operating and maintaining light railways. Descriptive matter, cash discounts and prices f. o. b. American ports or c. i. f. destination should be sent at once. Correspondence may be in English. No. 16071. [For address see first paragraph.]

Turbines.—Lumber dealers' association in Russia desires to receive catalogues, etc., from manufacturers of turbines. It is stated that it now desires to purchase a water wheel of 150 HP. capacity. Correspondence may be in Russian, French or German. Prices, etc., should be stated in Russian equipalents, and quotations should be c. i. f. Russian ports. No. 16059. [For address see first paragraph.]

Motor Trucks.—A Government official in the Far East desires catalogues, etc., from manufacturers of motor trucks. He wishes information direct from the manufacturers as to the working cost of motor transportation per mile of such bulky articles as salt and grain. He also wishes to be informed whether the motor will operate efficiently in a temperature of 40° below zero, F. No. 16060. [For address see first paragraph.]

Railway Supplies.—European builder of railways, tunnels, water construction and hydroelectric works is desirous of representing American manufacturers of articles and machinery used in his line of business. No. 16031. [For address see first paragraph.]

INDUSTRIAL NOTES

The American Cast Iron Pipe Co. has recently opened an office at 509 First National Bank Bldg., Chicago, Ill.

The Wyckoff Pipe & Creosoting Co., Inc., has removed its main office from 50 Church St., New York City, to 42d St. Bldg., 30 East 42d St.

The Burd High Compression Ring Co. has removed its general and executive offices to 307 S. Main St., Rockford, Ill.

NEW CATALOGUES

Platt Products.—Paper, 3½x6 ins.; 10 pp. Platt Iron Works, Dayton, Ohio.

Shows the various types of pumps, compressors, engines, heaters, turbines, etc., handled by the company.

Electric Fans.—Paper, 3¼x6 ins.; 24 pp. Sprague Electric Works, New York city.

Bulletin No. B-3330, listing and briefly describing the assortment of Sprague electric fans. Illustrated and gives all requisite data.

Industrial Railway Equipment.—Paper, 3½ x6¼ ins.; 12 pp. The Gregg Company, Ltd., 82 Wall Street, New York city.

Booklet No. D. 101 showing the portable track, switches, frogs, and crossings, turntables, dump cars, flat cars and other industrial railway equipment manufactured by the above company.

Excavators.—Paper, 6x9 ins.; 16 pp. James W. Hensley & Co., 629 Lemcke Bldg., Indianapolis, Ind.

Illustrates the Hensley center gravity excavators, showing construction and views of actual operations. Gives general description the bucket, and notes on the planning of an excavating plant.

Curb Guards.—Paper, 6x9 ins., 4 pp. Clip-Bar Manufacturing Co., 26th St. and Pennsylvania Ave., Philadelphia, Pa.

Describes the Anchor Galvanized Curb Guard, the special features of which are the perforated web which allows the formation of a solid concrete mass, and the anchor frogs. Illustrated.

Welding.—Paper, 6x9 ins.; 24 pp., Oxweld Acetylene Co., 36th St. and Jasper Place, Chicago.

Illustrated and detailed description of the Oxweld process of welding and cutting in gas main construction and repairing. Shows the oxy-acetylene apparatus used and method of application, and gives exhaustive cost data.

Concrete Sockets.—Paper, 6x9 ins.; 4 pp. Concrete Socket Manufacturing Co., Philadelphia, Pa.

Describes Y Concrete Sockets and the method of their installation in reinforced concrete for the purpose of supporting shaft hangers, pipes, conduits, etc. Illustrated by diagrams showing installation and cuts of the sockets.

Paving Mixers.—Paper, 9x11½ ins.; 16 pp., Oshkosh Manufacturing Co., Oshkosh, Wis.

Supplement to the 1915 General Catalogue, which describes the Oshkosh street-paving mixer. Gives specifications, diagram showing construction and dimensions, and several views with boom and bucket or distributing chute and other equipment.

Tools and Conduit Specialties.—Paper, 8½x 11½ ins.; 24 pp., B. S. Barnard & Co., 52 Church St., New York City.

Illustrated catalogue, descriptive of the line of tools and specialties for underground conduit work handled by this company. This line includes all manner of pick-up tools and devices for removing obstructions of various kinds, also conduit plugs, wrappers, cable binders, conduit threading machines, steel fishing tapes, etc.

Steam Shovels.—Paper, 5½x8 ins.; 29 pp. Marion Steam Shovel Co., Station F., Marion, Ohio.

Catalogue No. 92, entitled "Digging and Mixing Clay—One Operation," a comprehensive account of the construction and operation of Marion shovels for clay handling. Gives considerable general information of interest to clay workers and is illustrated with views of typical work.

CATALOGUE REVIEWS

Concrete Mixers.—Paper, 7½x10 ins.; 74 pp Milwaukee Concrete Mixer Co., 963 30th street, Milwaukee, Wis.

The Milwaukee Concrete Mixer Co. has recently issued a new and attractive catalogue, No. H-19, describing the Milwaukee and Wisconsin mixers and pavers. The details of design and construction are set forth clearly and briefly, with illustrations of the mixers on typical work and of the various types, parts and equipment. It is handsomely printed on cream paper with brown covers, and the illustrations are largely half tone reproductions of unusually fine photographs showing interesting construction and paving work. There is also a description of the Milwaukee concrete elevators, with diagrams showing construction and operation. The latter part of the book is occupied by diagrams showing plant arrangement, specifications for the mixers and pavers, diagrams showing constructions and dimensions, and a table of quantities of materials required in mixing concrete

Montezuma Asphalt.—Paper, 8x11 ins.; 56 pp. Warner-Quinlan Asphalt Co., 79 Wall street, New York City.

A most unique and effective publication, detailing the qualities of Montezuma asphalt, its adaptations and the range of territory through which this product has been used. One feature is to the writer at least, quite novel. This consists of half tone reproductions of letters from numerous widely scattered and variously employed users of "Montezuma" asphalt, such as city engineers, chemists, contractors, paving commissioners, consulting and testing engineers, etc. The most telling phrase in each of these letters is underlined and re-written in red crayon on the margin, with the pertinent word underlined. As these letters come from prominent men whose reputations are known throughout the engineering and contracting field, and are accompanied by handsome photographs of the roads and streets on which the asphalt has been used, this feature would appear to be a most convincing argument. Specifications for sheet asphalt, asphalt cement, asphaltic concrete and macadam, road binder and surface treatments are included, together with an explanation of the tests required, and a guide to area and quantities.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of August 24, 1912,

of Engineering and Contracting, published every Wednesday at Chicago, Ill., for April 1, 1915.

Editor—H. P. Gillette, Chicago, Ill.
Managing Editor—C. S. Hill, Chicago, Ill.
Business Manager—F. P. Burt, Chicago, Ill.
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Owners: (If a corporation, give its name and the names and addresses of stockholders holding 1 per cent or more of total amount of stock. If not a corporation, give names and addresses of individual owners)—H. P. Gillette, Chicago, Ill.; Nell M. Clark, Chicago, Ill.

Known bondholders, mortgagees and other security holders, holding 1 per cent or more of total amount of bonds, mortgages or other securities. (If there are none, so state)—None.

F. P. BURT,
General Manager.

Sworn to and subscribed before me this 25th day of March, 1915.

C. E. MEINDERS,
(Seal.) Notary Public.
(My commission expires June 7, 1916.)

CURRENT NEWS

The Doings of The Week.

Many interesting developments took place during the past week. There was a large amount of investment buying and stocks went to highest prices and were sold in largest volume since the re-opening of the exchanges. Government figures showed an excess of exports over imports for February of $173,000,000. Since Dec. 1 the excess of exports has amounted to over $552,,000,000. It is expected that March will show a much larger trade balance than that for the previous month. An interesting feature of the February export figures is that cotton fixed a new high record for the month, not only in quantity but in value. Many financial writers are predicting that it is only a question of a short time before the foreign trade and financial boom will produce country-wide prosperity. Industry and commerce continued to show advances during the week. Improvement in the steel and iron trade is holding, and the larger companies are now operating on better than a 70 per cent capacity basis. In the construction field there was an increase of activity in many lines. Highway improvements, bridge building and municipal undertakings made an excellent showing. In the water works, sewerage and paving fields many opportunities are now being offered to contractors. Government river and harbor work and drainage and irrigation have not shown much activity the past week. The new $25,000,000 river and harbor bill is now being apportioned to various projects and it is likely that the U. S. Engineers soon will be calling for bids on a considerable amount of work. In the iron and steel trade there is a good volume of business, even with the limited railroad buying. Orders for steel rails, plates and structural materials the past week were about up to the demands of recent weeks. Heavy pig iron sales were a feature of the past few days, Buffalo concerns booking about 175,000 tons of orders. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending March 24 were as follows:

Finished Iron and Steel.	Mar. 24.	Mar. 17
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.15	1.15
Iron bars, Pittsburgh.........	1.10	1.10
Iron bars, Chicago............	1.12½	1.10
Steel bars, Pittsburgh........	1.15	1.15
Steel bars, New York.........	1.319	1.319
Tank plates, Pittsburgh......	1.10	1.10
Tank plates, New York.......	1.269	1.269
Beams, etc., Pittsburgh......	1.15	1.15
Beams, etc., New York.......	1.269	1.269
Skelp, grooved steel, P'gh....	1.10	1.10
Skelp, sheared steel, P'gh....	1.15	1.15
Steel hoops, Pittsburgh.......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.80	1.80
Galv. sheets, No. 28, P'gh....	3.40	3.40
Wire nails, Pittsburgh...	1.60	1.60
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh.......	1.40	1.40
Barb wire, galv., P'gh........	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 cts.

Railways.—Quite a few minor contracts for railroad construction are reported to have been let during the past week. Few of these apparently are of a size to make or break a contractor. There are rumors that some big work is coming up soon, but nothing definite can be learned as to when contractors will be asked to submit their figures. The Illinois Central has awarded a couple of small jobs—one covering 6 miles of work near West Frankfort, Ill., to H. W. Nelson, 14 South Canal St., Chicago, Ill., and L. J. Smith Construction Co., Kansas City, Mo., has secured a 7-mile extension for the Minkler Southern, a Santa Fe line in California. In the South two or three contracts are reported to have been let. J. N. Gillis & Son, Brewton, Ala., were awarded 3.6 miles of line for Tidewater Securities Corp. of Mobile. Sanders & Co., Miami, Fla., secured a sub-contract for work on the Palm Beach & Everglades R. R.; and Ricks & Co., Lilly, Ga., obtained an 80-mile line in Georgia for the Flint River R. R. & Navigation Co. The best prospects for the near future appear to be the following: 6 miles of heavy work from Stone Coal Junction, W. Va., for the Virginian Ry., and changes in the channel of the Mississippi River at St. Paul for the Union Depot Co., Hackney Bldg., St. Paul, Minn.

Roads and Streets.—Many lettings for state and county road work reached the call for bid stage last week. New York began calling for proposals on 14 contracts aggregating 72 miles; Maryland is taking bids on 4 contracts (a total of 6 miles); Illinois opens bids April 7 on two contracts. Among the city paving contracts are a 128,000 sq. yd. job for Beloit, Wis., and a 146,000 sq. yd. letting at Bayonne, N. J. Houston, Tex., and Harris County are calling for bids on a joint street improvement to cost about $300,000. Maryland awarded contracts amounting to about $100,000 for state roads; New York awarded contracts for 12 highway improvements, one bidder receiving work that will cost over $300,000; Pulaski, Va., awarded a $103,000 paving contract; and Cedar Rapids, Ia., let work to cost about $150,000.

Bridges.—Small bridge and culvert construction predominate in the bids asked items of the week. Several groups of small structures are being advertised, that in the aggregate make fair-sized contracts. The County Commissioners at Columbus, Mont., are asking proposals on five concrete bridges; the County Auditor at Durham, N. C., opens bids April 6 on four steel bridges to cost about $20,000; the county auditor at Dakota City, Ia., is asking bids on 39 reinforced concrete box culverts. The largest contract let recently appears to be for the new Susquehanna bridge of the Cumberland Valley R. R. Robert Grace Contracting Co., 514 Smithfield St., Pittsburgh, Pa., at $270,290, was the lowest of the 38 bidders on this work.

Drainage and Irrigation. — Not many drainage or irrigation undertakings appear to have reached the call for bids stage during the past week. The Obion River Drainage District of Union City, Tenn., is asking proposals on 1,564,000 cu. yds. levee and 670,000 cu. yds. ditch, both floating dredge work.

Water Works. — Several large water works improvements are now being advertised. Sacramento, Cal., is calling for bids on work to cost about $800,000. It will require about 417,920 lin. ft. 4 in. to 16 in. cast iron pipe and 39,990 lin. ft. of 20 in., 24 in., 30 in. and 36 in. riveted steel pipe. Durham, N. C., opens bids April 21 on extensive water works improvements to include 9 miles 20 in. cast iron mains, pumping station and equipment and filter plant. Peoria Heights, Ill., opens bids April 19 on water works to cost about $65,000. Milwaukee, Wis., is calling for bids on the shore line section of its water tunnel. Billings, Mont., awarded contracts for water works improvements that call for an expenditure of about $153,000.

Sewerage.—A number of fair-sized sewerage jobs are being advertised. Rochester, N. Y., opens bids on March 31 on a concrete outlet sewer estimated to cost $145,000 and will take bids in about two weeks on a sewage disposal plant to cost about $100,000. Port Chester, N. Y., opens bids April 5 for sewer system and a disposal plant; Ravena, N. Y., is asking bids on 5 miles of 8 in., 10 in. and 12 in. sewers and a disposal works; Baltimore, Md., is advertising Section No. 1 of the Gwynn's Fall interceptor, requiring 4,350 ft. of 30 in. sewer; Richmond, Va., is calling for bids on a section of the Bacon Quarter Branch sewer, involving 1,150 ft. of reinforced concrete sewer; Oaklyn, N. J., opens bids April 6 on system of sanitary sewers and disposal plant estimated to cost $40,000; Greenville, Pa., is calling for proposals on sewage disposal works, intercepting sewer and laterals; Madison, Wis., will receive bids until April 9 on work calling for construction of about 69,000 ft. of pipe sewer.

Short Line Railway Construction.

One encouraging feature of the railway situation is the number of small companies whose projects appear to be nearing the construction stage. Since the first of the year many new companies have been chartered and quite a few older corporations operating short lines have applied for authority to build extensions. Many of these short line railways are in a prosperous condition and well able to carry out their proposed work. Much of the new financing now being done by the big railway systems of this country will have to be used to pay off maturing obligations. The case is different with many of these smaller concerns. They have no short term notes or bonds to meet and consequently can employ any new capital they may secure for construction purposes. There are also good prospects that several of the companies organized recently are more than hot air line propositions. Some of them are believed to be projects of larger railroads, while others are supported by interests with good financial backing. These little 20 to 30 mile railway undertakings are likely to furnish quite a few construction opportunities in the near future.

Municipal Work in Iron Range.

Engineers and contractors have had no reason to complain at the lack of municipal ambition in the cities and towns in the Messaba Range in Minnesota. More construction probably has been undertaken in these places in the last few years than in any other locality of similar size in the country. Almost over night some of these cities have graduated from dirt roads to paved streets, from country seats to bath rooms, and from the old oaken bucket to the water faucet. Instead of spreading the municipal improvements over a long period they have been done in two or three years. As a result taxes are high in the range towns. It is stated that the total levy for a group of 10 cities and towns with an aggregate population of 45,254 amounted last year to $2,066,608, or an average of $45.67 per capita. No one, however, objects to the expenditures for the civic works except the iron properties in the district, which are said to be paying approximately 95 per cent of the total taxation.

Public Utility Development.

One construction line that offers many possibilities in the future is public utility developments. Very little work in this field has been undertaken during the last two or three years. Electric railway building has been practically nil, both as regards new lines and extensions. There has been little activity looking to the construction or extension of privately owned electric light and power plants. Gas companies and telephone companies have undertaken no large amounts of work. Public utility developments have been at a standstill, because of the difficulty in financing such enterprises. Much remains to be done in this field. These developments are by no means complete. Opportunities exist in every state for the establishment of new utilities and unification, extension and perfection of the existing properties. A vast amount of work in the public utilities field will be undertaken in the next few years. The owners of these industries have had many difficulties to contend with in the past. The attitude of the public, and unfair attacks by statesmen and municipalities makes utility financing extremely difficult. Public opinion, however, is changing and with improved financial conditions the companies will have an easier road to travel.

HETCH HETCHY WATER SUPPLY PROJECT.

Present Status and Proposed Developments for 1915.

Construction Railroad—Reservoir Clearing—Diversion Dam and Tunnel.

The Hetch Hetchy project of San Francisco is the largest municipal water supply development in this country now nearing the active construction stage. The following details regarding the present status of this $75,000,000 undertaking and the development plans for the present year are taken from a report dated Feb. 17, of M. M. O'Shaughnessy, City Engineer, to the Boards of Public Works and Supervisors of the city and county of San Francisco.

During the past year work on the improvement has been actively advanced, both in the office and in the field. Hydrographic and meteorologic observations have been continued at Hetch Hetchy, Eleanor Creek and Cherry Creek. The location survey for that portion of the transportation road 22 ft. wide, now completed between the Hetch Hetchy dam site and Hog Ranch, a distance of 9.1 miles, was begun late in April, 1914, and completed by July 15. Since then the survey has been extended to Groveland, a distance of 40 miles from the dam site. One of the controlling features of this work was to keep the grade below 4 per cent to secure curves of 190 ft. minimum radius, and to locate a roadbed that will be adequate for transporting materials without involving too much outlay for a temporary construction road. Work on the extension of the railroad surveys has been prosecuted continuously. About 22 miles of the transportation line remains to be located to complete the location of the route to join the main line of the Sierra Ry. near Rosasco.

A survey was made of the high waterline of the proposed Lake Eleanor reservoir and also of the tunnel aqueduct leading from Cherry Valley to Hetch Hetchy Valley via Lake Eleanor, for the purpose of preparing maps for filing purposes in Sacramento and Washington to protect the city's right. A line for a canal to divert the water from Cherry Creek and conduct it to the Tuolumne River at Early Intake also was surveyed. In connection with the preliminary surveys for the transportation road, the line of the proposed tunnel aqueduct was located from the westerly boundary of the Stanislaus National Forest to the Priest regulating reservoir. This completes the present location of the tunnel aqueduct for right of way purposes from Hetch Hetchy dam site via Early Intake to the Priest Reservoir, a distance of 30 miles. Further geological studies and test borings may modify slightly the location.

Maps showing the location of the various structures that are to be part of the Hetch Hetchy system have been prepared to accompany applications to the Department of the Interior and the Department of Agriculture. Among them is the tunnel aqueduct from Hetch Hetchy dam to the Priest regulating reservoir. Other application maps made were for the transportation road, from Hog Ranch to Hetch Hetchy dam site and the road from Hodeau Flat into Hetch Hetchy Valley in the Yosemite National Park; the tunnel aqueduct from Cherry Valley to the westerly boundary of the Yosemite National Park and thence through the Park to Hetch Hetchy Valley, an amended map of Hetch Hetchy reservoir site and another of the Lake Eleanor reservoir and dam site.

Studies were made for the proposed hydroelectric power development. The following is a summary of the conclusions reached: (1) The development of the Moccasin Creek power plant and of the entire project should be progressive and should correspond with the development of the water supply. (2) The amount of water developed at first should be approximately 200,000,000 gals. per day, equal to 310 second feet, or one-half of the total to be developed ultimately. (3) The aqueduct should be built at once of the full size with a capacity of 400,000,000 gals. per day. (4) The conduit tunnel should discharge into a regulating reservoir of sufficient capacity to permit of regulation on a 65 per cent load factor and of sufficient reserve water to carry the plant for some time in case the conduit is out of service. Such a reservoir is possible at the selected site near Priest's, as it has capacity to carry the entire plant over nearly two days. (5) The power plant should be designed for an ultimate development of the power from 620 second feet of water. The ultimate plant should consist of six 12,000 kw. normally rated generators, operating on a load factor of 65 per cent, one generator to be a spare unit. This will carry a peak load of 76,300 kw. at the station. The average power will be 49,600 kw.

An investigation preceded the design of the cyclopean concrete dam to be constructed across the Tuolumne River at the lower end of the Hetch Hetchy Valley. Every type of arch and gravity section suitable for this site was considered in this study. A gravity dam, arched as an additional safety factor, has been chosen tentatively as the type best adapted to local conditions at the dam site. It will cost approximately $4,000,000. The design is complete, and detail drawings are now being made, but will be subject to the approval of a consulting engineer with recognized successful experience in high masonry dam construction, as this will be one of the highest dams in the world.

Before work can be undertaken on the construction of this dam and during the period of construction it will be necessary to divert temporarily the water of the Tuolumne River past the site. This will be effected by a small diversion dam, 60 ft. in height, costing $30,500, which will divert the flow of the stream into a by-pass tunnel about 450 ft. long and 26 ft. in diameter, with a capacity of 13,000 second feet. Work should be started on this tunnel so that it may be completed in the current year and facilitate the foundation work on the dam. The tunnel will cost about $60,000.

On the assumption that adequate funds are available, work will be started on the main Hetch Hetchy dam in the spring of 1916. By this time the temporary railroad should be completed from Rosasco to the dam site. It is desirable that the small diversion dam be started during the present year and hastened to completion. It is essential to construct at once a suitable saw mill on the Canyon Ranch, the property of the city and county of San Francisco, about 4 miles from the dam site, to supply lumber for forms and temporary buildings. Timber in excess of 3,000,000 board feet is standing on the 320 acres owned by the city in the vicinity of the mill site and this will be ample for all camp and other construction purposes.

It also is deemed advisable to immediately remove from the reservoir site all standing timber and such vegetation as will not be renewed before the reservoir is permanently filled with water. A portion of the basin will be submerged on the completion of the diversion dam to an elevation of 60 ft. and all brush and timber below this level should be removed at once. This will entail an expenditure of approximately $40,000 now, and $10,000 just before the reservoir is filled, when the low surface vegetation will be removed.

The contract for the first 9¼ miles of the transportation road was awarded on July 8, 1914, to the Utah Construction Co., and has been satisfactorily completed. The work called for grading a roadway 22 ft. in width, with a maximum grade of 4 per cent and no curves sharper than 30°, so that a temporary railroad could later be laid on the roadbed. The cost of grading on this road has been high, owing to the character of the country through which it passes, as the rock formation is almost entirely solid granite, the slopes precipitous and transportation of supplies through this rugged region has until recently been possible only by pack trains over indifferent trails.

In addition to the above, a wagon road 3¾ miles long, 17 ft. wide, with a maximum grade of 7 per cent, has been constructed from Hog Ranch to the South Fork of the Tuolumne River. An additional stretch of 3½ miles has been built easterly from the Screech claims and another 1 mile in length at China Gulch. All these roads were constructed in the early part of last year to eliminate the excessive grades on the old road from South Fork to Hog Ranch, and to enable supplies to be hauled with reasonable economy to the 400 men employed on the Hetch Hetchy Road. For the purpose of gaining approach to the northerly portal of the first division of the tunnel aqueduct, a branch road 3 miles in length has been started, with a width of 14 ft. and a maximum grade of 10 per cent. The haul of loads on this road will all be down hill. Some 20 miles of good trails also have been constructed during the past year.

During the construction of the Hetch Hetchy dam and aqueduct there will be hauled from the Sierra Ry. to the dam and the portion of the aqueduct lying east of Rosasco Station on the Sierra Ry., about 150,000 tons of cement and 75,000 tons of lumber, reinforcing steel, castings and other materials of construction, and contractors' equipment, camp supplies, etc. It is proposed to build a construction railroad to haul these materials and in the development program for 1915 the sum of $1,475,000 is provided toward the building of the road. As projected this railroad would extend from Rosasco Station, following the general line of the aqueduct to the Hetch Hetchy dam site, and would have a length of 59½ miles. The preliminary estimate of cost for the railroad is as follows:

Grading and culverts(includes 9.1 miles already completed)	$ 751,000
Track materials, $6,857 per mile	408,000
Track laying, surfacing and ballasting, $2,800 per mile	167,000
Bridge and trestles	38,000
Sidings	20,000
Telephone line, $200 per mile	12,000
Building, warehouses, depots, shops, etc., and tanks	28,000
Rolling stock	70,000
Lands and right of way	20,000
Total	$1,514,000
Engineering, contingencies, etc	151,000
Total	$1,665,000

In the above estimate the cost of the grading and culverts for the completed 9.1 miles of road from Hog Ranch to Hetch Hetchy Dam site was approximately $190,000. This makes the estimated cost of the grading and culverts for the 50½ miles of road from Hog Ranch to Rosasco, $561,000. The original estimated cost of the grading of this section was $457,000. This figure was based upon the prices paid to the Utah Construction Co. on its contract for grading east of Hog Ranch. The construction cost to the company up to Dec. 31, 1914, is said to have been about 45 per cent in excess of the contract prices—due mainly to bad weather conditions and difficulties of hauling equipment and supplies from the Sierra Ry. to the location of the work. However, as the work progresses westward, there will be a large proportion of work of the easier classifications, the cost of hauling on good roads with shorter distances will be less, and the work will be done under favorable conditions. In consideration of these matters and allowing a reasonable profit to the contractor, 15 per cent was added to the original estimate for the grading. The estimated cost of the culverts on the 50½-mile section was $35,622.

For track materials it is proposed to use 60-lb. rails and 6-in. by 8-in. by 8-ft. redwood or Oregon pine ties. The estimated cost of the rails f.o.b. Rosasco is taken at $39.30 per ton. It is estimated that redwood ties at San Francisco Bay will cost about 58 cts. each and that the freight to Rosasco will be about 24 cts., making the total cost 82 cts. It is assumed that 1,800 tie plates will be used per mile, the estimated cost at 15 cts. being $270 per mile. The estimated cost of the rail joints, track bolts, nut locks, and spikes per mile is $600. The bridges and trestles include a bridge over the Tuolumne River at Red Mountain Bar, estimated to cost $30,000, and trestles at Middle Fork, South Fork, Big Creek and Moccasin Creek, estimated to cost $7,540.

The Water Supply Development of San Francisco also provides for wells in the Sunset and Richmond District. During the last year 10 test holes were bored and used as a basis to determine the water-bearing possibilities of the district. It was determined that there is apparently a depression in the bed rock extending under Golden Gate Park toward the ocean; that the bed rock rises from Golden Gate Park southerly, to a ridge in the vicinity of Irving Park and Judah Sts., and thence descending rapidly towards the Lake Merced Rancho, making another basin in the Sunset District, which is probably independent of the drainage into Golden Gate Park.

A contract for boring and testing a well on Block No. 339, bounded by Balboa and Cabrillo Sts., 42d and 43d Aves., was awarded on Sept. 11, 1914, at $2,600. This well is 14 ins. in diameter and 256 ft. deep. A pump was installed, but it was found that the supply was insufficient to warrant maintenance. A second well has been sunk to a depth of 315 ft. on Fire Lot 30 ft. by 120 ft., on the west side of 44th Ave., between Fulton and Cabrillo Sts. This has 16-in. casing to a depth of 112 ft., beyond which is 14-in. casing to a depth of 138 ft., and 12-in. casing to a depth of 211 ft., This well has proven to be excellent in every respect and a supply of 350,000 gals. per day can be obtained from it. An additional well is being sunk in the same lot, and if a similar supply can be obtained therefrom a pumping station will be erected and both wells used as a source of domestic supply, the water being pumped into the Lincoln Park distributing reservoir. Bids on a third well were opened in February. Should funds be available it would be desirable to appropriate $500,000 to sink additional wells, install the necessary pumps and filtration plant if needed, as well as to construct a reservoir in Lincoln Park.

The estimate of the various amounts which should be made available for the development program for 1916 of the Hetch Hetchy Project are as follows:

Item.	Date From—	Date To—	Estimate.
Hydrography	Jan. 1	Dec. 31	$ 3,000
Surveys, roilroad location	Jan. 1	Oct. 1	8,000
Surveys, aqueduct location	Jan. 1	Oct. 1	2,000
Water rights, protective work	Jan. 1	Dec 31	5,000
Test borings	May 1	Dec. 31	20,000
Engineering and general office work	Jan. 1	Dec. 31	25,000
Temporary road and trail construction	Jan. 1	Dec 31	5,000
Railroad to dam site	Jan. 1	Dec. 31	1,475,000
Telephone line	May 1	June 30	1,000
Camps and equipment	May 1	Dec. 31	10,000
Installing sawmill	Mar. 1	June 1	12,000
Operating sawmill	June 1	Dec. 31	17,500
Clearing reservoir	Apr. 1	Dec. 31	40,000
Diversion tunnel	Apr. 1	July 31	60,000
Diversion dam	Apr. 1	Dec. 31	30,500
Completion of Contract No. 1	Jan. 1	Jan. 27	26,670
Co-operative road work	May 1	Sept. 1	3,500
Municipal well system	Jan. 1	Sept. 1	500,000
Consulting engineer, dam	Aug. 1	Sept 1	5,000
Total			$2,249,170

In regard to the proposed developments for the year it may be stated that due to the financial stringency resulting from the European war, there is at present little sale for the 4½ per cent Hetch Hetchy bonds. Consequently all of the work outlined above will not be undertaken this year, as the requisite funds have not been placed at the disposal of the officials in charge of the project.

HIGHWAY CONSTRUCTION IN WASHINGTON.

State Appropriates $6,200,000; County Funds $4,000,000.

Details of Work Proposed by 17 Counties.

State and county highway construction in Washington will offer many opportunities for contractors during the present season. The State Legislature early this month appropriated $2,152,288 and reappropriated $153,640 for the construction and maintenance of state highways, and $4,000,000 for the construction and maintenance of other permanent highways. These amounts will be expended during the biennium beginning April 1. In addition there will be expended about $4,000,000 from county funds for roads and bridges. These figures do not include any expenditures that may be made within the limits of incorporated cities and towns.

In our issue of March 10 a general outline was given of the highway construction contemplated for the present year in Washington. The present article gives some details of the work proposed in the various counties. A summary of the improvements to be undertaken this year in 17 counties is given in Table I. Further details regarding the construction follow:

TABLE I.—ROAD CONSTRUCTION PROPOSED FOR 1915 BY 17 WASHINGTON COUNTIES.

County.	Type of road: Earth, miles.	Gravel, miles.	Macadam, miles.	Other classes, miles.
Adams	12	8.5	..	..
Chelan	..	20	.	.
Douglas	8	8		..
Grant	300	10	9	..
King	92	..	.	9[1]
Klickitat	.	.	[illegible]	..
Lewis	..	..	..	5[2]
Lincoln	50	20	..	.
Mason	6	5	..	..
Pacific	..	..	4	..
Pend Oreille	50	2	4	.
Skagit	10	4	..	2[2]
Spokane	50[3]	..	..	15.5[4]
Stevens	..	..	12.5	..
Thurston	30	10		..
Whitman	[illegible]	[illegible]	8	..
Yakima	16	17	4.5	0.9[5]

[1] 2.5 miles brick; 6 miles asphaltic concrete; ½ mile concrete. [2] Concrete. [3] By Township. [4] Bituminous macadam. [5] Bituminous.

Adams County has $65,000 available for construction purposes. It will build 12 miles of earth road and 8½ miles of gravel road. Contracts will be let April 7. O. J. De Spain, Ritzville, Wash., is County Engineer.

Chelan County will construct 20 miles of gravel road. Work to cost about $25,000 will be done by contract. The lettings probably will be held in May or June. The county has $50,000 available for construction purposes. F. A. Warren, Wenatchee, Wash., is County Engineer.

Douglas County has about $50,000 available for construction purposes. It probably will build 8 miles of earth road and 8 miles of gravel road. Practically all of the work will be done by contract. One contract already has been let, and others will be awarded in the spring or early summer. Robert F. Foster, Waterville, Wash., is County Engineer.

Grant County has $25,000 available from the permanent highway fund. Nine miles of permanent highway (waterbound macadam) will be constructed. This work will be done by contract. Bids on the first section will be opened April 5 and bids on the remainder on May 3. About 300 miles of county earth road and 10 miles of county gravel road will be constructed by day labor or districts. E. H. Stradling, Ephrata, Wash., is County Engineer.

King County contemplates expending about $953,000 for road construction this year. This sum will provide for building 101.55 miles of highway and four steel bridges. Of the total 80.1 miles will be bond roads, to be constructed at an estimated cost of $683,000; 17.25 miles of road will be built out of the permanent highway fund at an estimated cost of $155,000. A 1.2 miles' extension of Bond Road No. 7 will be built into city limits of Renton, at an estimated cost of $35,500. The following is the construction program for 1915:

Bond Roads.

Bond Roads No. 2, Woodinville-Duvall, 10 miles, grading and graveling.

Bond Road No. 3, 290 ft. steel span at Fall City.

Bond Road No. 4, Renton-Issaquah, 11 miles, grading and graveling.

Bond Road No. 4, Issaquah-Redmond, 8.3 miles, grading and graveling.

Bond Road No. 6, Renton-Kennydale, 2 miles, grading and graveling.

Bond Road No. 8, Black Diamond-Maple Valley, 8.5 miles, grading and graveling.

Bond Road No. 8, Auburn-Enumclaw (two contracts), 10.5 miles, grading and graveling.

Bond Road No. 9, Enumclaw-Franklin, 7 miles, grading and graveling.

Bond Road No. 9, Franklin-Black Diamond, 3 miles, grading and graveling.

Bond Road No. 9, Black Diamond-Auburn, 4.5 miles, grading and graveling.

Bond Road No. 11, Meadows-Duwamish, 1 mile, brick.

Bond Road No. 11, Renton Jct.-Orillia, 1.5 miles, brick.

Bond Road No. 11, Duwamish-Renton Jct., incl. 2 steel bridges, grading and graveling.

Bond Road No. 14, No. End Vash Is.-Burton, 8.5 miles, grading and graveling.

Bond Road No. 18, Town of Issaquah, .8 mile, grading and graveling.

Bond Road No. 20, New Castle-Renton, 3 miles, grading and graveling.

Permanent Highways.

Newport-Issaquah, 2.2 miles, grading and graveling.

Redmond-Snoqualmie, 6.75 miles, grading and graveling.

Riverton-Renton Jct., 3 miles, asphaltic concrete.

Greenwood Ave. to Country Club, with connection to North Trunk Road, 3 miles, asphaltic concrete, and .5 mile concrete.

Bellevue-Medina, 2.8 miles, grading and graveling.

Road and Bridge.

204-ft. steel span over the Snoqualmie at Tolt.

D. C. Mitchell Road, 1.2 miles, grading and graveling.

Arthur P. Denton, Seattle, Wash., is County Engineer of King County.

Klickitat County has about $60,000 available for road construction purposes. The work for the present season has not been decided upon as yet. Macadam is about the only hard surface that the county will build. About $20,000 worth of the improvements will be carried out by contract. Lyman W. Ward, Goldendale, Wash., is County Engineer.

Lewis County will construct 5 miles of concrete roads. Four contracts have been let and the fifth will be let on April 5. J. D. Neville, Chehalis, Wash., is County Engineer.

Lincoln County has $160,000 available for highway construction and for maintenance of dirt roads. It will construct 50 miles of earth road and 20 miles of gravel road. Contracts were let in February. Guy G. Harvey, Davenport, Wash., is County Engineer.

Mason County has $25,000 available for construction purposes and will build 6 miles of earth road and 5 miles of gravel road. A small percentage of the improvements will be carried out by contract. A. L. Ward, Shelton, Wash., is County Engineer.

Pacific County will construct 4 miles of macadam. Contract will be let April 6 for part of this work. About $35,000 is available for construction purposes. Chas. B. Nims, South Bend, Wash., is County Engineer.

Pend Oreille County has $60,000 available for construction and maintenance during the present year. It will build 50 miles of earth road, 2 miles of gravel road and 4 miles of macadam. Work costing about $20,000 will be done by contract. Most of the earth road construction is let to ranchers and local parties. H. A. Sewell, Newport, Wash., is County Engineer.

Skagit County during 1915 contemplates constructing 10 miles of earth road, 4 miles of gravel and 2 miles of concrete. The work will be done by contract, the lettings to be held some time after April 1. The county has $50,000 available for construction purposes. A. L. Strong, Mt. Vernon, Wash., is County Engineer.

Spokane County will construct 15.5 miles of bituminous macadam. This work will be done by contract. Owing to questions of interpretation of appropriation laws the lettings may be delayed until June 13. There will be two contracts involving heavy grading; the estimated cost of these is about $150,000. In addition 500 miles of earth roads will be constructed by townships. This work will not be contracted. J. W. Strack, Spokane, Wash., is County Engineer.

Stevens County has $29,518 available from state appropriation and $13,000 available from permanent highway fund. It will construct 2½ miles of permanent highway and approximately 10 miles of state road. The work will be done by contract, the lettings probably being held in May.

Thurston County has $127,053 available for highway purposes. It will construct 30 miles of earth road and 10 miles of gravel road. Work costing about $60,000 will be done by contract. The lettings will be held in June or July. W. H. Yeager, Jr., Olympia, Wash., is County Engineer.

Yakima County construction program for 1915 includes 16 miles of earth road grading by Road Supervisors, 17 miles of gravel road, 4½ miles of macadam and ⅞ mile of bituminous construction. Some of the work will be done by contract. The county has $140,000 available for construction purposes. O. F. Brashears, North Yakima, Wash., is County Engineer.

Whitman County has $70,000 available from permanent highway fund, $62,654 for roads and bridges and $80,000 for road districts. The mileage of earth and gravel road construction for the present season has not been determined. About 8 miles of macadam will be built. The work will be done by contract. J. M. McCaw, Colfax, Wash., is County Engineer.

HIGHWAY CONSTRUCTION IN KANSAS.

Details of Work Contemplated by 16 Counties.

Earth Road Construction—Macadam—Concrete.

Kansas is primarily a dirt road state, although it has a considerable mileage of macadam and gravel surfaced highways. Sand-clay construction also has been used in some counties, and in the last year or so several miles of concrete pavement have been projected or built.

Road improvements are carried out by the county as a unit, the work being under the direction of the County Commissioners and the supervision of the County Surveyor or County Engineer. Table I contains the summary of the road construction contemplated by 16 counties for the present season. Further details of this work are as follows:

Allen County has $4,200 available for construction purposes this year. It will build about 40 miles of earth road. The work will be done by contract, the letting to be held in April or May. Henry L. Palstring, Humboldt, Kan., is County Surveyor.

Atchison County constructed 3 miles of macadam last year and also placed 2 miles additional on grade. No road work is contemplated for the present year. S. K. McCrary, Atchison, Kan., is Road Commissioner.

Bourbon County has about $15,000 available for construction purposes and will build approximately 40 miles of earth road and 3 miles of macadam. The work will be done by contract; date of letting has not been fixed. E. E. Toles, Fort Scott, Kan., is County Engineer.

Butler County has $20,000 available for construction purposes. It will regrade about 60 miles of earth road, and probably will spend $15,000 for bridges. The 29 townships in the county will expend $44,000 on roads and bridges. No contracts will be let for this road work. There are 157 miles of county road. C. W. Buskirk, El Dorado, Kan., is County Surveyor.

Dickinson County has $30,000 available from county taxes for construction of roads and bridges in 1915. The county has about 200 miles of roads and if certain legislation is obtained from the state it is possible that a contract will be let this spring for the improvement of the system. Karl Riddle, Abilene, Kan., is County Engineer.

Ellis County will construct no new earth roads this season. It will, however, repair about 10 miles of old highway. C. J. Loreditsch, Hays, Kan., is County Surveyor.

Geary County has $20,000 available for construction purposes this year. It will resurface ½ mile of gravel road by force account, and also will construct by contract ½ mile of 1:2½:4½ one-course, 7-in. thick concrete road. W. V. Buck, Junction City, Kan., is County Engineer.

Harvey County proposes to construct in 1915 ½ mile of concrete road and also will undertake about 2 miles of bituminous work. Contracts will be let about April 1. F. E. Devlin, Newton, Kan., is County Engineer.

Jackson County has $19,000 available for construction purposes during 1915, and will improve its earth roads. No contracts will be let. P. W. Wright, Holton, Kan., is County Engineer.

Labette County has about $5,000 available for road purposes. No construction, however, will be undertaken. W. H. Kutz, Parsons, Kan., is County Surveyor.

Linn County will oil perhaps ¼ mile of road for an experiment. The work will be done by contract; the letting may be held about Aug. 1. The county has about $20,000 available for bridges. James M. Mandell, Mound City, Kan., is County Surveyor.

TABLE I.—ROAD IMPROVEMENTS PROPOSED FOR 1915 BY 16 KANSAS COUNTIES.

County.	Type of road— Earth, miles.	Mac., miles.	Concrete, miles.
Allen	40	..	..
Bourbon	40	3	..
Butler	60[1]	..	..
Dickinson	?	?	?
Ellis	10[2]	..	..
Geary	..	..	0.5[3]
Harvey	..	..	0.5[4]
Jackson	?	?	?
Mitchell	?	..	..
Morris	50	..	..
Phillips	50	..	..
Reno	?	..	..
Sedwick	200	2[5]	..
Shawnee	50	1[6]	1
Sheridan	12	..	..
Wilson	30	..	..

[1] Regrade. [2] Repaired. [3] Also resurface ½ mile gravel road. [4] Also about 2 miles of bituminous work. [5] 1 or 2 miles of gravel roads. [6] Gravel road.

Mitchell County has $11,000 available for road construction purposes and $3,000 available for maintenance. It also has a bridge fund of $22,000. All highway work for the present season will be earth road construction and will include the placing of about 4,500 lin. ft. of corrugated steel culvert, the construction of a number of stone and concrete culverts and grade reduction by cut and fill. In addition about 80 miles of road will be brought to standard width and cross section by means of blade graders and engine, and about the same amount will be regraded with teams and small graders. Some earth roads may be oiled; definite decision on this matter, however, has not been reached. All the work probably will be done by day labor. A. E. Home, Beloit, Kan., is County Engineer.

Morris County has $12,500 available for construction purposes and will construct 50 miles of earth road. Most of this will be done by force account. Arthur E. Smith, Council Grove, Kan., is County Engineer.

Osage County has no new construction planned for the present year. A great deal of work was done in 1914. This continued up to the first of the present year, using up the greater part of the 1915 funds. Maintenance and repairs will constitute the bulk of this season's work. J. W. Mavitz, Lyndon, Kan., is County Surveyor.

Osborne County will undertake no new road construction during the present season. It will, however, grade and drag its highways and will build some steel bridges with concrete floors, and some concrete culverts. H. L. Parker, Osborne, Kan., is County Surveyor.

Phillips County has $15,000 available for construction purposes. It will build probably 50 miles of earth road. Glenn I. Vogles, Agra, Kan., is County Surveyor.

Sedgwick County has about $60,000 available in its road and bridge fund. It will construct about 200 miles of earth road, and several hundred miles also will be built by townships. There likewise will be 1 or 2 miles of gravel road built during 1915. Some sand-clay construction will be undertaken and a few miles of earth road may be oiled. No contracts probably will be let. E. V. Moore, Wichita, Kan., is County Engineer.

Shawnee County has $17,500 available for construction purposes. Its program includes 50 miles of earth road, 1 mile of gravel road and 1 mile of concrete. No contracts will be let. Walter J. Arnold, Topeka, Kan., is County Engineer.

Sheridan County has $4,533 available and will build 10 or 12 miles of earth roads. W. F. Wellman, Hoxie, Kan., is County Surveyor.

Sherman County will expend only a small sum for road construction this year. It will grade about 87 miles of earth road. D. A. Long, Goodland, Kan., is County Surveyor.

Wilson County has $16,000 available for construction purposes. It proposes to build 30 miles of earth road this year. No contracts will be let. H. S. McFadden, Fredonia, Kan., is County Engineer.

$250,000 Road, Bridge and Drainage Work in Jefferson County, Kentucky, in 1915.

Jefferson County, Kentucky, the county seat of which is Louisville, will spend $250,000 on road, bridge and drainage work during the coming season. Of this amount $150,000 will be expended on road work to be let by contract, $65,000 on land drainage and $20,000 on bridge construction. The remainder will be expended for work by day labor. This does not include state-aid road construction, which will probably amount to about $10,000.

For the most part the road work will consist of waterbound macadam, including both new work and resurfacing. Contracts range in size from $5,000 to $20,000 and will be let at intervals throughout the season. The construction of 4 or 5 miles each of bituminous concrete, bituminous macadam and rock asphalt is contemplated. Some oiling will be done.

For several years this work has been secured by local contractors, no outside bids having been received except for oiling. Local stone is used. The county contemplates doing its own oiling.

The special bridge fund of $20,000 provides for the construction of several steel and concrete bridges. Rubble stone is used in some of the bridges.

J. R. Gaines, County Engineer of Jefferson County, Louisville, Ky., has charge of the work.

State Highway Construction in New York.

Excellent competition was secured by the New York State Highway Commission on its first road letting of the present season on March 23. Bids were taken on 12 contracts. On some of these jobs the figuring was very close, there being a difference of only a few dollars between the low man and his nearest competitor. The following tabulation shows the number of bidders on each of these sections:

Road. No	Length, miles.	High bid.	Low bid.	Number bidders.
965-A	9.52	$ 29,937	$ 17,969	22
5543	6.98	125,727	107,770	11
5258	5.35	108,516	90,223	13
1230	4.97	66,183	58,922	13
5546	4.48	77,667	69,736	14
1222	.22	4,571	3,474	9
5269-B	.51	6,499	5,816	8
1237	.66	25,237	22,294	20
758-A	8.33	48,149	38,768	11
909-A	.13	2,346	1,733	5
5533	2.11	40,238	26,814	25
5234	8.51	49,488	37,127	10

The majority of the contractors figuring on the work, of course, were from New York states. Other states, however, were represented, five Pennsylvania contractors, four contractors from Connecticut, and four from Massachusetts submitting bids. One contracting firm from Iowa and one from Maryland also bid on the work.

One contractor, Austin W. Summers, of Buffalo, N. Y., bid on four contracts and was the low man on each of them. The aggregate of his bids was $306,498. On Road No. 5546 his total was $69,736, $18 less than the next lowest bidder. On Road No. 758-A he bid $38,767, while the next lowest figure was $38,880.

The next letting of the Commission will be held on April 14 on 14 contracts covering a total of about 72 miles of highway. The roads, their location and approximate lengths are as follows:

County.	Road No.	Name.	Length, miles
Albany	1229	Knox-Berne	2.80
Allegany	1246	Friendship - Bolivar, Part 2	6.71
Essex	1177	Raybrook-Lake Placid	5.34
Franklin	1250	Moody-Hamilton County line	5.50
Franklin	1251	Gabriels - Bloomingdale, Part 1	4.91
Franklin	1252	Santa Clara - Lake Meacham	11.41
Monroe	5507	Scottsville-Canawaugus, Part 1	2.14
Monroe	1236	Buckbee Corners-North Chile	1.87
Oneida	1158	Thomson's Corners-Taberg	6.65
Oswego	1243	Central Square-Constantia, Part 1	5.41
Oswego	1244	Phoenix-Mexico, Part 2	5.22
Oswego	1245	Ogdensburg - Waddington, Part 2	6.66
St. Lawrence.	5535	Fulton - Hannibal, Part 2	3.66
Wyoming	5410	Warsaw - Pavilion, Parts 2 and 3	3.88

Construction Work to Cost $10,000,000 to Be Started at Pittsburgh.

Construction undertakings calling for an ultimate expenditure of considerably more than $10,000,000 will be started in the near future in Pittsburgh, Pa. The projects include the following:

New city and county building	$3,000,000
Mt. Washington tunnel	2,000,000
Grade crossing elimination at Liberty Ave.	500,000
Street raising between 8th St. and the Monongahela and the Allegheny River front and Liberty Ave.	

The new city and county building will be erected in the block bounded by Grant St., Diamond St., 4th Ave. and Ross St. The construction of this structure has been held up for some months by legal proceedings. The Supreme Court, however, two weeks ago handed down a decision which removes this litigation and makes it possible for the County Commissioners to have work started at once.

The tunnel through Mt. Washington will connect Carson St. and Warrington Ave. According to the preliminary plans prepared by A. D. Neeld, Consulting Engineer, the tunnel proper will have a total length of 4,875 ft. The approach will be 775 ft. long. The designs provide for a twin tube tunnel, each 24 ft. in the clear, admitting of 20 ft. roadways and 4-ft. sidewalks. The clearance above the roadway is 19 ft. The project was approved by the December Grand Jury, and a court decision was rendered on Feb. 15 dismissing the objections filed by the opponents of the scheme. The County Commissioners have authorized Mr. Neeld to proceed with detailed plans for the undertaking. The County Commissioners propose to immediately sell $1,000,000 of bonds for financing the tunnel project.

The grade crossing elimination will be carried out by the Baltimore & Ohio R. R. and the Pittsburgh Rys. Co. The city a few days ago reached an agreement with those companies for a start on the work.

The street raising work will be carried out by the city and will involve an expenditure of several million dollars. The grades of all streets between 8th St. and the Monongahela River and the Allegheny River front and Liberty Ave. are to be raised. It is planned to commence the improvement by April 1, as most of the damage waivers given by property owners will expire on that date and the city is desirous of keeping out of any unnecessary litigation. The work entails not only the raising of several miles of thoroughfares in the very heart of the downtown section of Pittsburgh, but makes necessary the razing, rebuilding or extensive alterations of factories, mills, stores, dwellings and other structures.

A 128,000 Sq. Yd. Paving Job.

A 128,000 sq. yd. paving contract is being advertised by the Public Works Committee of Beloit, Wis. The streets to be improved are as follows:

	To	From
Bushnell	College	Milwaukee Road
Chapin	Church	Milwaukee Road
Church	Bushnell	Lawton
Clary	Prairie	Cemetery Gate
College	E. Grand	Bushnell
No. College	Lawton	Lawton
Emerson	Pleasant	Milwaukee Road
Harrison	Broad	Bushnell
Lawton	Pleasant	Park
Milwaukee Rd.	Bushnell	City Limits
Park	Lawton	White
Park	Broad	Bushnell
Prospect	St. Paul	Bushnell
Public	Pleasant	College
Short	St. Paul	East Grand
St. Paul	Mill	C. M. & St. P. Ry
White	Park	Milwaukee Road
Back	Cross	Rock River
Cross	E. Grand	115 Ft. South
Euclid	Eighth	Hackett
W. Grand	Eighth	McKinley
Highland	Bluff	Hackett
Locust	Bluff	Eighth
St. Lawrence	Eighth	McKinley
St. Lawrence	Fourth	Bluff
Vine	St. Lawrence	Portland

The improvement will require the following estimate of qualities: 128,000 sq. yds. of paving, 85,300 lin. ft. of combined curb and gutter, 500 lin. ft. of covered gutter. Bids will be received on any or all of the following types of pavement: Creosoted wood block, vitrified block, sheet asphalt, asphaltic concrete, reinforced, two course, Portland cement concrete, tar macadam, mixed method. All on a 5-in. concrete base. Bidders must submit separate proposals in accordance with the following classification based on the area of pavement awarded: 1,000 to 9,999 sq. yds., inclusive, 10,000 to 24,999 sq. yds., inclusive, 25,000 sq. yds. and over. Bidders may submit proposals on any or all of the divisions in the foregoing classification.

Bids on the above work will be received until 2 p. m., April 8.

NEWS LETTERS

St. Louis Items.

S. Dolman & Son have opened a branch office at Bonner Springs, Kansas. They still have some nice machine, wheel and drag scraper, also rock work on the Bonner Springs Electric line to sublet.

Tom Campbell has taken a piece of the Bonner Springs Electric line from S. Dolman & Son.

Jas. Dowd has moved his outfit over on the Bonner Springs Electric line.

Sam Poor secured a piece of the Bonner Springs Electric line from S. Dolman & Son, near Bonner Springs, Kansas.

Work will be completed this week on the electric line station being built by the City at Baden, the southern terminus of the Water Works line, which carries hundreds of persons each week to the City Water Works and its park at the Chain of Rocks. Edward E. Wall, the water commissioner, has made a thorough study and investigation regarding the equipment and managing of this line and has shown that the city can and has for a number of years successfully operated a street car system. The station was designed by Roth & Study, architects, and is in the Italian style of architecture. The brick work is noteworthy, being of large Roman brick, laid in patterns. The roof is red Roman tile. The building 225 feet long, contains a large waiting room and ticket office, tool shop and baggage room. The water works line, while affording the public a means for visiting and enjoying the water works parkway on top of the river bluffs at the Chain of Rocks, primarily forms the means for the city to transport its large force of engineers and workmen to and from the water works at the Chain of Rocks, Baden and Bissell's Point.

The Mississippi River Commission, which will hold its annual spring meeting on board the Steamer Mississippi at St. Louis, April 12, will make an inspection trip from St. Louis to New Orleans and will hold public hearings at St. Louis and at points along the route on matters concerning the rivers improvement.

L. T. Callahan, Fulton, Ky., has 180,000 yards of levee work to sublet at Dorena, Mo., just across the river from Hickman, Ky. Callahan also has several other nice pieces of levee work that he will sublet at good attractive prices.

Stockholders of the Bismarck, Bellevue Valley and Western Railroad, at the annual meeting held at Bismarck, Mo., on March 20th elected the following directors: J. T. Dobbins, Lesterville; S. J. Bunker, Redmond Black, Redmondville; James P. Ward, Irondale and E. E. Evans, O. W. Ramsey, Fred Oehrler, M. Bisplinghoff and J. R. Thompson of Bismarck. The Board organized by electing James P. Ward, president; S. J. Bunker, vice president; E. E. Evans, secretary, and J. R. Thompson, treasurer. Work on the construction will be resumed soon, it was announced.

The Bondurant Const. Co., of Hickman, Ky., can use several team outfits on levee work on the Mississippi river north and south. This firm has contracts at the present time for over 3,500,000 yards of levee work along the Mississippi.

A contract for digging the trench and laying a pipe line eight miles long from Bissell's Point to Fort Bellefontaine to supply water to the new Industrial School was awarded by the Board of Public Service to John F. McMahon on his bid of $10,306. A contract for the necessary pipe was recently awarded for approximately $15,000. A fund of $40,000 is available for the work.

The Illinois Board of Administration served notice on all interested parties that it would oppose any extension of time within which an electric line could be built from Alton to serve the Insane Hospital the State of Illinois is erecting east of Alton, and that it would insist that the agreement made that the electric line would be built be kept to the letter. The railroads interested wanted a deferment of the entering of an order until the question of damages that might arise from the changing of the grade of the roadway was settled.

The L. J. Smith Const. Co., 1111 Commerce Bldg., Kansas City, secured the contract for building ten miles of new line for the Santa Fe R. R., near Fresno, Cal. Work will be started immediately.

William H. Swift, for many years a leading Democrat and president of the Fruin-Bambrick Construction Co., died on March 17th, at his home, 4335 West Pine boulevard, after a week's illness. He was almost 83 years old. The infirmities of age, rather than any specific malady, caused death. "Col." Swift, as he was called, was a native of New York State and had lived in St. Louis since 1850. He was printer, foreman and finally owner of the State Journal, which was discontinued in 1861. Later was connected with the St. Louis Dispatch and the Missouri Republican. He left newspaper work in 1871, and went into the contracting business.

Mrs. E. Kyburc, 5004 Arsenal St., St. Louis, has three teams that she wants to place on work in this neighborhood.

The Board of Administration of Illinois has asked the General Assembly to appropriate $1,000,000 for construction work at the Alton Hospital. The board has on hand an unexpected balance of $100,000 for Alton and with the new appropriation would have $1,100,000 to expend at Alton in the next two years. Five buildings are nearing completion and a contract for the power house is to be let early in April.

A. B. Kerns

PERSONALS

Mr. Robert R. Caldwell, civil engineer and county surveyor of Rock county, Wisconsin, has been appointed Superintendent of Streets for Beloit, Wis. Mr. Caldwell was for six years assistant engineer for the Missouri Pacific and for four years was assistant engineer of Beloit. For 14 years he was city engineer of that city.

Mr. J. E. Root, who has been office engineer on the sewerage investigation work conducted by the Division of Sewerage for the City of Cincinnati since April, 1912, has been placed in charge of the designing part of the special sewerage construction work to fill the vacancy caused by the leave of absence granted Mr. F. C. Tolles and noted elsewhere. Mr. Root is an associate member of the American Society of Civil Engineers.

Mr. Frank C. Tolles, who has been designing engineer for the Division of Sewerage, Department of Public Service, City of Cincinnati, since April, 1912, was granted one year's leave of absence dating from March 15, 1915, to accept a position with Dr. Earl B. Phelps, Consulting Engineer for the International Joint Commission making the studies for the elimination of the pollution of the Great Lakes. Mr. Tolles is an associate member of the American Society of Civil Engineers.

Mr. Herbert M. Church has been appointed division engineer for the Baltimore & Ohio Railroad Co. at Baltimore, Md. Mr. Church has been in the service of the Baltimore & Ohio since 1901, having held positions as follows: Assistant in the engineering corps, assistant division engineer, assistant engineer, division engineer and in 1911, special agent, all at Washington, Ind.; from 1911-14, district engineer, maintenance of way, Wheeling, W. Va.; since August, 1914, division engineer at Philadelphia.

Mr. Hadley Baldwin has been appointed as assistant chief engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, at Cincinnati. Mr. Baldwin entered the service of that company in 1893 as assistant engineer on the St. Louis division. From 1895 to 1898 he was supervisor of track on that division. He was engineer of maintenance of way on the Chicago division from 1898 to 1902, and engineer in charge of double track grade reduction from June to November in 1902. He was then appointed as superintendent of the St. Louis division, remaining in that position until March 1 of this year, when he was appointed to his present position.

Mr. Samuel Gausmann, roadmaster of surface lines, Brooklyn Rapid Transit System, has resigned to enter business as a street railway track and paving expert with offices at 81 Cornelia street, Brooklyn, N. Y. Mr. Gausmann has been in railway work since 1894 when he became conductor and assistant superintendent for the Middletown-Goshen Traction Co. of New York. In 1899 he was made superintendent. He resigned in 1901 to accept a position as foreman on track construction for the Brooklyn Rapid Transit Co. From 1903 to 1911 he was assistant to the roadmaster of surface lines and since 1911 has been roadmaster of surface lines for that company.

Mr. George A. Ricker, for the past two years First Deputy Commissioner of Highways for the State of New York, has opened an office at 188 State street, Albany, N. Y., as consulting civil engineer. Mr. Ricker has had thirty years of experience in engineering work. He first entered railway work and was for a time division engineer on the Erie Railroad, and later assistant engineer on the Northern Pacific Railroad. He was resident engineer on the Buffalo Creek Railroad and chief engineer for the Niagara Gorge Railroad, the Buffalo Traction Co., the Pittsburgh, Binghampton & Eastern, and the Buffalo Frontier Terminal Railroad. He was also at one time consulting engineer to the Twin Lakes, Colo., Land & Water Co. Mr. Ricker conducted a private consulting practice with headquarters in Buffalo, for many years previous to his appointment in May, 1913, as First Deputy Commissioner of Highways of New York. He has had special experience in planning and building parks, cemeteries, and suburban developments, with all kinds of road and pavement work, concrete bridges, docks, grain elevators, etc. He is much interested in highway work and will continue in that line.

Mr. Walter Alexander has been appointed a member of the Wisconsin State Railroad Commission to succeed Mr. David Harlowe. Mr. Alexander was instructor in steam engineering at the University of Wisconsin from 1897 to 1900, and assistant professor of mechanical engineering at the Armour Institute during the year following. In the 1901-02 term he was professor of mechanical engineering at the University of Missouri. He then entered railway work and for two years was assistant district master mechanic for the Chicago, Milwaukee & St. Paul at Minneapolis, and for six years following held the same position at Milwaukee. Since 1910 he has been district master mechanic at Milwaukee. Mr. Alexander is a graduate of the University of Wisconsin, having received his M. E. degree in 1898.

Mr. Walton Van Winkle has resigned as assistant secretary of the Desert Land Board of Oregon. As such he has had supervision of all engineering and construction investigations and the preparation of reports. Mr. Van Winkle acquired part of his mechanical and civil engineering education at the University of Pennsylvania, and part at Cornell from which institution he received his degree in mechanical engineering in 1906. He was instructor at Cornell during 1906-7 in experimental mechanical engineering. He then joined the U. S. Geological Survey as assistant analyst in the Water Resources Board. From 1908 to 1913 he was assistant chemist for the Survey. Since the beginning of 1913 he has been assistant secretary of the Desert Land Board of Oregon. During 1911-12 he was special instructor in the chemistry of water at the University of Washington. He was also employed for a time in the Acme Steel and Malleable Iron Works at Buffalo, and served as cement expert on the Pacific Coast for the U. S. Reclamation Service at the laboratory at Berkeley, Cal. Mr. Van Winkle expects to travel for several months after leaving Salem on May 1, and then to make a permanent location in California for a general practice.

OBITUARIES

Hiram E. Terry, formerly city engineer of Saginaw, Mich., died recently at the age of 60 from the effects of a runaway accident. Mr. Terry was a graduate of the University of Michigan and was city engineer of Saginaw for eight years and of Flint, Mich., for four years.

Francis H. Hambleton, 80 years of age, who for many years was chief engineer of the Baltimore Consolidated Gas, Electric Light and Power Co., died at his home in Baltimore, March 19. In his early days Mr. Hambleton spent some years in Russia, where he was engaged in the construction of railroads as assistant to Ross Winans. Later he went to England, where he built for Ross Winans a "cigar ship," at that time a new type of marine construction. About 1871 Mr. Hambleton opened an office in Baltimore as consulting engineer, and in 1878 was engaged as engineer by the Consumer's Mutual Gas Light Co., which was organized at that year and which has grown into the present Consolidated Gas, Electric Light and Power Co. Mr. Hambleton remained chief engineer until three years ago when he retired from active practice.

Frederick Winslow Taylor, widely known as the "Father of Business Efficiency," died in Philadelphia, Mar. 21, of pneumonia. Mr. Taylor was world famous as the originator of the modern scientific management movement and as an exponent of industrial democracy. He was born in Germantown, Pa., in 1856. He received his degree in mechanical engineering from the Stevens Institute of Technology in 1883. He entered the employ of the Midvale Steel Co., Philadelphia, and was successively gang boss, assistant foreman, foreman of the machine shop, master mechanic, chief draftsman, and chief engineer in 1889. He left the company in that year to begin the work of organizing management of manufacturing establishments of various kinds, in shop, office, accounting and sales departments.

He also organized many large industrial plants, including the Bethlehem Steel, the Midvale Steel and the Cramp's Shipbuilding Co. Mr. Taylor was the inventor of the Taylor-White process of treating modern high-speed tools, for which he received a gold medal at the Paris Exposition of 1900, and the Elliot Cresson gold medal of the Franklin Institute. He received about 100 patents for various inventions. He was president of the American Society of Mechanical Engineers in 1905-6, and was the author of numerous books and articles on business and shop management and on concrete, cutting of metals, etc.

Walter A. McFarland, for nearly 19 years superintendent of the Water Department of the District of Columbia, died of pneumonia at his residence in Washington, March 17. Mr. McFarland was born in Brooklyn in 1864 and graduated in mechanical engineering from Lehigh University in 1888. From 1888 to 1896 he was engaged in engineering work under the Corps of Engineers, U. S. A., the first two years as assistant engineer on river and harbor work in New York and Connecticut, and after 1890 as resident engineer on the Mussel Shoals Canal in Alabama. In September of 1896 Mr. McFarland was appointed principal steam engineer of the Water Department at Washington, and two months later was made superintendent. Soon afterward he was commissioned to reorganize the department and rearrange the system of water distribution. Washington's present water system was designed, built and constructed in accordance with his plans. His first work was to lay large trunk mains and rearrange the distributing system into gravity and pump services. Other improvements which followed were the building of the pumping station, Brightwood reservoir, which is one of the most unusual of its kind in the country, and the supplying of water to Anacostia. So successfully were these projects carried out that Mr. McFarland early came to be recognized as one of the ablest officials in the District government service.

He took an active part in national and local engineering circles, and was president of the Washington Society of Engineers. He also was a member of the American Society of Civil Engineers.

CIVIL SERVICE NEWS

The Ohio State Civil Service Commission announces examinations as follows:

Assistant sanitary engineer; $1,000 per annum; Apr. 7, in Columbus.

Dredge engineer, $1,500 per annum; Apr. 8, in Cincinnati, Cleveland and Columbus.

Cranesman, $90 per mo., April 9, in Columbus, Cleveland and Cincinnati.

Supervising engineer, state institutions, to be held at Ohio State University at Athens, Apr. 17. Candidates should be graduate mechanical engineers or equivalent by experience.

Candidates should address the State Civil Service Commission at Columbus, Ohio, where application blanks will be furnished. Applications must be in the office of the commission at least three days before date of examination.

The United Stataes Civil Service Commission announces the following examination:

Assistant Supervisor of Accounts, Valuation Division, Interstate Commerce Commission, $3,000 to $4,200 per annum, April 27.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

Volume XLIII. CHICAGO, ILL., APRIL 7, 1915. Number 14.

A Profitable Line of Reading for Engineers.

With April, in our northern latitudes, the construction season begins. This issue, the first in April, of Engineering and Contracting, recognizes the opening of the new working season with articles and statistics and advertisements directed to the contractor and construction engineer. It will be noted that advertisements are named with, and moreover on an equality with, technical articles and statistics. This is done purposely. This editorial will discuss advertisements in respect to their educational value to readers of engineering journals.

Tools and machines bind with shackles every designer and builder of engineering works. He cannot plan a structure without keeping in mind the limitations of the tools and machines by which fabrication and erection must be prosecuted. If he contemplates tasks beyond those previously performed his first thought is to ascertain if the toolmaker or manufacturer stands ready to produce the machine or tool necessary to accomplish this extra task. His standing as a designer and builder more notable than others, depends largely upon his greater alertness to perceive that new tools or machines permit innovations. First news of these new tools and machines is important and this news is the purpose of the advertisements in the engineering journal.

Gladstone once remarked, it is said, that he subscribed for a number of American popular magazines "just to read the advertisements." He was justified. They are pages of wonderful enlightenment. So in their more special field are the advertising pages of the engineering journals. Count the number of tools and machines listed in the advertisements of only one issue of one journal and that number is nearly the number of all the constructive tasks of the engineer. Examine the illustrations and there are seen the representative structures that the engineer builds and the devices with which he works. Read the text and there will be found the records of performance which the constructor has made in his work. Are these overstatements? Then it certainly will not be an overstatement if instead of one issue of one journal we take the year's 12 or 52 issues of several leading engineering journals. The overworked Man from Mars, from this wealth of advertisements, could very nearly picture the engineering accomplishment of the Sons of the Earth.

All taint of extravagance obliterated, there is in the advertising pages of a large enginering journal a great deal of value to the engineer and contractor. The time was, within easy memory, when this was perhaps not so true. The art of advertising has progressed. Its character has improved. Facts have largely replaced exaggerated claims. The presentation of these facts is skillful. The appeal is to reason and common sense. Very few advertisements now printed in engineering journals are deliberately false—practically none are so. Assertions that are even greatly misleading are seldom made. They cannot be made safely; competition is too keen and data of actual costs and outputs are too plentiful to permit gross mis-statement without danger. And finally if all claims of superiority, all records of performance, and all costs of operation be discounted, there remains real value to the constructor in the illustrations and descriptions of a wide variety of tools suited more or less perfectly to his uses.

It must not be forgotten that the advertisement writer just as truly and with even more earnestness than the editor or article writer, writes his pages to be read by the subscriber. His pages, like the articles of the editor, are not all of equal interest but it is seldom that all of them are without interest. While the subscriber is not bound to read either the editor's or the advertiser's pages he should read both if he reads one. He should do this for purely selfish reasons. The advertiser who knows that his pages in any journal are always read is encouraged to more and more liberal expenditure in that journal for space in which to address his readers. This extra money gives the editor means with which to buy better information and writing for his pages and to the subscriber accrues this gain in value. Indirectly then, as well as directly in information gained from them, the subscriber benefits who reads the advertisements which his technical journal publishes.

Much of all that is said above has been told before in many ways. It is told again here because of the hope that the reader of this issue will test for himself, if he has not been in the habit previously, the value of careful perusal of the advertising pages of Engineering and Contracting. Editors read the advertising pages, and—this is an editorial secret—they do it because from suggestions secured there they have often put before their subscribers some of the most appreciated articles which they have published.

Clothes and the Engineer.

Every applicant for a position undergoes an appraisal based on outward appearances. This initial valuation may or may not be correct, but it counts for a great deal with most employers, for the average employer flatters himself that he is an excellent judge of human nature at sight. First he looks at the features, then at the garments of the man, or he takes in both at a sweep. Instantly he classifies the applicant, and, since he has made this tentative classification, is slow to change it.

Carlyle, with his ponderous levity, has given immortality to the subject of clothes. But we fail to find anywhere in "Sartor Resartus"—the great clothes philosophy—mention of the reactive effect of clothes upon the wearer of them. Throughout there is uppermost in Carlyle's thought the effect of clothes upon others than the person clothed. Exception to this statement may be taken, and, in illustration, his picture of mankind suddenly made naked may be cited. Dismissing this extremity, because we are considering not a non-existence but an existence, let us touch upon the effect of clothes upon a wearer, and particularly upon a wearer who is an engineer.

However much the engineering student is given to well dressing, or even to ultra dressing, it is noteworthy that when he graduates from college and goes out upon his first field work, he slips speedily back into barbarian disregard of garment. He is brother to the Indian who, leaving the reservation school, pants for the good old days of no-pants.

We have all experienced this rush for freedom from the yoke of custom, particularly the yoke of the custom tailor. And we can not afford to rail at the young engineer who glories in looking like a cross between a farm hand and a hand-me-down. Yet we may at least suggest to him the wisdom of making as short as possible his clothes vacation. Occasional actions have a way of repetition, and repetition speedily begets habit. Of all habits that do not pay, there is none worse than the habit of ill dressing. Particularly is this true of professional and business men.

An old and wrinkled suit may yield a sort of delightful devil-may-care freedom, but there comes in time a mental mating of the character to the clothes. This is the reactive character to the clothes. This is the reactive effect of the raiment. While a devil-may-care man may be, and often is, a delightful as well as a capable fellow, he suffers a certain loss of ambition which both his talk and his clothes proclaim. This is why an employer generally reasons that a poorly clad engineer will be satisfied with small compensation, and generally the reasoning is correct.

We are of the opinion that young engineers engaged in field work—surveying, construction, etc.—will ordinarily find it well to dress the part. By this we do not mean that they should wear out their old suits in the field, but we mean that they should adopt some conventional garb that looks as if it were made specially for the purpose. Although fun is occasionally poked at the wearer of corduroy knickerbockers and leggings as a surveying costume, there is, we think, a growing tendency among young engineers to adopt some such uniform. And with that tendency we are in hearty accord. Not only does a neat uniform command a certain respect from employers, but it has a reactive effect of like nature upon its wearer. It increases his own self-respect.

Men are rather given to humorous remarks upon the gowns of women, yet with subtle intuition the women smilingly accept the chaffing, for they know that they are the better liked for being the better dressed. So, too, the man who is a trifle particular about his clothes may be the butt of some jesting, yet find that he thus pays but a small price for a very substantial ultimate gain in income.

Small Contracts and Limited Competition in Road Construction.

Dividing road construction work into small contracts usually limits competition to local bidders. By a small contract is meant one involving less than $10,000. In some exceptional cases it may be desirable so to limit competition. In the majority of cases, however, it is not desirable.

That competition is limited by dividing work into small contracts is a well established fact. The reasons for lack of outside competition under these conditions are obvious. The main reason lies of course in the fact that the amount of work involved in a single contract is not sufficiently large to justify a foreign contractor in moving construction plant any considerable distance or in purchasing plant on the strength of a small job. Also travelling expenses and other expense incident upon the preparation of a bid are frequently a large item in small contracts. The redeeming feature of limited competition, if there is such a feature, is the fact that contractors of limited means are able to bid upon the work and the work is secured by contractors familiar with local labor conditions and local material and by men well known to the engineer in charge of the work. There is a question, however, whether the work is accomplished as economically when competition is limited or when more bids are received.

The method of advertising for bids also has a bearing upon the number of contractors bidding upon work. When contracts are small and are let at intervals through the construction season it is frequently thought unnecessary to publish the time of letting in other than the local newspaper. The limited extent to which these papers reach contractors undoubtedly affects competition. With larger contracts it is the general practice of progressive engineers to reach as large a number of contractors as possible by means of advertisements in the engineering journals.

The condition may be relieved somewhat by so grouping the small contracts and receiving bids at the same time that a contractor may bid on several contiguous sections of road. Even under this system, however uncertainty exists with regard to securing contracts on a continuous section of road and the danger of having work thus chopped up frequently discourages such bids. Moreover many specifications do not permit a contractor to modify the form of the proposal so as to make the price bid upon several sections of road contingent upon the awarding of them all to one bidder. High bids upon each section result under these conditions.

We believe it to be a much more satisfactory practice both from the standpoint of the engineer and contractor to let construction work in large contracts. Contractors with small capital may then take sub-contracts and may so choose their work that it fits the plant they possess. The clerical work of the engineer is reduced materially and he is assured of the ultimate and timely completion of all the work in hand.

An Exceptionally Promising Sewage Treatment Method.

The most promising sewage treatment method of the moment is that of forced aeration in the presence of activated sludge. At several places, in this country and abroad, and notably at Milwaukee, Wis., and Urbana, Ill., experiments are under way to test the possibilities of this process. The experimenters are all exceedingly enthusiastic over these possibilities. Remembering past experiences, especially in the case of the septic tank, sanitary engineers while interested in this new process and hopeful of its practicability are not oversanguine that it will prove to be a cure-all. That it may become established for a period of years alongside of present day methods, for uses in certain favorable localities, seems fairly probable.

The process, as tested in the experiments at Urbana, is described in the sewerage section of this issue. The experiments indicate a stable effluent and a commercially valuable residual sludge for fertilizing purposes. The process is remarkably free from nuisance to the senses and the compact nature of the requisite works will minimize the land area necessary for the site of the plant. How important the latter consideration may become is well illustrated by the early results of the experiments now under way in Milwaukee. The amount of land necessary for an Imhoff tank and sprinkling filter installation to treat the sewage of Milwaukee, in 1930, is estimated at 108 acres, while to treat the same volume of sewage by the new process would, from present indications, require only 5 or 6 acres. In the former case, moreover, the tanks would probably be upwards of 30 ft. in depth, while in the latter case a depth of 12 ft. would probably suffice. These considerations make for obvious first cost and interest savings in favor of the new method of treatment. On the other hand the cost of providing compressed air is sure to be considerable and continual. Thus there are many pros and cons which will readily suggest themselves to the reader.

The article to which we have referred merits a careful reading. The vigor with which the experiments are being conducted is commendable. Experimenters are urged to cooperate to obviate, so far as possible, the duplication of work and to impart knowledge as fast as it is gained.

The cost question is, of course, the chief consideration. The process must be economically feasible if it is to emerge from the laboratory. Among the other points to be cleared up are the effect of temperature on the rapidity of the action, the amount of air necessary for sewages of varying strengths, the identification of the active agencies at various localities, and the building up of favorable environments for these organisms.

Local Associations of Highway Officials.

The tendency of all engineering workers to form local associations for the study of local problems of common interest, which has become so strong in recent years, is beginning to take form among county and township highway officers. Thus in Illinois there is already one portion of the state in which the highway officials meet at intervals for the exchange of experiences more or less common to the locality, and for the purpose of mutually strengthening each other in knowledge and enthusiasm. Other associations are planned. It is hoped, before long, that every county in the state will thus affiliate itself with adjoining counties having comparable conditions as to wealth, population, topography and soil. By this means those having most in common can meet frequently, owing to the small expense of traveling short distances, and the common character of the problems up for consideration will make for meetings of short duration. Every matter considered will be of interest to all present. The larger problems, of state-wide interest, will naturally be left to the meetings of all the state highway officials. This plan of local gatherings for the study of local problems and central, state meetings for the consideration of matters of interest to all, is to be fully commended.

The Importance of Taking Thought in Choosing Hand Shovels.

All hand shovels seem to look alike to the average contractor or construction engineer. That this indifference toward the scientific choice of shovels is a source of considerable financial loss is readily demonstrated.

The editor observed an interesting example of this indifference a few months ago in this city. At a point where steam railway tracks were being elevated over a street carrying a double track trolley line, three different gangs of laborers, representing three different interests, were engaged in excavating hard yellow clay by hand tools. The steam railway gang excavated for a bridge abutment, the water pipe extension gang excavated for the lowering of a large main, and the street railway gang excavated for track depression. Each gang used the ordinary square pointed shovel, commonly used in mixing concrete by hand, in excavating the clay. It was not at all uncommon for a laborer to work diligently for at least a full minute to sink his shovel into the clay the full length of the blade. To do this much "pumping" of the shovel handle and much pushing with the foot was necessary.

This clay soil is the same as that lying under the black top soil of the Illinois prairies. In digging ditches through it for tile drains farmers have uniformly used a long, narrow-bladed spade locally known as a "tiling" spade. This spade is referred to in some localities as a "sharp-shooter." In the soil mentioned one or two thrusts by the foot will sink it in for its full length. Spades of this type should have been used on the excavating operations above mentioned. Illustrations of this character might be multiplied indefinitely.

An article which forcefully emphasizes the importance of choosing shovels suited to the work in hand was published in this journal of March 31. The article is based on studies which show that a shoveler works most efficiently with a shovel of the right size to hold 21 lbs. of the material to be handled. The studies show that where a laborer furnishes his own shovel he usually gets the smallest one he can find and keeps on using it as it becomes worn or cut to smaller size. Careful observation showed that men in the same gang worked with equal speed regardless of whether they were using No. 2 or No. 4 shovels. In both cases the shovel blades were filled whenever it was possible to do so. It was figured that in a gang of 38 men at 20 cts. per hour 19 men were using worn shovels which held but 7 lbs., while the other 19 used new shovels holding 13 lbs. If the second group earned $1.80 per man per day the first group earned but 97 cents per man per day, although all were paid the same wage. Moreover all these shovels were No. 2 and even the new ones were too small for best efficiency.

That this subject is one of great importance to the contractor we are fully convinced. Where there is much shoveling to be done the economy available in a proper choice of shovels affords the contractor a splendid opportunity to add substantially to his profits by cutting his costs.

Portable Railway Hauling in Road Construction.

Two articles in this issue direct attention to the use of industrial or portable railways for hauling materials and supplies for road construction. These are merely the latest of several articles that have been published by us within a year, and all of which have given similar data. It is now scarcely more than two years since the active attention of road engineers generally has been enlisted in this method of hauling. Records of operation are now available from Oregon, Illinois, Wisconsin and Michigan, and doubtless could be had from many other states were one to search for them. On the whole the records available are sufficiently representative, however, to furnish a fair criterion of the possibilities of this method of hauling for the kind of construction being considered.

Experience indicates the adaptability of portable railway to nearly any condition of ground met in most road construction. The track being light is readily blocked up and carried on rough ground and precise alinement and surface are not demanded, although the records show clearly that good track is worth trouble to secure where the haul is considerable and speed is desirable. On the Michigan road work described in this issue a grade of over 5 per cent on curve was readily negotiated with eight to twelve-car trains. With the little Shay locomotive, also described in this issue, one might expect considerable increase in capacity to overcome grades.

Perhaps the most specific statement of the ability of portable railway to satisfy the conditions of ground common in road construction comes from Wayne County, Michigan, famous for its extensive system of concrete roads. The official report states that track for portable railway can be laid on any surface over which transportation of any kind is possible; that rainy weather or muddy roads do not impair the efficiency of the railway, and that the load is not too heavy for the ordinary highway bridge. The railway service is not confined to road materials; coal, tools, supplies, etc., are handled equally well, particularly if a few flat cars are added to the equipment.

With reasonably good track, speeds of 10 miles per hour are practicable on portable railway. In practice, however, one must ordinarily expect considerably smaller average speeds. Including time for coaling and watering, time taking up and putting down track sections where railways are crossed, and other minor delays, the average hauling speed will frequently drop to half the figure named. The possible size of train will depend upon conditions of track, grades, power of locomotive, etc., but for grades under say 3 to 4 per cent and other conditions of average character, 20 to 30-car trains are easily handled.

Motive power practice shows much variation, and here there seems to be a feature of portable railway practice in road construction which calls for investigation by road builders. In Wayne County the locomotive used was a seven-ton 30-hp. engine; that for the Delta County, Michigan, road described in this issue was also a 30-hp. engine; in Indiana road work now in progress a 12-ton Shay locomotive is employed; on the Oregon state road work described in our issue of March 3 a 20-hp. gasoline Milwaukee locomotive was employed. The records available do not give data for comparison, but the fact is well established by them that a special design of low center of gravity engine is demanded.

The special field of the portable railway is as would be expected, where hauls of considerable distance are necessitated. Average hauls of 4.91 miles, 3 miles, and 3.17 miles are among those recorded. The portable railway system of hauling involves obviously a central materials yard and this involves storage and loading plants. Cost of central yard storage and loading, including plant investment, is, therefore, an item to be kept in mind in portable railway hauling. The article in this issue describes a loading plant of rather notably good design and which gives an idea of the outfit expense to be counted upon.

Costs of portable railway hauling are not in most records well analyzed. Those in another column of the Delta County, Michigan, road are among the most complete. On roadwork in Illinois in 1913 the ton-mile cost of hauling shown by portable railway was 14 cts., and this does not include loading. Records kept for about two months in Wayne County, Michigan, gave a cost of 15.6 cts. per ton-mile. One also notes records of 9 cts. per ton-mile, but these are from data not well itemized and are to be accepted with reservation. It may easily be that other far better records exist, but as stated in the beginning, the summary here made is based on records that have come to us directly.

The portable railway has been used much, perhaps most used, for concrete road construction, and in some ways it is particularly adapted for service in this type of construction. It accommodates equally handily stone and sand and cement in bags or in bulk. More important to notice, however, is the innovation introduced in the Oregon state road work described in our issue of March 3. Ordinarily with portable railway hauling in concrete road work the practice is to haul separately the several materials and distribute them in stock piles on the road grade where mixing and placing are proceeding. The mixers are then charged by barrow from the stock piles on the grade. In the Oregon work a proportioned batch of sand, stone and cement was, at the central yard, placed in each car. The train was then hauled to the mixer and by a special crane on the mixer the car bodies were swung off the trucks and discharged one at a time into the mixer. The success of this method is commented on in the report of the engineer of the state road work.

The Regulation of Subcontracts in 1915 and a Hundred Years Ago.

The contractor . . . of this work shall not sublet the same or any part thereof without the written consent of the State Highway Engineer for each individual subcontract, and the terms of such prospective subcontract shall be submitted at the same time the request is made.

The contractor shall not in any instance let or transfer his contract or any part thereof to any other person without the Superintendent's consent, and in every instance where such subcontract may be made the price per perch to be allowed to such subcontractor shall be fixed with the said Superintendent's approbation.

One of these quoted clauses is from a road contract written in 1915 and the other is from a road contract written in 1815. A phrase or word of unusual use at present tells which quoted clause is a hundred years old. The things stipulated are identical. The reasons for the stipulations show as clearly between the lines of the clause written in 1815 as they do between the lines that are dated 1915. One wonders, in looking at the two quotations, how long before 1815 was it held wise by those directing engineering construction to retain the power to regulate the subcontracting of work and the prices received by subcontractors.

SEWERAGE AND SANITATION

Tests of Circular and Egg-Shaped Reinforced Concrete Sewer Pipe.

The use of reinforced concrete sewer pipe is an innovation in Philadelphia, and its introduction led to the investigation here described. A number of questions presented themselves relative to this form of sewer construction, as follows: With the type of pipe used what was the minimum time permissible for curing? What was the most desirable method of curing? Was the specified system of concrete cradle foundation construction justified, or necessary? Were the pipes sufficiently impervious and sufficiently strong to resist reasonable internal pressures? These and other questions required an investigation the results of which are here given from matter contained in the paper read on this subject before the 11th annual convention of the American Concrete Institute by Mr. A. T. Goldbeck, assistant engineer, testing laboratory, Bureau of Surveys, Philadelphia, Pa.

DESCRIPTION OF PIPES.

Two kinds of pipes were made: one was circular in cross-section, 36 ins. in diameter and 4 ins. thick, and the other was egg-shaped, having a long diameter of 36 ins., a short diameter of 24 ins., and was 3½ ins. thick. The egg-shaped section was provided with a flat base, 8 ins. wide.

The materials used in the manufacture were a well known brand of Portland cement from the Lehigh Valley district which satisfactorily passed the standard tests. New Jersey bank sand, and well graded ¾-in. crushed run trap. In a few of the pipes, crushed shale of undesirable qualities was used, but as it was not suitable, its use was discontinued. Four experimental sections were also made of concrete containing ¾-in. graded, air-cooled blast furnace slag having a weight of 74.7 lbs. per cubic foot, when shaken to refusal in a cubic foot measure. The concrete was machine mixed in the approximate proportions, 1:2:3½.

The pipes were reinforced with triangular mesh placed 1¼ ins. from the inner surface and described in Table I.

After pouring in special steel moulds, the pipes were allowed to harden, some of them under atmospheric conditions, others when subjected to a hot vapor bath continued for a period of about 12 hours. The application of hot vapor at a temperature of about 100° F. accelerates the hardening and permits of the removal of the forms on the day after pouring without danger of injury to the pipe during the removal. It thus permits the manufacturer to economize on moulds. It likewise enables him to make pipes in freezing weather. After the moulds were stripped the green concrete was kept damp by daily sprinkling for one week.

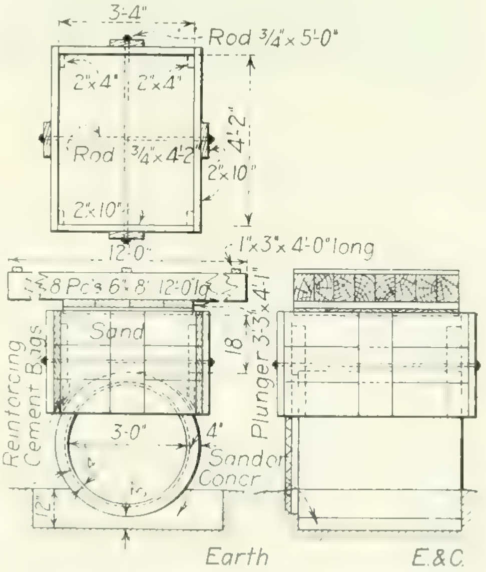


Fig. 1—Detail of Test Box for 3-ft. Circular Reinforced Concrete Sewer Pipe, Philadelphia, Pa.

EXTERNAL LOADING TESTS

Method of Bedding.—Two methods of bedding the pipes were employed, (a) damp sand bedding and (b) bedding in a concrete cradle. Three inches of sand or concrete was used under the pipes extending on each side to a height of one-quarter of the vertical diameter. Where a sand bedding was used, the pipe was placed on the layer of lightly tamped sand and sand was heaped and tamped around the sides to the proper height. In the case of the concrete cradle bedding, the pipe was placed in the soft concrete and it remained there until tested. In some cases the cradle was only one day old when the pipe was tested, but generally was older than this.

The specifications under which the pipes were laid called for a concrete cradle such as described, but the sand bedding tests were made in order to inquire into the necessity for the concrete cradle construction.

Method of Loading.—The load was transmitted to the specimen under test through a cushion of dampened sand, contained in a bottomless box resting on the specimen. The box was properly braced with tie-rods to prevent its spreading under load. A wooden plunger, carrying a timber platform, rested on the sand, and the load was obtained by piling bags of cement on the platform. This method was adopted in the absence of a testing machine of the desired type and capacity. It was a very expensive method but was quite effective. The loads were applied at the rate of 10 bags (950 lbs.) in about 5 minutes and vertical distortion readings were taken after each 10-bag increment. Figure 1 shows the method of loading in detail for the circular pipe. The egg-shape pipe were loaded in a similar manner.

TABLE I.—DESCRIPTION OF REINFORCING IN PHILADELPHIA SEWER PIPE.

	[illegible] egg-shape	[illegible] circular
No. of strands, longitudinal......	1	[illegible]
Gage of longitudinal strands	[illegible]	[illegible]
Gage of cross wires..	[illegible]	[illegible]
Sectional area, long., sq. ins.	[illegible]	0.124
Sect'nal area, cross wires, sq. ins.	[illegible]	[illegible]
Cross sectional area, per ft. width	0.110	0.146
Wt. per 100 sq. ft., lbs............	50	63

Tensile strength, 80,000 to 90,000 lbs. per sq. in.

Method of Measuring Vertical Distortion.—In order to note the elastic behavior of the pipes under load, distortions of the vertical diameter and in some cases distortions of the horizontal diameter were measured. This was done in two ways: (1) by the use of an Ames dial reading to 0.001 in. and (2) by the measurement of the middle ordinate between two light wooden battens sprung into place between the crown and invert. A very slight movement in vertical distortion produces a comparatively large increase in the middle ordinate. This device is extremely cheap and convenient to attach. It is held in place entirely by the compression in the battens. The middle ordinate readings were taken on a scale reading to 0.01 in. and were readily converted to vertical deflections by calibration. This device was used merely as an expedient during the temporary lack of an Ames dial. It, however, is quite accurate and is capable of refined application in other fields of testing where deflection measurements must be made.

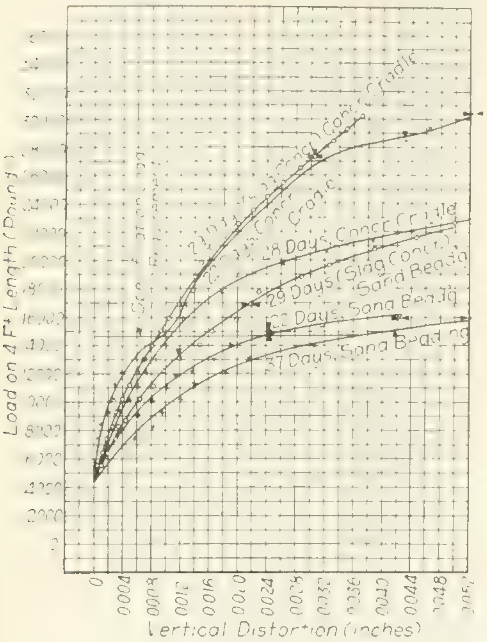


Fig. 2—Results of Tests on Steamed 36-in. Circular Reinforced Concrete Sewer Pipe, Philadelphia.

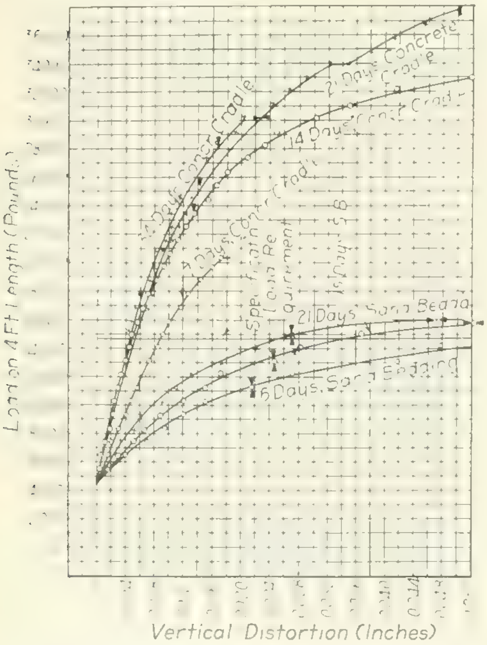


Fig. 3—Results of Tests on Unsteamed 36-in. Circular Reinforced Concrete Sewer Pipe, Philadelphia.

THE TESTS.

It was the aim to test a single pipe of each kind at the age of 7, 14, 21 and 28 days, bedded in sand and concrete and cured with and without steam, and this program was followed as completely as weather and other conditions would permit. The pipes were placed in their cradle at least one day before testing. Vertical distortion readings were not taken until the sand box and loading platform were mounted into place, and the initial readings were made under the weight of sand box and platform loading. After each increment of 950 lbs., distortions were read and the surface carefully searched for hair cracks.

CURVES OF VERTICAL DISTORTION.

The readings for vertical distortion are plotted as abscissas on Figs. 2, 3, 4 and 5, and the ordinates are the corresponding loads carried on the test section of pipe, 4 ft. long. The curves thus obtained indicate several facts concerning the pipes.

Considering first the unsteamed pipes, it will be seen that stiffness is gained with age, and the load under which the first hair cracks became visible likewise advances with the age of the pipe. This is to be expected, and is in agreement with other tests on reinforced concrete. Note the great increase in stiffness resulting from the use of a concrete cradle rather than sand bedding. As an accompanying result, cracking occurs at a much higher load when a concrete cradle is used than where the pipe is merely bedded in sand. This is true of egg-shaped and of circular sections, but is particularly true of the circular pipes. It was required by the city specifications that the pipes be able to withstand an external load of 1,000 lbs. per square foot without showing cracks. This was a reasonable requirement for the conditions under which the pipes were laid. It will be noted that the circular sections embedded in sand, when unsteamed, are unable to pass the specifications at 6 and 15 days and lie uncomfortably close to the requirements at 21 days. When a concrete cradle is used, however, no difficulty whatever is encountered in exceeding the loading requirements. In constructing a sewer of circular pipes such as these, with a likelihood of their being subjected to a load of 1,000 lbs. per square foot, a concrete cradle, extending in height one-quarter of the diameter of the pipe above the base is recommended as necessary in order to avoid cracks.

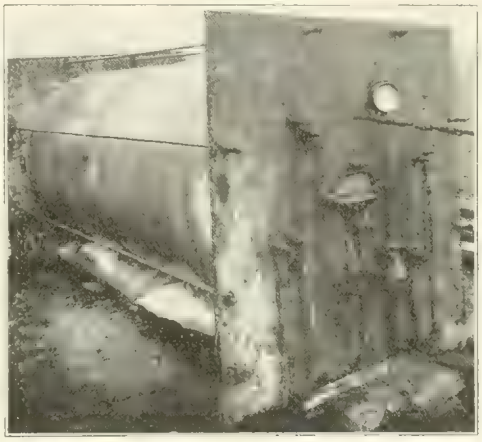


Fig. 6—View of Apparatus for Making Permeability and Internal Hydraulic Pressure Tests of Reinforced Concrete Sewer Pipe, Philadelphia.

As might be expected, the egg-shaped pipes were stiffer than the circular pipes, and were not afforded as much extra support by the concrete base as were circular pipes. However, even in the egg-shaped sections, the extra stiffness and resistance against cracking provided by the concrete warrant its use.

A comparison of the steamed and unsteamed pipes is of interest. There seems to be an indication that the steam cured pipes, that have had their setting accelerated, are more uncertain in their strength at the later periods than are the pipes cured under normal conditions. The strength of the normally cured pipes follows a fairly definite law of increase in stiffness with age. The steam cured pipes on the other hand are extremely erratic, some of the older pipes exhibiting less stiffness than those of lesser age. The steam method of initial curing is open to some question, and if allowed, should be very carefully controlled in order not to drive out the moisture from the concrete before the cement has attained its set.

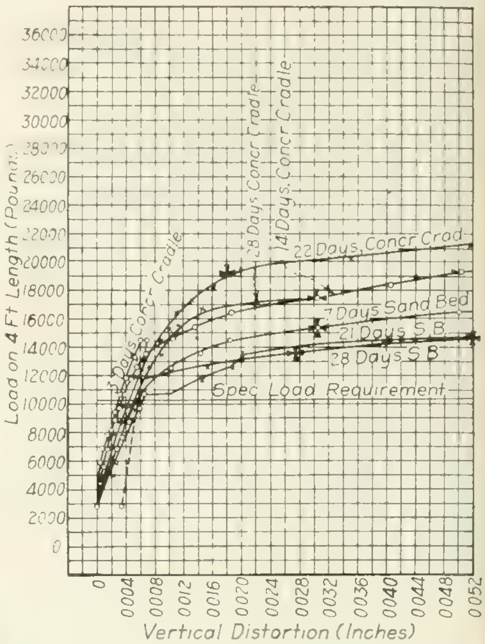


Fig. 4—Results of Tests on Steamed 2x3-ft. Egg-Shaped Reinforced Concrete Sewer Pipe, Philadelphia.

The behavior of the experimental pipes made with blast furnace slag coarse aggregate is interesting in indicating that the strength and stiffness of the pipes of this material equaled or even slightly exceeded those of pipes made with crushed trap.

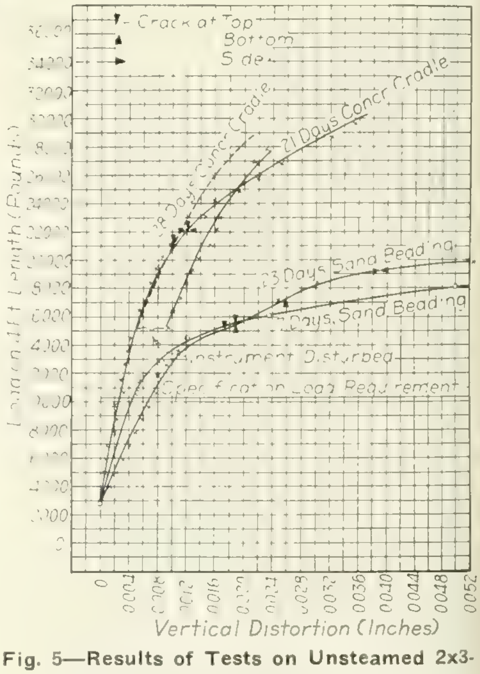


Fig. 5—Results of Tests on Unsteamed 2x3-ft. Egg-Shaped Reinforced Concrete Sewer Pipe, Philadelphia.

HAIR CRACKS.

It is highly undesirable to subject a reinforced concrete sewer pipe to a load such that hair cracks are likely to form, because of the danger of corrosion of the reinforcing metal that must result. That load which causes a visible hair circle to form is therefore to be regarded as the ultimate strength of the pipe, even though the load necessary to cause actual collapse may be much higher.

On the curves, the loads at which cracks were first noticed are indicated by arrow heads, and the position of the arrow indicates the position of the cracks, whether at the bottom, top or sides of the pipes. The pipes embedded in sand almost invariably failed by cracking at the bottom, inner surface or invert, and in the circular pipes a crack was generally first noticed at the top inner face. The side cracks which occurred on the outer surface of the sand embedded pipes were sometimes noticed simultaneously with the top and bottom cracks, and sometimes not until after the top and bottom cracks had formed.

When a concrete cradle is used, the first crack almost invariably occurs at the top, and is sometimes accompanied by side cracking on the outside. Cracks do not form at the extreme bottom when the pipe is bedded in concrete, although under very high loads, and after all other cracks have formed at the top and sides, inside cracks will develop just above the level of the concrete cradle.

A very green concrete cradle, even when not more than one day old, adds greatly to the strength of the pipe.

The order of formation and position of the cracks are very reassuring, particularly when a concrete cradle is used. Thus it has been seen that the invert remains intact even long after the pipe has been loaded sufficiently to crack it at the crown. The sand bedded pipes, however, cracked at the invert under quite a low load. This is an additional argument for the use of a concrete cradle rather than earth bedding. The fact that cracking occurs at the top or bottom on the inner surface before it occurs at the sides on the outer surface is significant. It shows that the steel is correctly placed to provide for the tension at the dangerous sections of the pipe. Increased resistance against complete collapse would perhaps be obtained by shaping the steel to approach the outer surface at the sides, but collapsing strength is not of much interest as it is well above the load required to produce the first visible crack. The extra expense which would be involved in this procedure is therefore not warranted.

TABLE II.—RESULTS OF PERMEABILITY TEST OF REINFORCED CONCRETE SEWER PIPE.

Age, days.	Pressure, lbs.	Duration of test, hours.	Leakage, gals. per mile per 24 hrs.
30	5	1	7,920
31	5	1½	13,860
31	5	1	11,900
32	5	1	15,840
33	5	1	10,890
34	10	½	27,700
40	10	1	*13,860

*Muddy water.

TESTS FOR IMPERMEABILITY AND RESISTANCE AGAINST INTERNAL PRESSURE.

In a sewer of the size tested, a leakage amounting to more than about 10,000 gals. per mile in 24 hours might well be regarded as the maximum allowable limit. A reasonably tight sewer placed in the wettest soil at a considerable depth should not admit more than this amount of ground water. Not only should the sewer be safe against excessive inward leakage but it should likewise be capable of resisting a possible interior pressure due to flooding without cracking and thereby developing large leaks.

The specifications required, therefore, that excessive leakage should not occur under a pressure of 5 lbs. per square inch and should not crack nor burst under a pressure of 10 lbs. per square inch interior pressure.

In order to make the hydraulic test, two sections of pipe were grouted together in the same manner in which they would be treated in the trench. Heads made of steel plates were bolted to the ends by means of long bolts extending through the pipe and along the sides, as shown in Fig. 6. Rubber carriage tires of the correct diameter were used as gaskets to prevent leakage at the ends. The leakage was collected in a tin drip pan and measured. The grouted joint connecting the two sections was about two weeks old when the first test was made, and the pipes were 30 days old. Table II gives the results of the permeability tests.

The internal pressure required to crack the pipes was 25 lbs. per square inch.

A corresponding test made on a slag concrete pipe showed a leakage of 5,470 gals. per mile per 24 hours, and required an internal pressure of 32 lbs. per square inch to cause rupture. Most of this leakage occurred at the grouted joint.

TABLE III.—TESTS ON SAND USED IN CONCRETE SEWER PIPE AT PHILADELPHIA.

Sp. gravity			2.654
Per cent voids (loose)			42.5
Wt. per cu. ft. (loose)			95.7
Strength tests—Tension, 1:3 mortar:			
	7 days	28 days.	3 mos
Bank sand	199	341	415
Ottawa sand	330	460	493
Ratio, per cent	60.3	72.7	84.3
Compressive strength, 1:3 mortar:			
	7 days.	28 days.	
Bank sand	850	1,842	
Ottawa sand	1,194	2,625	
Ratio, per cent	71.1	70.2	
Passing ¼			99.3%
Passing ⅛			96.2
Passing 10			93.9
Passing 20			82.7
Passing 30			72.0
Passing 40			62.8
Passing 50			35.5
Passing 80			9.6
Passing 100			4.1
Passing 200			0.5
Silt			0.0

The above results for the stone pipe are not particularly good. Concrete as rich as that used in the manufacture of these pipes can be made practically watertight against 5 lbs. per square inch pressure. Most of the leakage occurred in the upper half of the pipes as molded, showing that a difference in density existed in the concrete, depending on its position in the forms. However, in the trench leaks such as those due to somewhat porous concrete and not to actual cracks in the concrete would soon become filled with silt and no undue leakage should thereafter result.

CONCLUSIONS.

The following conclusions seem warranted:

1. Reinforced concrete pipes, when properly made and properly cured, are very satisfactory for the construction of sewers.

2. The use of a concrete cradle greatly inceases the stiffness of the pipe and raises the load under which initial cracking takes place.

3. For sections of the size tested and for smaller sections, the placing of the reinforcing near the inner face throughout the entire circumference seems to be justified.

4. The matter of curing should be very carefully controlled, as much stronger pipes will result if care is taken to keep them thoroughly wet, preferably for a period of two weeks.

TABLE IV.—CRUSHING STRENGTH AND ABSORPTION TESTS ON CONCRETE USED IN PHILADELPHIA SEWER PIPE.

Cylinders Made from Concrete Used in Pipe.

No.	Age, days.	Crushing strength, lbs.	Steamed, hrs.	Buried in ground, days.
1	82	2,260	10	77
2	82	2,910	10	77
3	60	2,650	11	55
4	60	2,410	11	55
*5	55	1,930	10	50
*6	55	1,700	10	50

*Nos. 5 and 6 made of blast furnace aggregate.

ABSORPTION TESTS OF CONCRETE, PER CENT APSORPTION AFTER 48 HOURS.

Stone concrete	4.4 per cent.
Slag concrete	6.1 per cent.

The manufacture of concrete pipe is a process that can be controlled very precisely, and the character of the concrete produced should be much superior to that made in the average concrete construction. The quality of the various materials available should be very carefully investigated before use. Much can be done toward producing stronger concrete by the selection of first class sand and coarse aggregate. But the manufacturer should not stop at merely obtaining satisfactory constituent materials, he should go further. He should find out by very simple density tests how he should combine these constituent materials in order to obtain with them concrete of the greatest density and greatest strength, for it must be emphasized that dense concrete is vitallv necessary for concrete sewer construction.

Tables III and IV give data on the sand used in the pipe, and on strength and absorption tests of the concrete.

Sewage Collection and Pumping Systems on Low-Lying Park Point Near Duluth, Minn.

Park Point forms the sole protection for Duluth-Superior harbor; it averages in width about 500 ft., and is in many cases not over 10 ft. above the lake level. It is several miles in length, and is separated from Duluth proper by the U. S. ship canal. The district is strictly residential, and is built up almost entirely of small cottages. Two streets run parallel with the axis of the Point, Lake Ave. on the lake side and Minnesota Ave. on the side of Duluth harbor. For the first five blocks from the ship canal Lake Ave. is the principal residence street, after which almost the entire population is confined to Minnesota Ave. (The sewer described later was accordingly built on Lake Ave. for a distance of five blocks, then passed over to Minnesota Ave., on which it extends 26 blocks further, being in all a little short of three miles long.) A preliminary study showed that the highest portion of the street was about 9 ft. above mean low water in the bay, while the lowest point was about 2 ft. above; the average was probably about 7 ft. The highest water of record was about 2 ft. above the mean low water, which is the datum plane, to which all elevations hereafter are referred. The average daily consumption of water amounted to about 25,000 gals. A majority of the cottages were provided with shallow cess pools, which leached into the surrounding sand. Plans for the sewerage of this sand spit are described in a paper before the recent annual meeting of the Minnesota Surveyors' and Engineers' Society by Mr. John Wilson, City Engineer of Duluth. One plan was to construct at frequent intervals a sewer across the point connecting the lake with the bay, into which the service sewers would empty; and allow the current produced by the difference in elevation of the water in the bay and that of the lake to carry away the accumulating sewage. This current would vary from time to time, first being in one direction and then in the opposite. The most serious objection to this scheme was the probability of the first storm completely filling the sewer with sand, unless the outlets were carried out into the very deep water, which would be very expensive. Another plan was to construct a series of septic tanks along the bay, into which the sewage would be discharged. As this would mean the construction of not less than twelve tanks, none of which could be located further than 150 ft. from some cottage, and as the effluent would be discharged into the bay, which is used for bathing purposes at several points, this plan was also seriously objectionable.

The plan which was finally adopted was the construction of a sewer with boosting pumps placed at various intervals along the line, five in all, and discharging the sewage beneath the surface of the water in the U. S. ship canal.

The first pump was located one block from the ship canal, and discharges through a 6 in. cast iron pipe, which upon reaching the government pier passes down a well, thence under the pier and up on the outside about 5 ft. above the bed of the channel. The velocity through this pipe is supposed to be from 4 to 4½ ft. per second, which should be sufficient to carry sand or small gravel of a size which might enter the pump. The second pump was located on Minnesota Ave. where the sewer passes to Lake Ave., and lifts the sewage through a 6 in. cast iron pipe to the sewer on Lake Ave. The third pump is located eight blocks further on, the fourth nine blocks further, and the last pump seven blocks beyond the fourth.

The sewer is all constructed of 10 in. vitrified sewer pipe, except the last two blocks, which are 8 in. As over half the sewer is below the level of the lake, the deepest point being —3.16 and the highest —3.69, it was desirable to make the joints as nearly watertight as possible; therefore the joints were all made by the use of G. K. Compound or Pioneer Sewer Joint Asphalt.

The 10 in. pipe is laid to a grade of 0.15 per cent, and the 8 in. to a grade of 0.25 per cent; which will give a velocity of about 1.5 ft. per second. There is no doubt however but that this velocity is increased by the action of the pumps

SPECIFICATIONS FOR PUMPING PLANTS.

The specifications for the pumping plant shown in Fig. 1 were as follows:

All manholes and pump pits shall be constructed of concrete, one part Portland cement, two parts sand and three parts approved gravel or broken stone, which will pass a 1½-in. ring. The walls shall all be waterproofed with approved compounds, such as Medusa or Ceresit, which shall be applied according to the instructions of the manufacturers. Special attention must be given to the problem of excluding ground water, and all pump pits must be made watertight, and the manholes nearly so, before the work will be accepted. The centrifugal pump shall be of the vertical, single-stage type, delivering from 350 to 375 gals. per minute. The impellers shall be of the open type, and made of close-grained cast iron. Packing rings, interior nuts, linings of stuffing box, throats and glands must be of non-corrodible material. Surfaces subject to wear shall be removable without removing the pump casing, impeller or shaft. All passages must become accessible upon opening the pump casing. All main bearings shall be of the self-oiling type, and liberal oil grooves provided so as to insure lubrication over the entire bearing. The pump thrust and weight of shaft shall be taken up on ball bearings. The rated head against which the pumps must operate will be as follows: Pumps one and two, 13 ft; three, four and five, 7 ft. The motors will be vertical, direct connected to the pump shaft by flexible coupling; and shall be of a speed suitable for the pump. One and two shall not be less than 5 hp., and three, four and five shall not be less than 3-hp. The current will be alternating, single-phase, 60-cycle, and can be either 110 or 220 volts. The motors shall be of some well-known make, and shall be equipped with the necessary fuses, switches, etc. An automatic starter and cut-out shall be provided, which will operate by a float in the adjoining wall. As the motor will be below ground, it must be especially adapted to working under damp conditions. Everything must be in perfect running order before being accepted. This must be determined by actual test.

The pumps are placed in separate pits from the sewer, and are all placed low enough to be self-priming. In most cases the sewage rises to elevation 2 before the pump starts. It will thus be noticed that the sewage is backed up in the sewer a considerable distance before the pumps start; which under normal conditions would be considered objectionable.

It was necessary to place the pumps at sufficient depth to make them self-priming; but to place them any lower than this meant an increase in cost, together with the probability of pumping much more ground water.

All house connections are 4 in., and carried up vertically, except where the sewer is above water. This fulfills the two-fold purpose of preventing the sewage from backing into the house connections, and also prevents careless connections from being made later on, which might admit a large quantity of ground water.

The suction well or manhole of each pump is provided with an overflow at elevation 2.5 which is about 1 ft. higher than usual high water and 6 ins. higher than the highest point of which we could find any record. Thus if any one of the pumps should fail to work the sewage will overflow to the bay, until the pump can again be placed in operation. The pump pits are of rectangular shape, about 4 x 5 ft. The suction passes through the wall of the pump pit and enters the suction manhole or pit, the drop pipe of the suction being 1 ft. below the invert of the sewer and 6 ins. clear of the bottom.

The lower ends of the suction pipes vary on the different pumps from 4½ to 3 ft. below mean low water in the lake. The pumps discharge into another manhole which is at the head of the sewer, passing on to the next pump, except for pumps 1 and 2, which have been previously described. Previous to starting the pumps the amount of infiltration was found to be about 18 gals. per minute with the sewer empty and the water in the bay at about elevation 1; in which case approximately two miles of the sewer was below water. The pumps have now been in operation about nine months, and have so far performed their work without any serious trouble.

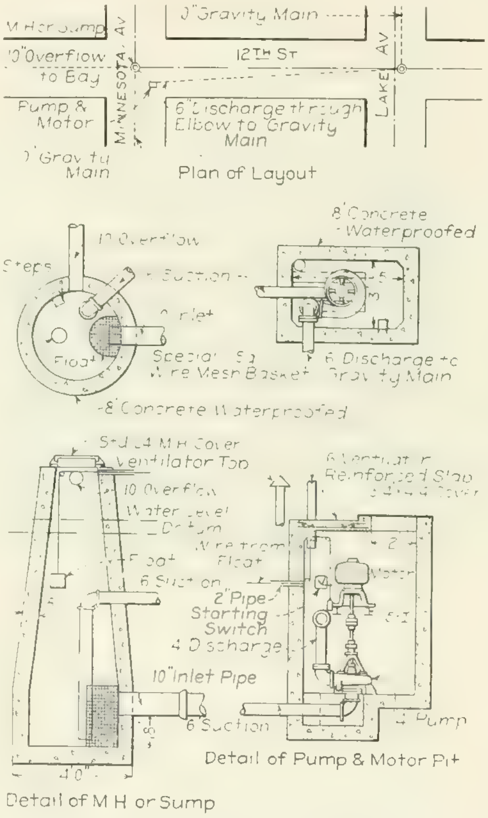


Fig. 1. Details of Typical Sewage Pumping Station on Park Point, Duluth, Minn.

The contract price for each pumping plant was $900. My preliminary estimate for the cost of maintenance and operation was $720 per year; and although the cost of current is considerably higher than estimated, being $1 per month per horse power, the cost of the first year will no doubt not exceed that figure.

At present there are 34 connections made with the sewer, which contribute about 175,000 gals. per month. Many more connections will be made the coming season. Due to the fact that so few connections are being made to the last section of the sewer it will probably be necessary to provide a flushing device to insure the last pump operating more frequently, and thus prevent an odor from the manholes.

Early Results of Experiments on the Purification of Sewage by Aeration in the Presence of Activated Sludge.

During recent months experimentation has been taken up at several points in this country on the purification of sewage by aeration in the presence of activated sludge. As the experiments have progressed the enthusiasm of the experimenters over the apparent possibilities of the method has increased. Editorial comment is made elsewhere in this issue on some of the present aspects of this method of treatment. The present article describes the early results of the experiments, along this line, in the laboratory of the Illinois State Water Survey at the University of Illinois. Our information is from a paper before the American Chemical Society at New Orleans, April 1-3, by Dr. Edward Bartow, Director, and F. W. Mohlman, Assistant Chemist, of the Illinois State Water Survey.

Acting under the advice of Prof. Gilbert J. Fowler, of the University of Manchester, England, the Illinois experiments have followed the lines described by Ardern and Lockett in J. Soc. Chem. Ind., 33, 523-39, 1122-4. Some repetition of work has been necessary to become familiar with the process, to get some activated sludge, and to study reactions involved. Studies are being made of necessary mechanical devices, the physical, chemical and biological conditions of the process and the properties of the sludge. The experiments are on intermittent flow, continuous flow having been abandoned for the present by Ardern and Lockett.

Our first experiments were made using bottles of 3 gals. capacity. Later, we constructed a tank 9 ins. square and 5 ft. deep. This tank has plate glass front and back to permit easy observance of the condition of the sewage and sludge. A porous plate was placed 4 ins. above the bottom. An inlet for air and an outlet for any water which might pass through the plate were provided in the space below the plate. All compressed air is measured through an ordinary gas meter. The purified sewage is removed by means of a siphon. Experiments have been carried out in the laboratory at room temperature, thus far, with no special precautions to regulate the temperature.

Champaign city sewage is used. It is collected from a point in the main sewer and when taken is fresh. It is a fairly strong domestic sewage, containing no trade wastes.

Aeration of Raw Sewage Without the Addition of Sludge.—Air has been blown into five separate portions of sewage until complete nitrification was accomplished. To show the progress of the reaction tests for free ammonia, nitrites and nitrates were made at intervals during each treatment. The time required for complete nitrification has varied from 15 to 33 days. The best result was obtained in the tank, where the air was distributed through the porous plate. For all analyses, samples of the supernatant liquid were taken after one hour settling without filtration. In each case the *free ammonia* nitrogen was almost quantitatively changed to *nitrite* nitrogen, then the *nitrite* nitrogen in turn was changed almost quantitatively to nitrate nitrogen. This change is illustrated in Figs. 1 and 2. The formation of nitrate in the tank was accomplished in 15 days with the use of 4,830 cu. ft. of air.

Aeration With Sludge.—The supernatant liquid was siphoned off and a fresh portion of sewage added to the sludge. In this, the second treatment, the effect of a small amount of sludge is very nicely illustrated by the reduction of the time required for complete nitrification from 15 days to 4 days and the reduction in the amount of air used from 4,830 cu. ft. to 1,270 cu. ft. Thirty-four parts per million of free ammonia nitrogen in the raw sewage produced 23.8 p. p. m. of nitrate nitrogen in the supernatant liquid.

The supernatant liquid was again siphoned off, fresh sewage added and aeration continued. In this, the third treatment, nitrification was complete in two days and but 720 cu. ft.

of air was used. Thirty-three p. p. m. free ammonia nitrogen produced 22.3 of nitrate nitrogen. In the twelfth treatment the purification was completed in less than eight hours with the use of less than 128 cu. ft. of air and 36 p. p. m., as free ammonia nitrogen produced 29.5 p. p. m. of nitrate nitrogen. In the 31st treatment with sludge and sewage in the proportion of 1:5 purification was complete in less than five hours. Thirty-five cubic feet of air were used, equal to .20 cu. ft. per square foot of surface area per minute, or about 3 cu. ft. per gallon of sewage. We have not yet attempted to determine the minimum amount of air required.

Samples taken at the end of each hour of aeration during some of the treatments have been tested for stability. A sample taken at the end of one hour aeration in the 31st treatment had not decolorized methylene blue at the end of 12 days. Since in one hour nitrification was not complete, it is, therefore, evidently unnecessary to obtain complete nitrification in order to obtain a stable effluent. Since it is impossible to separate the oxidized liquid entirely from the sludge it is probable that the stability is promoted by the oxidizing action of the nitrate in the residual liquid.

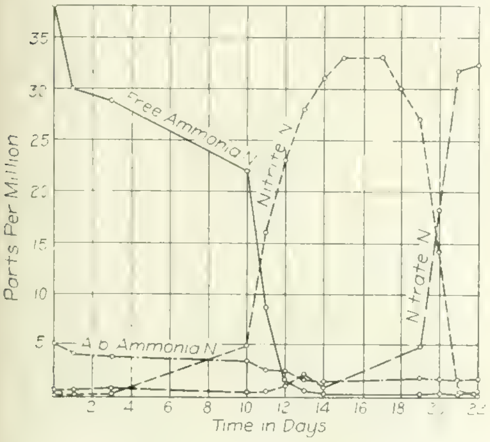


Fig. 1—Diagram Showing Progress of Nitrification of Aerated Sewage—No Activated Sludge Present.

The progress of nitrification in the presence of activated sludge is apparent. The results are shown in Fig. 3. From this and from other series of analyses it is indicated that there is no quantitative conversion of free ammonia to nitrate, followed by oxidation to nitrate, but that nitrates are formed simultaneously with nitrites.

The number of bacteria were determined during one treatment. Samples were taken after one hour settling. The raw sewage showed a bacteriological content of 750,000 per cc. The supernatant liquid after aeration and settling one hour showed but 20,000. Further tests are planned, to include the determination of species.

Worms in Sludge.—Through the courtesy of Prof. Frank Smith, Professor of Systematic Zoology of the University of Illinois, biological examinations have been made of the sludge. Among the microscopic animals found are many Vorticella and Rotifera, but the predominent organism is an annelid worm, known as Aeolosoma hemprichi. This organism is about 2 to 5 millimeters long and is quite slender. It abounds in various kinds of fresh-water bodies where there is an abundance of decaying organic material, and thrives especially well where there is much fermentation, and in waters contaminated with sewage, provided there is an abundance of oxygen.

It belongs to a group of worms in which reproduction occurs very rapidly by asexual methods. A fission zone is formed near the middle of the body of the parent worm and develops the head of one daughter worm and the tail of the other and thus two new worms are formed from one. This requires not over 2 or 3 days and is repeated for an indefinite number of generations.

They feed greedily and almost continuously on any small organic particles that they can obtain and presumably destroy at least their own weight of organic matter every day and probably more. Because of the mode of reproduction, it takes but a short time to produce extensive colonies with great capacity for the destruction of organic material.

Sludge.—The activated sludge has evidently been developed by the multiplication of these worms originally present in the sewage and the species found at varying points might differ. The sludge does not have an unpleasant odor, due to the fact that it consists largely of living organisms. If kept for a long time in a moist condition without air it will putrefy.

Composition of Sludge.—Analyses of the sludge made by W. D. Hatfield have shown the following results: After drying first on the water bath and then for three hours in an oven at 100° C. the loss, or moisture, was 95.54 per cent. The dried material contained 6.3 per cent nitrogen, 4.0 per cent fat, 1.44 per cent phosphorus, equal to 3.31 per cent P_2O_5 and 75 per cent of volatile matter by loss on ignition.

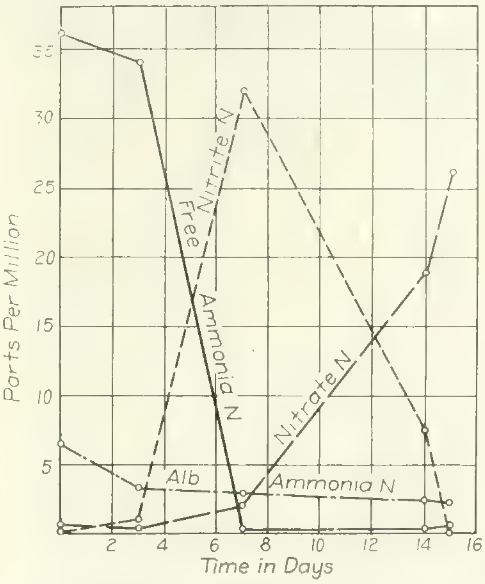


Fig. 2—Diagram Showing Progress of Nitrification of Aerated Sewage with Uniform Distribution of Air through Porous Plate—No Activated Sludge Present.

From these chemical data the dried sludge would evidently have value as a fertilizer. If we calculate the value as 20 cts. per pound of nitrogen and 12 cts. per pound of phosphorus, it would have a market value of $29 per ton. In order to determine whether the theoretical value would correspond to the actual value pot cultures have been started. Four pot cultures were started. Portions of dried sludge were added to two pots (Nos. 3 and 4) in Fig. 4, an equivalent amount of nitrogen from dried blood to another (No. 2), and no nitrogen to the fourth (No. 1). At the end of 18 days the cultures containing the dried sludge show better growths than the culture containing an equivalent amount of nitrogen from dried blood and far better growth than the culture to which no additional nitrogen was added.

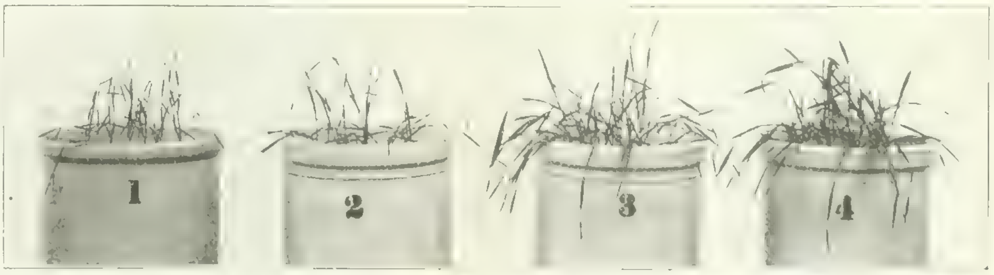


Fig. 4—View of Pot Culture of Wheat 23 Days after Planting to Show Fertilizing Value of Activated Sludge.

(Each pot contains pure sea sand to which the same amount of plant foods except nitrogen has been added. No. 3 contains 20 grams of dried activated sludge. No. 4 contains the same amount extracted with ligroin. No. 2 contains an equivalent of nitrogen from dried blood and No. 1 contains no nitrogen.)

A plant to operate on a larger scale is under construction in which to continue the experiments.

Municipal Garage Records, Oakland, Cal.

The municipal garage was established in March, 1913, with 18 automobiles in city service. There are at present 38 machines in service according to the report of the Department of Streets, William J. Baccus, Commissioner, for 1913-14. The Department has assumed not only the care of these machines, such as washing, supplying with gasoline, oiling, and caring for ordinary running repairs, but has also undertaken the complete overhauling or rebuilding of the machines when they have run 10,000 miles or more. All repainting, body-building and re-upholstering is now done by the department. Complete check is kept on the use of all machines by an "In-and-Out" register; complete check is kept on the handling of the machines by the "Efficiency Marking System on Auto Drivers;" and segregated cost against each machine gives complete check on operation. An analysis of the garage statement for the year 1913-14 shows the following:

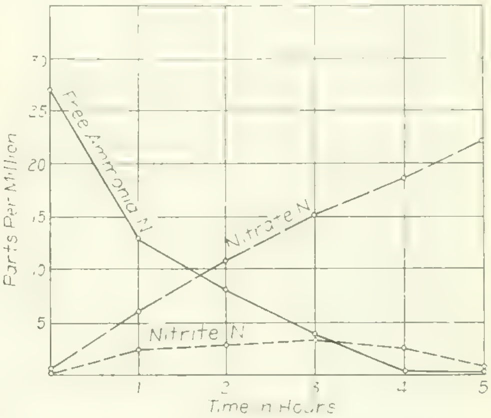


Fig. 3—Diagram Showing Nitrification of Aerated Sewage in Presence of Activated Sludge—Ratio of Sludge to Sewage 1:5.

A total maintenance charge on autos of	$17,541.34
An average charge per machine of	501.17
An average mileage per car, miles	6,683
Average cost per mile (including repairs and overhauling)	0.075
Total charge for gasoline	2,864.20
Total overhead charge to machines due to shortage in charge on supplies, material and time	337.39

The average cost of $501.17 covers the overhauling of 15 cars and the repairing of 12 cars. Experience has demonstrated that economy and high efficiency requires the rebuilding or complete overhauling of a car after it has run 9,000 to 10,000 miles. This requires the rebuilding of practically every car once a year. Two men working together can overhaul a car every two weeks on an average, or an equivalent of one month for one man. To overhaul 38 cars in a year requires the full time of 3⅙ men.

BRIDGES

Construction Features of the Reinforced Concrete Cantilever Bridge on Runnymede Ave., Cincinnati, Ohio.

(Staff Article.)

In our issue of March 24, 1915, we described and gave detail drawings of the design features of the reinforced concrete cantilever bridge on Runnymede Ave., Cincinnati, Ohio. In this article we shall consider the construction features of this bridge. The structure consists of a central span of 65 ft. in the clear and two cantilever arms of 32-ft. 6-in. span each. The piers have spread footings resting on hard blue clay, while the reinforced concrete abutments (which are essentially retaining walls but also act as anchorages and supports for the cantilever spans) are founded on reinforced concrete piles. The superstructure consists of two curved girders which support a beam-and-slab floor system. The bridge, which is on a 5 per cent grade, has a clear roadway of 24 ft. and two 5-ft. clear sidewalks. A reinforced concrete railing surmounts both the main structure and the abutment wing-walls.

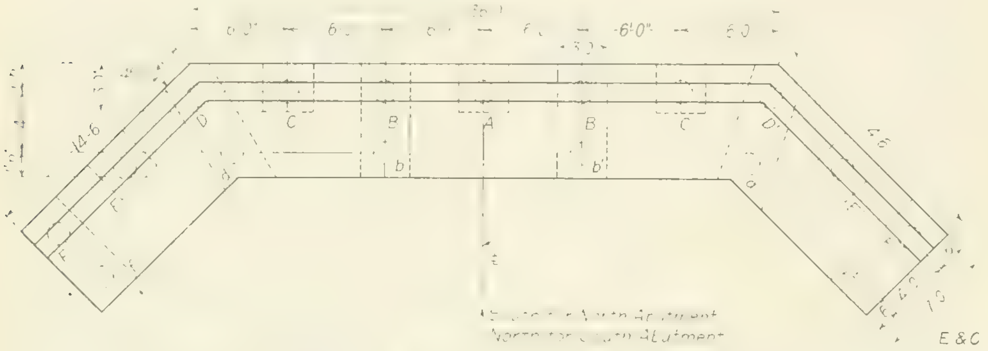


Fig. 1—Footing Plan of Abutments Showing Location of Reinforced Concrete Piles—Runnymede Ave. Bridge, Cincinnati, O.

TABLE I.—DATA ON CASTING AND DRIVING OF REINFORCED CONCRETE PILES.

North Abutment.

Pile*	Total length		When moulded	When driven	No. of blows	Penetration	Length driven	
	Ft.	In.	1913.	1914		In	Ft.	In.
F'	30	6	Nov. 24	Feb. 11	50	1	21	0
E'	30	6	Nov. 24	Feb. 11	60	3	25	0
D'	30	6	Nov. 24	Feb. 11	280	8	24	6
C'	30	6	Nov. 21	Feb. 11	150	8	23	3
B'	30	6	Nov. 21	Feb. 10	150	8	22	6
A	30	6	Nov. 21	Feb. 10	70	2	22	0
B	30	6	Nov. 28	Feb. 10	150	4	24	[illegible]
C	30	6	Nov. 28	Feb. 10	120	8	23	0
D	30	6	Nov. 28	Feb. 10	200	8	24	6
E	30	6	Dec. 22	Feb. 11	40	1/2	22	6
F	30	6	Dec. 22	Feb. 11	70	1	21	0
b'	25	6	Dec. 6	Feb. 10	12	1	22	0
b	25	6	Dec. 6	Feb. 10	10	3	21	6
d'	25	6	Dec. 6	Feb. 11	35	3	24	6
d	25	6	Dec. 29	Feb. 11	50	3	25	0
f'	25	6	Dec. 29	Feb. 11	60	5	21	0
f	25	6	Dec. 29	Feb. 11	50	3	25	0
			South	Abutment.				
F'	30	6	Dec. 10	Apr. 6	10	1/2	22	0
E'	30	6	Dec. 10	Apr. 6	10	5/8	16	6
D'	30	6	Dec. 16	Apr. 6	10	[illegible]	17	6
C'	30	6	Dec. 16	Apr. 6	10	3/8	22	0
B'	30	6	Dec. 16	Apr. 6	10	1/2	19	6
A	30	6	Dec. 10	Apr. 6	10	1/2	19	6
B	30	6	Dec. 13	Apr. 6	10	1/2	19	0
C	30	6	Dec. 13	Apr. 6	10	[illegible]	19	6
D	30	6	Dec. 22	Apr. 6	10	1/2	22	0
E	30	6	Dec. 19	Apr. 10	10	1/2	20	0
F	30	6	Dec. 19	Apr. 10	10	1/2	19	0
b'	25	6	Dec. 22	Apr. 6	10	7/8	19	0
b	25	6	Dec. 13	Apr. 6	10	1/2	18	0
d'	25	6	Dec. 22	Apr. 10	10	7/8	21	0
d	25	6	Dec. 25	Apr. 10	10	1/2	21	0
f'	25	6	Dec. 25	Apr. 6	10	3/4	20	0
f	25	6	Dec. 25	Apr. 6	10	1/2	19	0

*See Fig. 1 for location.

PILE FOUNDATIONS FOR ABUTMENTS.

On account of the depth to a firm foundation material, it was decided to support the abutments and wing-walls on reinforced concrete, pre-cast piles. The footings, as constructed, extend only a few feet below the original ground surface; the present fill practically buries these abutments. The piles were cast in two lengths—30 ft. 6 ins. and 25 ft. 6 ins.—each abutment containing 17 piles. Figure 1 shows the arrangement of the piles in the footings; piles *b, d, f, b', d'* and *f'* have a length of 25 ft. 6 ins.; all others have a length of 30 ft. 6 ins. The piles are hexagonal in shape, with a long diameter at the top of 12 ins. and at the bottom of 8 ins.; the end 6 ins. being beveled to form a point.

After being cast the piles were thoroughly seasoned before being driven. The data in Table I give the dates when each pile, for both abutments, was moulded and driven.

In driving the piles a No. 1 "Union Iron Works" steam hammer was used. The weight of the ram was 1,548 lbs., the stroke of the hammer 21 ins., and the average number of blows per minute 110. The steam pressure varied from 80 to 100 lbs. per square inch, and the weight of the hammer plus the effect of the steam pressure at 80 lbs. per square inch exerted a blow of 5,800 lbs.

Each pile was driven until its carrying capacity, as indicated by the "Engineering News" formula, was at least 25 tons. The length of pile actually driven, for each pile, and the number of blows required to give the penetration upon which its carrying capacity was computed, are given in Table I. By referring to the data contained in this table, it will be noted that there is considerable variation in the driven length of the various piles and in the number of blows required to secure a given penetration. The piles were driven through strata of loam, sand and yellow clay to a stratum of hard blue clay—practically shale.

PIERS AND ABUTMENTS.

The reinforced concrete piers have spread footings resting on hard blue clay. For the south pier shafts the bottoms of the footings extend 27 ft. below the pier caps, which are directly below the spring line of the curved longitudinal girders (see Fig. 3). The footings of the north abutment extend 24 ft. 6 ins. below the pier caps. These footings are 11x16 ft. x 3 ft. high. The south pier shafts have dimensions of 6 ft. x 11 ft. at the bottom and 3 ft. x 7 ft. at the top, while the north pier shafts are 6 ft. x 10 ft. 7 ins. at the bottom and 3 ft. x 7 ft. at the top; the heights of the south and north shafts are 24 ft. 0 in. and 21 ft. 6 ins., respectively.

An outline drawing of the footings for the abutments and wing-walls is shown in Fig. 1. The abutments have a height, from bottom of footing to top of wall, of 17 ft. 1½ in. They are of the cantilever type of reinforced concrete construction, the thickness of wall being 14 ins. The wing-walls make an angle of 45° with the axis of the bridge.

In concreting the substructure the concrete was chuted to place from a 40-ft. tower located near the south (higher) abutment. The concrete was mixed in a batch mixer of ⅓ cu. yd. capacity. Figure 2 is a view of the bridge site showing the concreting equipment, the view being taken directly after the completion of the substructure work. The view

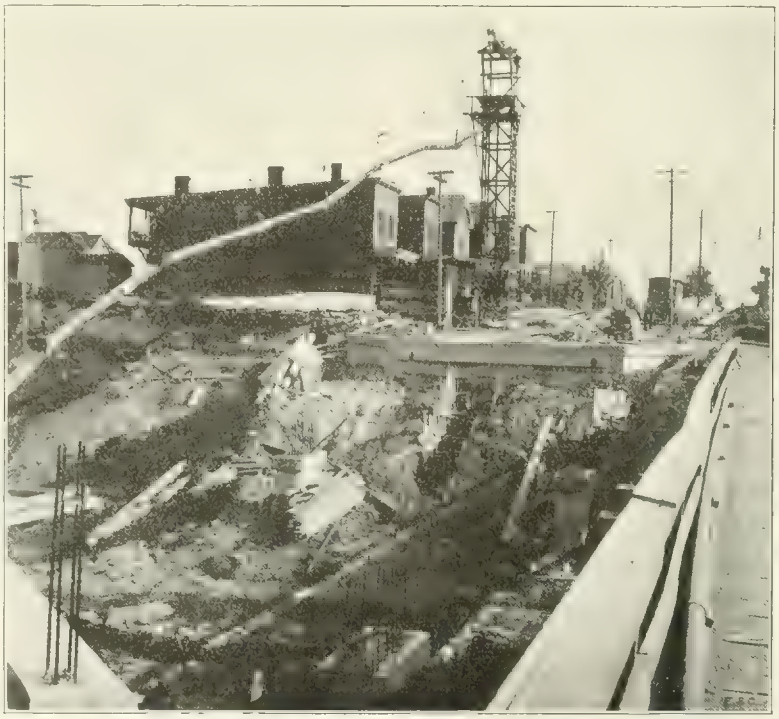


Fig. 2—View, Looking South, of Substructure and Concreting Equipment for Runnymede Ave. Bridge—Piers and Abutments Completed.

shows clearly the projection on the south abutment, which forms an anchorage and support for the cantilever span. The "cut-offs" from the foundation piles are shown in a pile near the south abutment (see Fig. 2). During the construction of the bridge the traffic was carried on a temporary plank roadway, placed along the west side of the bridge site.

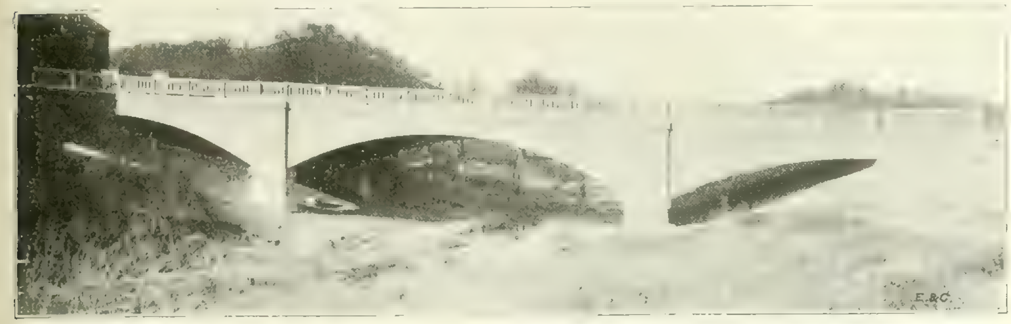


Fig. 3—View of Completed Runnymede Ave. Bridge—Reinforced Concrete Cantilever Type.

SUPERSTRUCTURE.

As has been noted, the superstructure consists of a center clear span of 65 ft. and two cantilever spans of 32 ft. 6 ins. each. The two main longitudinal girders, which are spaced 34 ft. on centers, are curved, as shown in Fig. 3, and carry a beam-and-slab floor.

In order to give a clear waterway under the center span during construction, two 24-in. 80-lb. I-beams, each about 80 ft. long, supported by timber grillages spaced about 60 ft. apart under each beam and connected transversely by 12x12-in. timbers, were used to carry the form work.

The superstructure was poured in two sections, the north half, from the abutment to the middle of the center span, being constructed first.

The panels of the reinforced concrete railing were cast separately in a wooden form laid flat on the ground, and were placed in position and brought to line and grade after the posts were cast, the latter being poured in place. The wood forms used were lined with sheet iron, and it was found after the forms were removed that a neat, even surface finish was secured with very little rubbing. Both the panels and the railing posts were made of a 1:3 cement mortar.

The roadway slab was waterproofed with a layer each of burlap and felt saturated and coated with coal tar pitch. The pavement consists of 4-in. vitrified brick laid on a 2-in. sand cushion, the joints being filled with cement grout.

TABLE II.—QUANTITIES OF MATERIALS AND ITEMIZED COSTS OF THE BRIDGE.

	Unit cost	Total cost
Removal of old bridge and abutments		$ 150.00
Grading, 2,636 cu. yds.	$ 0.50	1,318.00
Trench excavation, 1,460 cu. yds.	1.00	1,460.00
Concrete piling, 977 lin. ft.	1.60	1,563.20
Reinforced concrete, 784 cu. yds.	14.50	11,368.00
Waterproofing, 392 sq. yds.	0.50	196.00
Brick paving, 379 sq. yds.	1.40	530.60
Bituminous macadam, 472 sq. yds.	1.00	472.00
Cement curbs, 128 lin. ft.	1.00	128.00
Cement walks, 1,730 sq. ft.	0.10	173.00
Concrete railing, 346 lin. ft.	1.50	519.00
Drains, 12-in. pipe, 99 lin. ft.	1.00	99.00
Total cost		$18,276.80

Figure 3 is a view of the completed structure, taken after the grading work was finished. The original ground surface at both abutments was considerably lower.

QUANTITIES OF MATERIALS AND COSTS.

The total cost of the bridge, including the removal of the old structure, was $18,276. Table II gives the actual quantity of material, and the unit and total cost, of each item of the bridge.

PERSONNEL

The bridge was built by Roos Brothers, Cincinnati, O., under the supervision of F. S. Krug, chief engineer, Engineering Department, City of Cincinnati, Frank L. Raschig, principal assistant engineer, Paul Laur, assistant engineer in charge of construction, R. N. Maxwell, inspector, and Edgar K. Ruth, assistant engineer in charge of office and design. We are indebted to Mr. Ruth for the data upon which this article is based.

A Type of Reinforced Concrete Floor for Beam Spans Designed to Replace a Wooden Floor.

It is estimated that there are approximately 20,000 bridges in Minnesota, with only a small percentage of those built in the past few years of permanent types of construction. Many of the bridges in that state are wooden pile-bent spans, light steel-truss bridges, and wooden floorbeam spans, the joists of which are of insufficient strength to carry an ordinary concrete floor and a traction engine. The following data apply to a proposed design for a concrete floor to be constructed on joists which are lighter than are required by the present standard concrete floor. Some data are also given on the standard floor now in use. The data were taken from a paper by C. E. Nagel, engineer of bridges, Minnesota Highway Commission, presented before the recent meeting of the Minnesota Surveyors' and Engineers' Society.

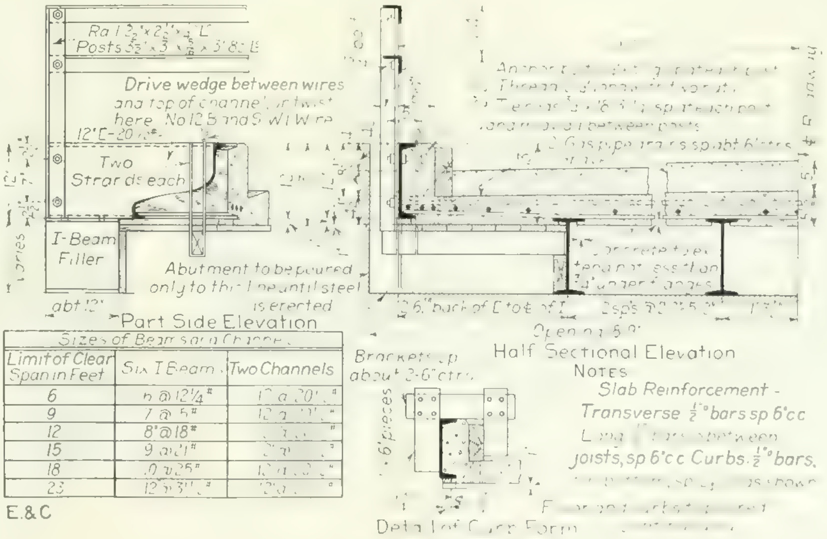

Rail 3½"x2½"x¼" L
Posts 3½"x3"x5/16"x3'8½" L
Drive wedge between wires and top of channel, or twist here. No. 12 B and S W. I. Wire
12" E-20
Two Strands each
I-Beam Filler
Abutment to be poured only to this line until steel is erected
abt 12"
Part Side Elevation
Sizes of Beams and Channels
Limit of Clear Span in Feet | Six I Beams | Two Channels
6 | 6 @ 12¼#
9 | 7 @ 15#
12 | 8" @ 18#
15 | 9 @ 21#
18 | 10 @ 25#
23 | 12
Brackets sp. about 2-6" ctrs.
6' pieces
Detail of Curb Form
Half Sectional Elevation
Opening 5.0"
2'6" back of E to E of I
Notes
Slab Reinforcement -
Transverse ½" bars sp 6" cc
Long. ½" bars between joists, sp 6" cc Curbs ½" bars.
E.&C

Fig. 1—Details of Standard Beam Spans with Reinforced Concrete Floors of Minnesota Highway Commission.

STANDARD CONCRETE FLOOR.

In the present standard concrete floor the top flanges of the I-beams are embedded 1 in. in the bottom of the concrete slab, the latter being 5½ ins. thick at the center and 4½ ins. thick at the sides.

The slab reinforcement consists of ½-in. square rods spaced 6 ins. on centers and running transversely with the roadway, with three longitudinal rods of the same size in each space between the I-beams.

The position of the outside channel is somewhat different from the customary placing of it, as it is raised by placing 1-ft. lengths of I-beams (of the same size as the I-beam joists) under the ends of the channels. The curb and the outside edge of the floor are poured against this channel which acts as a form. For spans up to 23 ft., 12-in. channels are used, and for spans ranging from 24 to 30 ft. 15-in. channels are used. The channels are tied together with ¾-in. rods placed at each rail post and midway between the posts to prevent their lateral deflection when the concrete is poured. Figure 1 shows the details of beam spans with reinforced concrete floors now in use.

PROPOSED DESIGN.

In the proposed design the slab is raised above the tops of the slab about 2 or 3 ins., and is supported at the end of the span on concrete, which is carried up on top of the abutments and embeds the ends of the joists. In addition to this the slab will be supported at the quarter points of the joists by concrete girders built integral with the slab and running transversely with the roadway, these girders being reinforced both at the top and at the bottom. The bottom of the girder is about 2 ins. below the top of the joists, the girder being about 12 or 18 ins. wide.

The chief advantage of this design is that the wheel loads are carried at the quarter points of the joists, the maximum moment thus being only three-fourths as large as if these loads were carried at the center of the joists. The maximum dead load moment with the quarter-point loading is three-fourths of the dead load moment produced by the ordinary slab, as one-eighth of the slab at each end is supported directly by the abutment.

It is necessary to reinforce this slab in both the top and bottom in a longitudinal direction, the extra reinforcing steel amounting to little more than the difference in weight between the smaller joists thus made available and the heavier joists which otherwise would be necessary.

The form work for the new design is considerably less expensive than that required for the floor now used, as the boards are run across the top of the joists and are wedged up on top of the top flanges. After the concrete in the floor has set the wedges are driven out and the boards removed.

The present construction requires that the forms be cut in width to fit between the I-beams, these forms being carried on supports resting on the bottom flanges.

The dead load will be considerably lessened by using a 1-in. bituminous concrete wearing surface in place of the present 4-in. gravel covering.

Preliminary computations indicate that, with the new design, 7-in. I-beams may be used in place of the 9-in. ones now required, 10-in. I-beams in place of 12-in., and 12-in. beams in place of the present 15-in. beams.

It is estimated that the use of the new type of slab will result in a saving of 40 per cent in the maintenance cost of the floor. As the type of slab now in use requires the replacing of the light joists in order to use a concrete floor, the yearly cost of the slab and the new joists will about equal the cost of maintaining the plank floor.

Methods and Equipment Used in Renewing Bridges Under Traffic on the Wheeling & Lake Erie R. R.

(Staff Article.)

During the spring of 1914 the Wheeling & Lake Erie R. R. dismantled eleven 130-ft. through Pratt truss spans located over Short Creek on the east end of its Toledo division. These bridges were designed for Cooper's E-35 loading, and were fabricated and erected by the Edgemoor and Toledo bridge companies in 1897. Four of the spans were straight and are to be utilized for other locations; the remainder were skew spans and were scrapped. The replacement of these spans was made necessary by the use of heavy locomotives, practically equivalent to Cooper's E-60 loading. On the Toledo division two new 65-ft. deck plate girder spans were erected, while on the Cleveland division a 155-ft. through truss span was replaced by two 77-ft. deck plate girder spans. The new bridges were designed in the bridge department of the Wheeling & Lake Erie for Cooper's E-60 loading; they were fabricated by the American Bridge Co. and by the King Bridge Co. The methods used in dismantling the old truss spans and erecting the new girder spans were practically the same in all cases. The following data apply to the replacement under traffic of a 130-ft. truss span at Herrick, O. (on the Toledo division), by two 65-ft. deck girder skew spans.

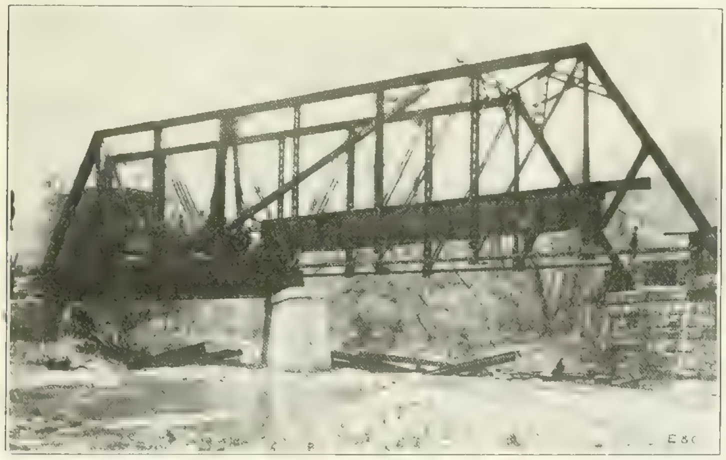


Fig. 2—View Showing Manner of Placing First 65-Ft. Girder Span—Bracing and Floor System Removed from Half of Truss Span.

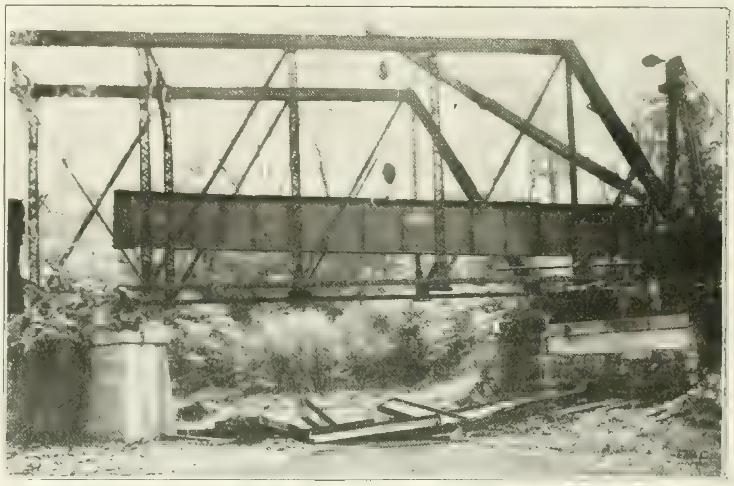


Fig. 3—View Showing Derrick Car Placing Second 65-Ft. Girder Span—Portal Bracing at One End Still in Place.

EQUIPMENT AND METHODS USED.

The work of replacement was done with a derrick car, specially fitted for this purpose. The "A" frame of the derrick had a height of 23 ft., the boom having a length of 47 ft. and a carrying capacity of 20 tons. The three-drum hoist was equipped with 10x12-in. cylinders, and was operated by a "Lambert" engine. The car had a capacity of 100,000 lbs. and weighed 39,000 lbs.

In dismantling the truss spans all rivets in the floor system and in the top bracing were first removed and replaced with bolts, the trains being operated over the structure at a reduced speed. During a suitable interval between trains the track was torn up, and the contractor's crew removed one of the portals and the sway bracing at the two adjacent panel points (see Fig. 1). The four end panels of the floor system were then removed, and the girders of the first span set in place, all material being handled by the derrick car (see Fig. 2).

The laterals and cross-frames were placed in the first girder span and bolted up. The track was then laid on this span, and the gap between the new girders and the old floor system was closed with the old stringers. The traffic was then resumed, being carried for 65 ft. on the new girder and for the remainder of the distance on the old structure.

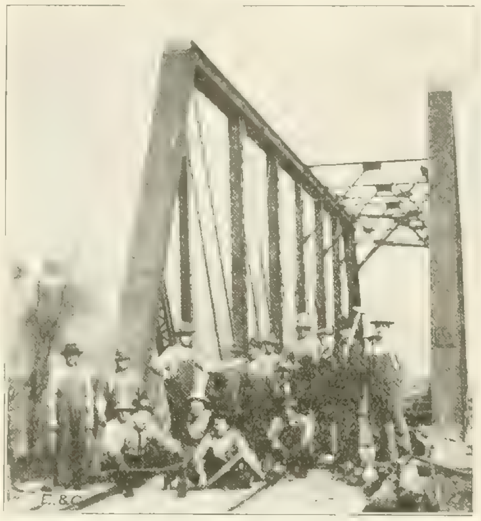


Fig. 1—View Showing 130-Ft. Through Truss Bridge Ready for Placing First Girder Span.

At the next suitable interval the two remaining intermediate struts and all of the old floor system were removed, the end portal being left in place to hold the trusses in position. The second span of girders was then set (see Fig. 3), the track was replaced and the traffic carried over the new structure.

To support the trusses during their demolition two inverted gallows bents were used, one being suspended from each girder span. Figure 4 shows an end elevation of these bents and illustrates the manner of suspending them from the girders and of supporting and bracing the trusses. As shown in the drawing, two 9x18-in. yellow pine stringers were placed below the trusses from the bents to the piers, the old trusses being supported on these stringers. The intermediate posts of the trusses in the planes of the gallows bents were bolted to the 12x12-in. uprights to these bents; and the trusses were dismantled in this position and loaded onto cars.

For spans where the trusses were to be saved a change of one 65-ft. span was made in about 3½ hours. However, on the spans where it was unnecessary to handle the old trusses with care it was possible to remove the entire floor system from a 130-ft. span, to place two 65-ft. girder spans, to lay the track, and to have the bridge ready for traffic in about 3 hours 40 minutes.

PERSONNEL.

The old truss spans were dismantled and the new girder spans erected by the Ferro Construction Co., Chicago. The work was done under the direction of W. L. Rohbock, chief engineer of the Wheeling & Lake Erie R. R., to whom we are indebted for the data contained in this article.

Effect of Proportions on Density and Strength of Gravel Concrete.

The strength and density of concrete depend to a considerable extent upon the proper selection, grading and proportioning of its ingredients, yet it is difficult to insure adequate consideration of these items. In a paper by R. W. Crum, presented before the recent meeting of the Iowa Engineering Society, this subject was considered, and some data on the results of tests and investigations were given. The following data from this paper apply to the proper proportioning of concrete after satisfactory materials have been obtained.

PROPORTIONS AND STRENGTH.

There are two general laws which express the effect of the proportions upon the strength of concrete; these are: (a) With the same aggregate the strongest concrete is that containing the most cement in a given volume; and (b) with the same amount of cement in a given volume the strongest concrete is that which has the greatest density. The degree to which the strength varies as the density has often been underestimated.

A determination of the percentage of voids is valuable as an indication of the quality of the material, but it is of little use as an aid to accurate proportioning. The methods proposed for determining the best proportions to use for a given case are based on the density of the resulting concrete. They consist in determining the mixture that will yield the least volume of concrete for a given weight of materials. The proper relation of fine to coarse aggregate can be more readily determined than the relation between cement and aggregate. For example, sieve analysis curves may be used for combining materials, or for grading different size materials, or for screening and remixing.

There is one class of material which is used extensively in Iowa to which the law of density especially applies, namely, pit run gravels used without screening. It is in the use of this material that lack of appreciation of the effect of density upon the strength has caused the manufacture of a vast quantity of poor concrete.

It is customary to state the proportions of concrete as a ratio between cement, sand and stone. Since, in natural gravels, sand and stone occur together, it is often assumed that the fine and coarse material already bear the proper relation to each other, and the proportion is stated as a ratio between cement and gravel. This assumption is far from being a true one. To a man who has the law of density in mind the statement of a proportion such as 1:6 has absolutely no significance as to the quality of the resulting concrete. For his use both that portion of the gravel which may be called sand and that which may be called coarse aggregate must be known. The proportion 1:6 may be 1:2:4, or 1:3:3, or even 1:5:1. Which of these three would be the strongest, or would they all be the same? Since the amount of cement is constant the density of the concrete would decide.

PROPORTION FOR MAXIMUM DENSITY.

Considering just two divisions of the material, it has been shown by Fuller and Thompson that for gravel aggregate of 1 in. maximum size, to attain maximum density, the amount of material larger than ⅛ in. in diameter should be approximately twice the material less than ⅛ in. in diameter. The farther we get away from this relation the less dense will be the concrete. The first of the above combinations (1:2:4) would approach nearest to the maximum density and would be the strongest, and the last (1:5:1) would be very much the weakest.

Consider a gravel in which the ratio of sand to coarse aggregate is 5:1. How shall we use this material to make concrete equivalent to the 1:2:4? Since the density will be less, the only other procedure is to increase the total amount of cement. It is generally considered that if the ratio of cement to sand is the same for both cases equivalent concrete will result. This would make our proportion 2½:5:1 or 1:2:2/5, or 1 part cement to 2 2/5 parts of gravel, instead of 1:6.

On large and important projects where it is possible to screen the material into a number of sizes and then remix, the sieve analysis curve of maximum density will indicate the quantity of each size to use. But on a large amount of important work in small units the method outlined will be the only feasible one.

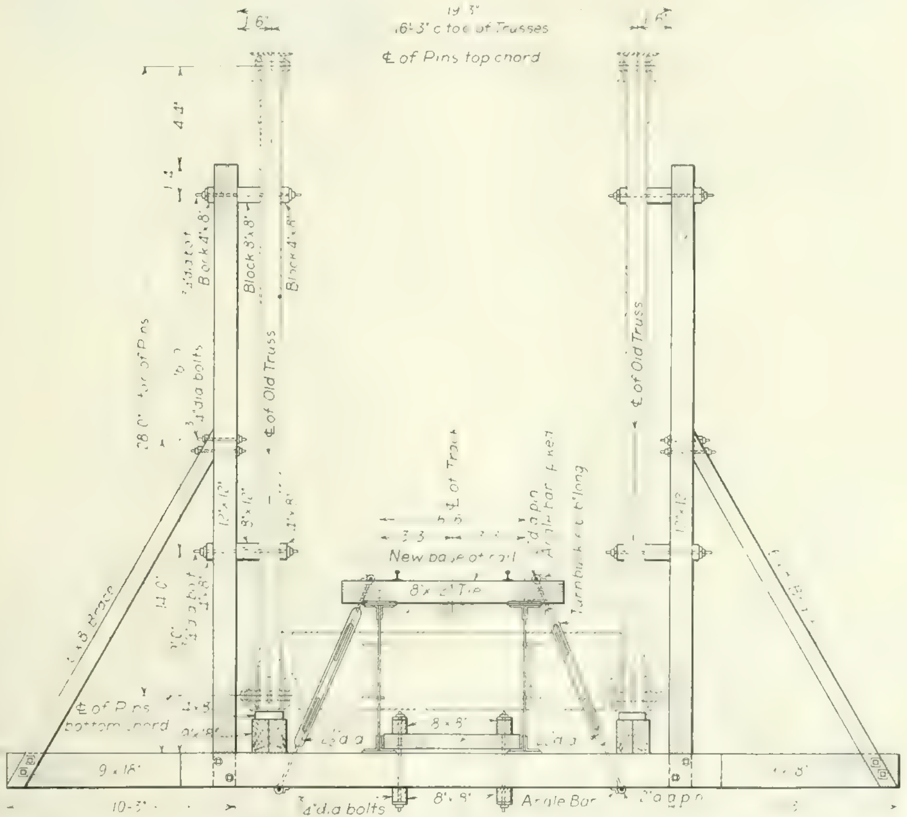
For most natural sands maximum density will occur when the cement is about one-half of the sand. The ratio, 1 cement to 2 sand, is commonly used as correct for reinforced work and water-tight concrete.

In selecting a sample of the gravel for investigation, one should be careful to get a sample truly representative of the supply. It should be borne in mind that gravels are frequently variable in composition, and it may be necessary to change the mix at frequent intervals.

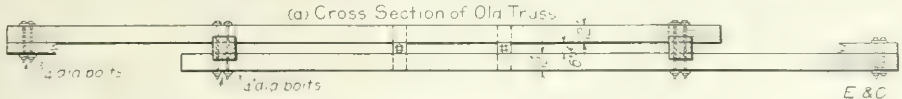
Extreme accuracy in determining the relative quantities of sand and coarse aggregate is not necessary since common methods of measuring materials make it advisable to state proportions in round numbers. In practice the proportion 1:2 2/5 (determined above) would become 1:2½.

Instead of making this a 1:2½ mixture, the 1:2:4 proportion might be maintained in either of two ways, namely, the excess fine material might be screened out; or the necessary coarse material might be added from another source.

As to which of the three methods of arriving at the result in a given case should be used is entirely a matter of cost. The comparative costs can be readily computed if the local conditions are known.



(a) Cross Section of Old Truss



(b) Section A-A

Fig. 4—Inverted Gallows Bent Used in Supporting Truss Span During Its Removal—Note Manner of Suspending Bent from Girder Spans.

RESULTS OF SOME TESTS.

For a laboratory demonstration of the effect of density upon the strength of concrete the writer had four tests specimens prepared, using as aggregate gravels containing different percentages of sand—namely, 40, 55, 75 and 95 per cent—and keeping the cement constant throughout. The ratio of cement to total aggregate in each case was 1 to 5, but the actual proportions were 1:2:3, 1:2¾:2¼, 1:3¾:1¼ and 1:4¾:¼. The first stated mixture comes nearest to 1:2:4 conditions, and the others vary from this mixture in the order stated. The ratio of sand to coarse aggregate in the specimens was determined by weight. (In making such an analysis by volume measurement the resulting percentages will always total more than 100 per cent, but they will be practically in agreement with measurements by weight if the results of such measurements are reduced to their proportionate part of 100.) The specimens were tested at the end of 12 days. Table I gives the results of these tests. The cost of the materials per cubic yard of concrete for specimen No. 1 was $2.63, and that for specimen No. 3, $2.44.

TABLE I.—RESULTS OF TESTS OF 1:5 GRAVEL CONCRETE SPECIMENS CONTAINING VARIOUS PROPORTIONS OF SAND TO COARSE AGGREGATE.

Specimen No.	Per cent sand to coarse aggregate.	Proportions.	Density.	Strength, lbs. per sq. in.
1	40	1:5 (1:2:3)	0.789	1,600
2	55	1:5 (1:2¾:2¼)	0.770	1.200
3	75	1:5 (1:3¾:1¼)	0.737	800
4	95	1:5 (1:4¾:¼)	0.680	240

To show to what degree the strength may be held up, the data in Table II are given. The specimens in these tests were made from the same materials as were used in the tests recorded in Table I; the specimens were tested at the age of 7 days.

TABLE II.—RESULTS OF TESTS SHOWING STRENGTH OF VARIOUS MIXTURES.

Specimen No	Per cent sand to total aggregate.	Proportions.	Density.	Strength, lbs. per sq. in.
1	42	1:4¾ (1:2:2¾)	0.784	1,872
2	53	1:3¾ (1:2:1¾)	0.775	1,792
3	75	1:2⅔ (1:2:⅔)	0.709	2,120
4	95	1:2 1/10 (1:2:1/10)	0.712	2,360

It will be noted that the strength of the specimens reported in Table II increases with the proportion of sand in the total aggregate. It is possible our assumption that the ratio of cement to sand should be constant for equal strengths is too liberal, and that the cement may be decreased somewhat with safety.

The data recorded in Tables I and II are the results of one of 24 series which are being made at the Iowa Engineering Experiment Station to investigate these conditions. Each value is the average of five 8x16-in. concrete cylinders. It is the purpose of the investigation to eliminate uncertainties as much as possible by using sands from several localities, by using different proportions of cement to sand, and different division lines between sand and gravel.

Construction Work in Russia.—It is reported that the city of Petrograd is planning to install a $35,000,000 water supply system and a $60,000,000 sewerage system. It is also said that rapid expansion in general building work is expected in Russia and simultaneously the extension and building of numerous railway lines.

WATER WORKS

Method and Cost of Making Test Borings for the Winnipeg Shoal Lake Aqueduct.

Contributed by Douglas L. McLean, Assistant to the Chief Engineer.

In connection with the extensive field investigations undertaken by the Greater Winnipeg Water District and pushed forward under the direction of W. G. Chace, Chief Engineer, during the winter of 1913-14 for the location of the aqueduct and appurtenant works from Intake Site, Shoal Lake, to the city of Winnipeg, considerable boring and test pit work was carried out. At the Intake Site and the Falcon River Crossing a number of wash borings were made by Party No. 3 of which the writer had charge. Hand auger borings were also made by this party for the location of the aqueduct from the intake across the summit some ten miles westward to Boggy River. Mr. R. T. Sailman, who had considerable experience on deep drilling in New York state, was detailed from the Head Office to assist on this work, as well as to look after the entire underground explorations along the line to Winnipeg.

TABLE I.—HAND AUGER TEST BORING COST DATA, WINNIPEG, AQUEDUCT.
(Small "Empire Drill" earth auger used without casing as hand auger.)

	Totals.
Number of holes	29.0
Frost depth in feet, 1	55.9
Peat depth in feet, 2	234.1
Sand and gravel depth in feet, 3	0.9
Clay depth in feet, 4	409.7
Total depth in feet of 1, 3, 4	465.5
Total depth in feet of 2, 3, 4	644.7
No. of men per day, or man-days	65.8
Cost per day	$208.66
Work done from Feb. 1-28	Feet.
Average depth frost per hole	1.93
(This is frozen peat and water.)	
Average depth peat per hole	8.07
Average depth sand and gravel per hole	.03
Average depth clay per hole	14.10
Average total depth	22.20
Average cost per foot run, 1, 3, 4, cts.	44.8
Average cost per foot run, 2, 3, 4, cts.	32.4
Average cost per man-day	$3.175
Average man-days per hole	2.27
Average man-days per foot run, 1, 3, 4	0.141
Average man-days per foot run, 2, 3, 4	0.102
4-men gang—	
Average cost per day	$12.70
Average bored, 1, 3, 4, feet per day	28.4
Average bored, 2, 3, 4, feet per day	39.2

Note.—Cost of auger, axes, etc., not included in table.

These holes were about 2,000 ft. apart and considerable time was required transporting outfit and traveling to camp.

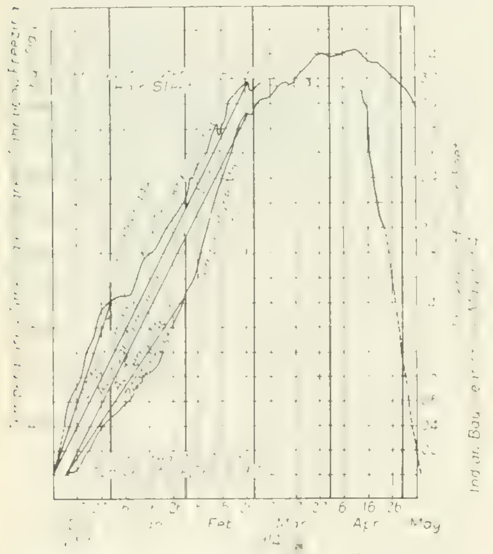


Fig. 1. Ice Thickness and Temperature Curves for Indian Bay, Shoal Lake, Greater Winnipeg Water District 1913-14.

Ice thicknesses measured on clear ice area 100 ft. x 50 ft. and each measurement taken at a new hole each day. Temperatures taken at 7 a. m., 12 m. and 7 p. m. Average of these taken for daily mean.

TABLE II. — HAND AUGER TEST BORING COST DATA, WINNIPEG AQUEDUCT.

	Total.	Totals to April 22.
Number of holes	396.0	370.0
Frost depth in feet, 1	759.6	759.6
Peat depth in feet, 2	2,608.9	2,490.9
Sand and gravel depth in feet, 3	59.3	59.3
Clay depth in feet, 4	3,530.8	3,352.3
Total depth in feet, 1, 3, 4	4,349.7	4,171.2
Total depth in feet, 2, 3, 4	6,199.0	5,902.5
No. of men per day, man-days	245.9	236.9
Cost per day	$690.10	$662.70
Summary of results to April 22—		
Average depth frost per hole, feet		2.05
Average depth of peat per hole, feet		6.73
Average depth of sand and gravel per hole, feet		0.16
Average depth of clay per hole, feet		9.06
Average total depth, feet		15.95
Average cost per foot run of 1, 3, 4, cts		15.9
Average cost per foot run of 2, 3, 4, cts.		11.2
Average cost per man-day		$2.80
Average man-days per hole		0.64
Average man-days per foot run, 1, 3, 4		0.057
Average man-days per foot run, 2, 3, 4		0.040
3-man gang		
Average cost per day		$8.40
Average bored, 1, 3, 4, feet per day		52.8
Average bored, 2, 3, 4, feet per day		75.0
Cost of equipment—		
3 rod augers at $10.70		$32.10
6 spanners at 20 cts		1.20
3 monkey wrenches at 70 cts		2.10
1 pipe auger at $15.00		15.00
4 10-qt. galv. pails at 21 cts		.84
1 doz. 3½-lb. axes at $1.00		12.00
Total		$63.24

This equipment cost is not included in table.

This work was carried on under the severe climatic conditions of a Manitoba winter. Maximum ice conditions on Shoal Lake from December, 1913, to June, 1914, are shown graphically on Fig. 1. This chart shows the growth of the ice from day to day on an ice space kept clear of all snow. Corresponding to the curve of ice thickness is a temperature curve to show the amount of cold which produced this ice. In order to measure this in degrees below freezing over a stated period, the ordinates for the curve were taken as "degrees Fahrenheit below freezing times one day." The maximum depth of ice on snow covered portions of the lake was 2.3 ft. thick as compared to 3.2 ft. on clear space. On the peat bogs the depth of frost averaged about 2 ft. The maximum depth of frost encountered was 3.7 ft. in sandy soil while the minimum in sheltered snow covered places was 1.5 ft.

Fig. 2. View of Typical Open Peat Bog, Indian Bay Division, Winnipeg Aqueduct.

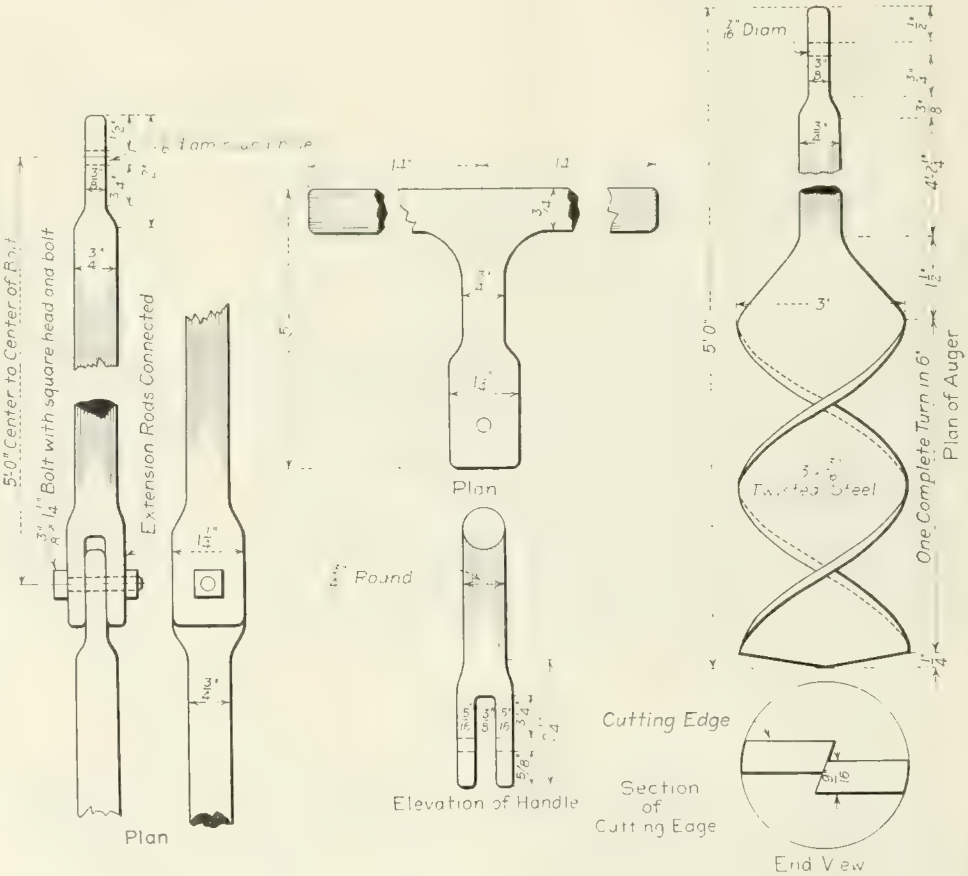


Fig. 3. Hand-Operated Rod Auger Used in Making Borings, Winnipeg Aqueduct.

The located line for the section of the aqueduct on which Party No. 3 made borings ran for the most part through a clay country covered with peat bogs. A view of this country is shown in Fig. 2. For the seven miles from Snake Lake to the Boggy River the peat bog averaged about 8 ft. in depth.

Cost data relating to a portion of the test boring work is given herewith under the following headings: (1) Salaries and board allowance. (2) Empire drill costs. (3) Hand auger costs. (4) Wash boring costs.

Salaries and Board Allowance.—The following were the standard rates paid by the Greater Winnipeg Water District:

Position.	Rate.
Instrumentman, per month	$100*
Leveler, per month	90
Topographer, per month	75 to $80
Field draughtsman, per month	60 to 70
Rodman, per month	40 to 45
Head chainman, per month	40 to 45
Rear chainman, per month	35
Head picketman, per month	40 to 45
Cook, per month	60 to 75
Cookee, per month	35
Leader, per day	1.75
Laborer, per day	1.50

*All grades where boarded free while in the field. An additional allowance of 15 cts. per day per laborer while on boring was given to make up for extra wear and tear on mitts and clothing.

For the boring costs given in this article a board allowance of $1.05 per working day has been charged.

Empire Drill Costs.—Total and average costs for 645 ft. of boring using the small auger drill spoon with necessary drill rods, wrenches and handles of a Junior Empire Drill Set, are given in Table I. The Junior Empire Drill Set ordered by the district cost $259.85 delivered at Winnipeg. It was supplied by the New York Engineering Co., whose catalog gives a complete description of its various parts. The test holes put down were at 2,000-ft. intervals, averaged 22.2 ft. in depth and cost 32.4 cts. per foot run, including the peat in the depth.

In opening up the holes through the frozen material axes were used on all hand auger work, as the axe was found more efficient than a chisel, crowbar or pick.

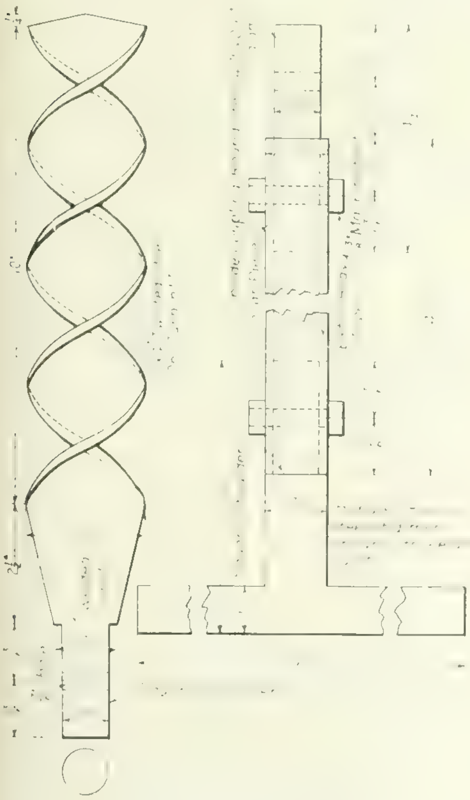


Fig. 4. Hand-Operated Pipe Auger Used in Making Borings, Winnipeg Aqueduct.

Hand Auger Costs.—Table II gives the cost of some 6200.0 ft. of boring for which was used the hand augers shown in Figs. 3 and 4. These hand augers give practically the same efficiencies for depths of 15 to 20 ft., but for depths under 15 ft. the pipe auger is the faster. The rod auger, Fig. 3, consisting of 1 auger piece, 1 handle, 5 extension rods with 12 extra bolts ⅜ in. x 1¼ ins., cost $10.70. To this should be added cost of a couple of spanners and a handle for lifting.

The pipe auger, Fig. 4, consisting of 1 auger piece, 5 rods with couplings and bolts, 1 handle, 1 extra set of bolts and 2 spanners, together with 2 only ⅜-in. steel chains 4 ft. long, with one grab and one slide hook attached to each, cost $15.

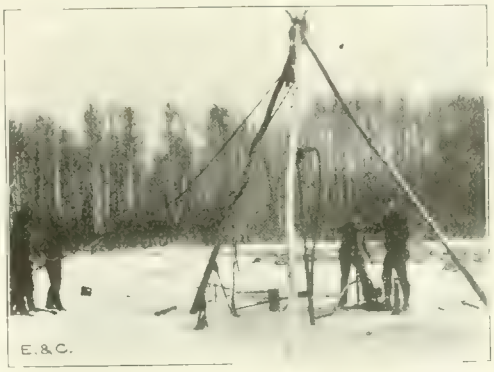


Fig. 5. General View of Wash Boring Outfit, Winnipeg Aqueduct.

TABLE III.—LIST AND COST OF EQUIPMENT FOR MAKING WASH BORINGS ON WINNIPEG SHOAL LAKE AQUEDUCT.

Quantity and description.	Unit price.	Cost.
50 ft. 2½-in. extra heavy pipe (drive casing) in 5-ft. lengths	$0.57	$28.50
Cutting and threading pipe	....	5.00
50 ft. 1¼-in. heavy pipe, five 4-ft. lengths and six 5-ft. lengths	.25	12.50
Cutting and threading pipe	....	3.30
10 2½-in. couplings	.16	1.60
11 1¼-in. couplings	.08	.88
1 malleable 1¼-in. tee	.16	.16
1 double run 10-in. wooden block	1.85	1.85
60 ft. ¾-in. manila rope, per lb.	.14	1.40
1 hand force pump R. 470—30 gals. per minute	7.00	7.00
2 24-in. Stillson wrenches	2.25	4.50
15 ft. 1½-in. discharge hose	.30	4.50
20 ft. 2-in. suction hose	.25	7.00
1 1¼-in. street elbow	.15	.15
1 1½-in. coupling for hose	.30	.30
1 2x1½-in. bushing	.10	.10
1 1½-in. short nipple	.10	.10
1 1½x2-in. nipple	.10	.10
1 drive weight 7 ins. diameter by 15 ins. long, 2-in. hole all the way through long dimension, widened to 3½ ins. from 4 ins. below top to top	....	....
3 ft. of ¼-in. flexible wire rope for handle	5.60	5.60
2 1½-in. chopping bits of drill steel with 1¼-in. threads 8 ins. long	6.00	12.00
6 pairs lumberman's rubbers, two buckles, sizes 10, 11 and 12	1.60	9.60
1 pipe vise to take 2½-in. to 1¼-in. pipe	2.00	2.00
1 2-in. foot valve	.45	.45
1 machinist's hammer	1.10	1.10
2 cold chisels	.35	.70
1 pair jacks, 2 ins. by 18 ins., with handles	6.80	13.60
Steel spindles for same, per lb.	.10	1.20
2 sleeve couplings, 1¼-in. W. T.	.10	.20
3 sleeve couplings, 2½-in. W. T.	.16	.48
2 1¼-in. nipples, 6 ins. long	.06	.12
2 1½-in. to 1¼-in. reducing couplings	.10	.20
2 1½-in. nipples, 6 ins. long	.08	.16
6 1-gal. pails	.21	1.26
1 pint machine oil, black	.15	.15
1 2-in. nipple, 6 ins. long	.10	.10
1 recovering tap	3.75	3.75
2 sister hooks	2.50	5.00
1 clasp for 2½-in. pipe	2.00	2.00
1 hoisting plug	1.75	1.75
6 couplings for 1¼-in. pipe (extra)	.08	.48
1 ice chisel	3.50	3.50
2 axes, 3½-lb.	1.25	2.50
1 air tight heater	2.10	2.10
1 length stove pipe	.10	.10
[illegible] chain tongs, No. 33 Vulcan	1.50	9.00
2 pairs extra leather (front and back) for piston of Meyer's low-down force pump	.35	1.40
3 logs for tripod	....	.
Delivery from C. P. R. station to to site (18 miles)	....	12.10
Total		$171.5[illegible]

Wash Borings Costs.—Wash borings were made for the Intake Site and at the Falcon River Crossing with a "string of tools" which, though complete for the purpose, was not as elaborate as that necessary for deep drilling. The list of equipment with cost of same, given in Table III, may be used for reference when similar work is contemplated.

With this equipment, a general view of which is shown in Fig. 5, the process of sinking the test holes was very simple and usually was as follows:

TABLE IV. — WASH BORINGS AVERAGE COST DATA FOR WINNIPEG AQUEDUCT.

Depth of—	Totals.	Average.
Water	523.0	...
Muck	45.3	
Clay	594.2	.
Sand	73.7	. .
Gravel	31.7	.
Depth of material bored	744.9	27.6
Total length of casing, includes ice, water and material	1,267.9	47.0
Labor and food cost	$404.75	$15.00
Cost per foot below lake bottom		$0.541
Total cost per foot of casing in ice, water, material		$0.319

The derrick or tripod, consisting of three logs, was set up over the station where a hole was cut through the ice and the depth of water obtained by sounding. After this suitable length of casing was put down; at the same time a hole for the pump suction was made and a fire was started in the heater to warm water, which facilitated the thawing of the tools. Then drill rods of the required length with chopping bit on lower end and hoisting water-swivel on upper end connected to derrick-rope and by hose to the force-pump, were put down inside the casing. The position of the bottom of the casing and the drill rods having been noted, the drill rods were churned up and down by means of rope over block attached to tripod. At the same time water was forced down the center of these rods to the outlet in chopping-bit and then up between the rods and the casing. The chopped material brought up by the water jet was noted by the leader in charge of the work. To sink the casing, chain tongs were attached and it was rotated. This rotation or turning of the casing to keep it free from sticking to the material drilled through, was the detail that added most to the speed of work, not only in sinking the casing, but more especially in the pulling of the pipe. This method of sinking the casing was not practical at all times and in such cases the drive weight was used to pound the casing down. After it had been used it was necessary to use the two

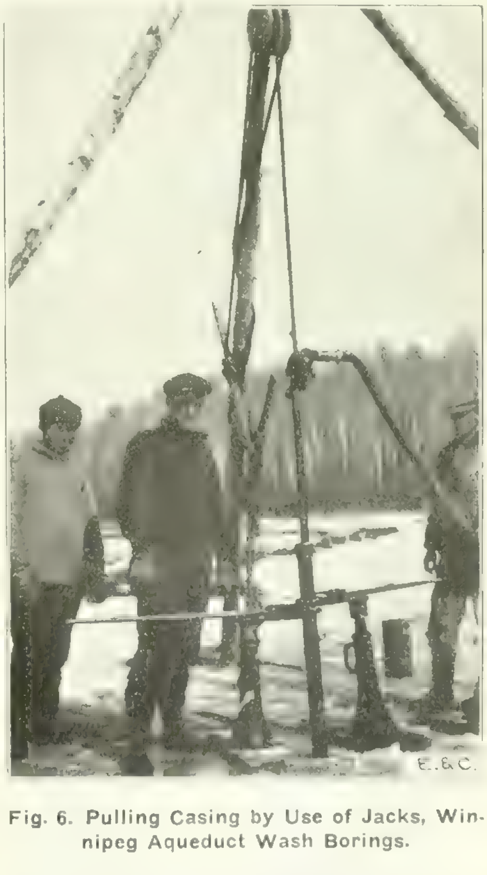


Fig. 6. Pulling Casing by Use of Jacks, Winnipeg Aqueduct Wash Borings.

jacks to draw the pipe as shown in Fig. 6. As the hole was sunk either by rotation of casing, or driving, constant watch was kept of the position of the bottom of the casing and the drill rods, together with careful note of the materials brought up by the water jet. For this particular piece of work at Indian Bay it was found advantageous to use a force of one leader or foreman, J. D. Logan, and four laborers.

The progress than can be made under winter conditions and the cost of same is given in Table IV. This gives total and average figures on the footage, the materials encountered and the labor and food costs and should be of use for information when similar work is contemplated. The force on this work usually consisted of 1 topographer at $3.95 and 3 laborers at $2.55 each, or 1 foreman at $2.80 and 4 laborers at $2.70. The work was done, with the exception of one day in December, between Jan. 9 and Feb. 27, 1914. The thickness of ice ranged fairly gradually from 1.46 ft. on Jan. 9 to 2.60 on Feb. 9. On that day the temperature dropped to —35° and work was discontinued until Feb. 24, when the temperature was +5° at 7 a. m. and the thickness of ice was 3.17 ft.

Cost of Excavating and Grading for a Small Pumping Plant.

Contributed by H. R. Ferriss, 203 Times Block, Victoria, B. C.

The following cost data pertain to the excavation for a pumping plant which, owing to certain requirements of the company, was placed completely underground and covered with grass.

The hole excavated was 18x38 ft. in plan by 11½ ft. deep, with a sump hole in one corner of 1½ cu. yds. The top 18 ins. of excavation was soft black loam, the next 2 ft. was clayey loam, and the rest of the excavation blue clay, requiring picking. The ground stood without bracing, and there was no trouble from water. Two good-sized boulders were removed from the hole.

Of the 292.5 cu. yds. excavated, 150 cu. yds. were hauled one mile over pavements and spread in place; 110 cu. yds. were hauled ½ mile over good roads and dumped without spreading. The balance, 32½ cu. yds., was back-filled.

Unfortunately, the foreman neglected to separate the team time hauling to each dump. The foreman sharpened the tools and assisted in various other ways with the labor. The cost data follow:

Item.	Time and Rate.		Amount.	Unit Cost.
Foreman	91 hrs.	44½ cts.	$ 40.50	0.138 per cu. yd. excavated.
Labor excavating	532 hrs.	30 cts.	159.60	0.545 per cu. yd. excavated.
Teams and extra wagon	123 hrs.	75 cts.	92.25	0.354 per cu. yd. hauled.
Spreading on dump	45 hrs.	30 cts.	13.50	0.090 per cu. yd. spread.
Backfill	20 hrs.	30 cts.	6.00	0.185 per cu. yd. backfill.
Delivery of tools			6.90	0.023 per cu. yd. excavated.

Design and Cost of New Middle System Reservoir, Duluth, Minn.

The new middle system reservoir of the Duluth water works was placed in operation in July, 1914. The capacity is 5,240,000 gals. The reservoir, of reinforced concrete, is circular in form and 183 ft. in diameter at the bottom of the walls and 187 ft. 4 ins. at the top. The wall is 23 ft. high and the overflow is 1 ft. below the top. These are inside dimensions. The bottom slopes downward 5 ft. to a line 20 ft. from the wall and thence slopes downward 1 ft. to the center. In the reservoir proper there are about 197 tons of steel and 1,835 cu. yds. of 1:2:3 concrete.

The wall is 3 ft. thick at the base, 18 ins. thick 11 ft. above the floor and 10 ins. thick at the coping, which is 12 ins. wide and high. The base of the wall rests on a footing 5 ft. wide. The floor is 10 ins. thick and is faced with a mortar coat troweled to a sidewalk finish. Walls and floor are 1:2:3 concrete. The walls are reinforced circumferentially with square deformed bars proportioned for stress of 12,000 lbs. per square inch, no deduction being made for external earth pressure. The floor is reinforced with ½-in. square deformed bars on 1-ft. centers both ways.

A considerable amount of ledge rock was encountered in excavation. This was taken out 1 ft. below grade and covered with well-tamped gravel from the excavation. The excavated earth was returned to form an embankment reaching within 10 ft. of the top of the coping. The surface of this embankment was fertilized and seeded. A cement gutter was constructed to carry off storm water from the slope above the reservoir. A steel ladder was provided to give access to the interior. Bituminous waterproofing was applied to the inside of the wall, extending from the water line about 13 ft. downward.

Connection to the 12-in. mains previously laid was made by two 12-in. mains extending to the valve chamber, which is of concrete about 10 ft. square. From the valve chamber inward the size of inlet and outlet pipes is increased to 16 ins. In the valve chamber, an arrangement of check valves forces all water entering the reservoir to travel entirely across it before it leaves. There is a 12-in. flow, off from the reservoir to a nearby watercourse. The 10-in. overflow and the drain from the valve chamber lead to this blow-off line. In the watercourse a concrete pier protects the bank from washing by the discharge from the blow-off.

COST.

The costs of the reservoir and appurtenant structures complete, exclusive of engineering and overhead, was as follows:

	Unit Cost.	Total.
11,559.0 cu. yds. earth excavation	0.526	$6,079.50
875.9 cu. yds. earth in trench	0.75	656.93
1,331.9 cu. yds. rock excavation	6.00	7,991.40
299.7 cu. yds. gravel fill over rock	1.00	299.70
196 ft. 16-in. pipe laying	0.20	39.20
1,286.5 ft. 12-in. pipe laying	0.15	192.98
706 ft. 8-in. pipe taken up	0.10	70.60
93.8 cu. yds. "Class C" concrete	3.00	281.40
335 lin. ft. cement gutter	0.50	167.50
1 valve chamber		100.00
1 blow-off pier		50.00
Reservoir proper, including ladder and steel		28,755.30
48.6 tons pipe	25.90	1,259.09
10,337 lbs. specials		402.31
Valves		351.40
Pipe hauling		54.22
Electric alarm and conduit		59.28
Painting exterior with cement		45.87
Inspection, including inspection of steel and cement		358.57
Miscellaneous labor and material, including seeding		100.54
Total, exclusive of engineering and overhead		$47,315.79

ACKNOWLEDGMENT.

The reservoir here described was designed by E. W. Kelly, Engineer of the Duluth Water and Light Department. It was built by D. H. Clough & Co. Mr. D. A. Reed is Manager of the Department.

Method of Repairing Crack in Large Cast Iron Tee at Duluth.

A 42x42x36-in. cast iron tee cracked about one month after its insertion in a steel force-main at Duluth, Minn. The crack extended about three-quarters of the way around the casting close to one end flange. Mr. E. W. Kelly, engineer of the water department, gives the following description of the method of making the repair:

The crack was driven full of dry fine wedges from the inside. This permitted resumption of pumping while preparations for permanent repair were made. The permanent repair consisted of a ring of angle iron with the outstanding leg drilled to match holes in the tee flange. This was made in halves, which were welded together around the tee with the oxy-acetylene torch. It was bolted to the tee flange, but spaced about ½ in. from it. A similar space was left between the body of the tee and the flat leg of the angle, in which a groove had been cut for a "lock." The space between the angle and tee was then poured with lead, and the joint caulked from both sides. The result was a perfectly tight and satisfactory job.

GENERAL

A Modern Small Sized Construction Camp With Some Costs on Feeding Men.

Contributed by E. W. Robinson, Civil Engineer with McKenzie Construction Co.

In July, 1914, a contract was entered into to construct a reinforced concrete and brick building to be located upon the County Poor Farm for Bexar County, Texas. The building was about ten miles from the center of San Antonio, county seat of Bexar County, and about two miles from the nearest railway siding. While located in a good and prosperous farming district there were an insufficient number of farm houses close enough to board the required number of white laborers, let alone the Mexicans and negroes, that would be necessary to carry on the work satisfactorily. A plan of furnishing transportation to and from town each night and morning was considered, but on further consideration was abandoned in favor of a camp, both because of cost and because it was thought that better work could be obtained from the men if their living conditions, and especially food, were kept under control. This conclusion was proven correct in the end. Also as the cotton picking season was on when the work was started good men were hard to get and keep and every Saturday, and on other days too, the streets in town were lined with farmers trying to get cotton pickers. With a camp it was thought a man could be kept on the job a week at least and that there would be less chance of him being tempted to change quite so often as he would were he to go to town every night, and that it would tend to discourage the tendency so common among the negroes and Mexicans to lay-off every few days, for they were given to understand that they would be paid only on Saturday afternoons.

After deciding upon a camp to handle the labor proposition the next questions were the kind of camp to be constructed and the amount of money that could be economically expended for that purpose. As stated in a preceding paragraph, the prime consideration was the condition of the men which in most cases largely controls their output of work. Another important consideration was the ultimate cost. Owing to the sudden increase of cost of staple articles of food early in August it was seen that anything like a profit from boarding the men was impossible, provided of course the price charged was made reasonable in comparison with the prevailing rate of wages and the quality and quantity of food were sufficient to keep a man in shape for hard labor. The proposition then resolved itself into one of charging the men about what they would have to pay elsewhere for ordinary substantial board and then giving them the best possible in every way and yet make the camp self sustaining or as nearly so as possible. Very little information and cost data of value could be found which were entirely applicable to the given conditions for various reasons. So much data published on cost of feeding men in construction and other camps do not give quantities and unit costs of the various items of food making up the bill-of-fare, and where there is unusual fluctuation in prices of food stuffs, as in this case, or where local conditions and racial habits have considerable to do with the kinds of food available and suitable, such data are worse than none at all. Also cost of board and camp on large undertakings extending over a year or more and in different climates must be handled with care to be comparable. Another instance of un-reliable cost figures suitable for a basis on which to figure for a camp to meet the above set out requirements is where the camp and commissary is depended upon for the principal source of profit, either by the contractor for the work in hand, or by a sub-contractor on the board and camp alone.

As shown on the accompanying sketch, Fig. 1, almost an ideal location for a small camp was secured near the work on a knoll of sandy porous soil with excellent drainage in three directions. There were two or three large trees and many small mesquite shrubs that afforded considerable shade. The cooking and eating house was located on the highest point and near the center of the camp. This was built of one-inch boxing with corrugated iron roof. A screened open space thirty inches in width and about the same distance above the ground, together with screened doors afforded plenty of light and air all around the building except next to the store room. This made a decided hit with the boarders and visitors alike. When the weather got so cool that fresh air could be had in plenty the screened space was covered with 10-oz. white canvas left so it could be rolled up on warm days. This provided plenty of light without needing any windows except on the very darkest of days. The store room and kitchen were in the center of the building with tables at one end for Mexicans and negroes and for the whites at the other end. At the latter end there was one small table for the superintendent, foremen and other officials and visitors, and two tables for the white laborers. Water was brought through a 1½-in pipe to within 50 ft. of the cook house. This was creek water and was soft and good for laundry purposes, but as a precaution was boiled for drinking purposes.

Separate tents were provided for cook, foremen, white laborers and for Mexicans and negroes. Lumber for flooring the tents was furnished free of charge but the men had to put it down themselves. The carpenters and others who brought their families with them furnished their own tents and furnishings, and the superintendent and office man furnished their own tent as well as did a few other men. Those boarding in camp were entitled to a place under a tent, a bunk and mattress. Folding cots with springs were furnished superintendent, foremen and other officials instead of the common bunk. Those who boarded themselves were allowed water free but they were required to pitch their tents some distance away from the main camp so there would be no interference. A commissary on a small scale, supplying bedding, mosquito nets, gloves, overalls, and tobacco was maintained at the office. While all these goods were bought at wholesale prices it is doubtful if the small profits made off of them offset the bother in looking after the business and it was maintained principally as an accommodation to keep the men from wanting to go to town for such articles or from asking every one who did go to load himself down coming back. The office contained desk, drafting and common tables, telephone and all the books and other data pertaining to this job.

A negro man and wife were secured to do all cooking and other work incidental thereto for $75 per month. He furnished a one-horse wagon to haul the week's supply of groceries from the railroad station two miles away, and also to collect such produce as could be bought from nearby farm houses and to haul fire wood from the saw at the building site. Fortunately a thoroughly reliable and honest cook was obtained, one who did his work well and maintained order and impartiality among those of his own race. In starting the camp a study had been made of the U. S. Army garrison ration through the medium of "The Mess Sergeants' Handbook" (Holbrook & Dunne) and an attempt was made to follow the methods outlined in that valuable book. However as with most everything else the problem of quantity, quality and variety had to be solved according to conditions at hand, that is the likes and dislikes of the men to be fed. The writer can recommend this book as being a good guide in laying down some general principles. As soon as it was found out that the cook had a pretty good head in regard to the bills-of-fare he was allowed to regulate the food pretty much to suit himself with occasional changes and suggestions of course. All white men paid $5 per week or $0.25 per meal and there were absolutely the same dishes on all tables at this end of the eating house, and the fact that the superintendent ate the same food from the same kind of dishes undoubtedly tended to keep down complaints from chronic knockers. Negroes and Mexicans were charged $3.50 per week or $0.20 per meal and were given the same food as the white so far as meat, vegetables, etc., were concerned but were allowed none of the expensive things such as milk, butter and eggs. There is no doubt these people ate as much in value as the $5 men, but the price was set and maintained at this figure for the reason that were the price higher the average Mexican or negro would board himself and then be unfit for work half of the time. In fact the only cases of sickness among the men in camp where anyone was too sick to work were among the Mexicans who kicked on paying $3.50 and were boarding themselves for $2.00 and $2.50 a week. Had everyone paid the $5 rate the camp would just about have been self-sustaining, but it is a question whether or not this gain would not have been offset by decreased efficiency in the laborers, or lack of them altogether, for certainly few negroes or Mexicans would have paid that much. The one mistake made was in allowing a rate per meal instead of charging a flat price per week. Had this been started at first the writer believes it could have been made to stick and the increased receipts would have paid part or all of the overhead expense of the camp on Sundays when there was generally only half a dozen or so people around. The reason for allowing the meal rate in the beginning was because it was hard to induce skilled laborers with families to leave them in town and come this far in the country, and the argument was offered to get them that they could board as cheaply in camp as they could at home, could be with their families over Sunday and would not have to pay for meals they did not eat. No distinction could be made between those with families and those without, and the result was that about 90 per cent of the men left Saturday without eating supper and came back after breakfast Monday morning.

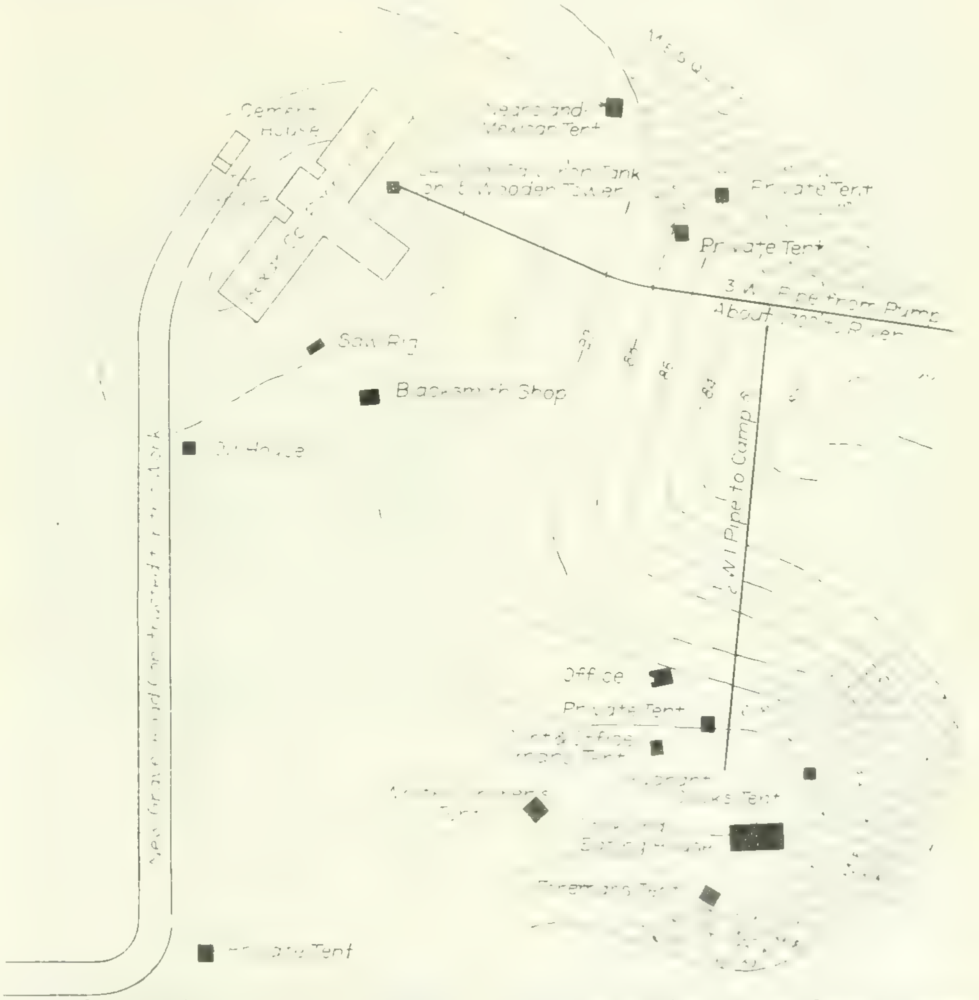


Fig. 1—Construction Camp Plan, County Poor Farm Building, Bexar County, Texas.

For the 3½ months between Aug. 15 and Nov. 28 there were served 6,100 meals, or 2,033 rations, and the following tabulation gives the total foods used and actual unit and total costs for this period:

Sugar, 456 lbs. at $0.074 average	$33.92
Coffee, [illegible] lbs. at $0.20 average	[illegible]
Navy beans, [illegible]	[illegible]
Mexican beans, [illegible] average	11.25
Bacon Belly, 751 lbs. at $0.181 avge.	[illegible]
Fresh meat, 1,210 lbs. at $0.125 avge.	151.21
Potatoes, 565 lbs. at $0.022 average	12.66
Onions, 457 lbs. at $0.029 average	12.99
Cabbage, [illegible]	[illegible]
Hominy, 121 [illegible]	[illegible]
Corn, 216 2-lb. cans at $1.10 doz.	19.60
Peas, 168 2-lb. cans at $0.85 and $1.40	17.2
Tomatoes, 24 2-lb. cans at $0.90; 53 3-lb. cans at $1.35	7.76
Flour, 3⅞ bbls. at $5.92 average	22.94
Cornmeal, 496 lbs. at $0.023 average	11.14
Syrup, 25 10-lb. cans at $0.43 average case Mexican [illegible]	[illegible]

Rice, 37 lbs. at $0.04½ average		1.67	
Lard, 285 lbs. at $0.09 average		25.50	
Baking powder, $2.00 per doz. for 25-oz		4.78	
Red pepper, 6 boxes		0.45	
Black pepper, 25 boxes		1.88	
Salt, 67 lbs.		0.42	
Soda, 12 packages at $0.06		0.72	
Macaroni, 3 cases, 75 boxes		5.09	
Grits, 9 boxes at $1.00 per doz.		0.75	
Baker's bread, 730 loaves at 26 for $1		28.08	
Butter, 116 lbs. at $0.35		10.60	
Skim milk, 81.5 gals. at $0.10		8.15	
Buttermilk, 36.5 gals at $0.20		7.30	
Eggs, 136 doz. at $0.30		40.80	
Pet milk, 240 large cans at $1.00 doz.		20.00	
Prunes, 50 lbs. at $0.13 average		6.51	
Evaporated apples, 65 lbs. at $0.12 average		7.75	
Miscellaneous fruit and vegetables		3.83	
Pickles, 9 gals. at $0.55		4.95	
Vinegar, 2.5 gals. at $0.50		1.25	
Extracts and spices		2.55	
Soap, 1.5 cases		4.00	
Matches, at $4.25 per case		2.70	
Lye, 6 cans at $0.70		0.42	
Washing powder, 18 cans		0.84	
Ice, at $0.20 per 100 lbs.		20.60	
		$765.32	
Per meal			$0.125
Cook, 3.5 months at $75		262.50	
Per meal			0.043
Clerk, 3.5 months at $65		227.50	
Per meal			0.037
Lumber, nails, roofing, etc.		190.39	
Stove, second hand		15.00	
Ice box and water cooler, second hand		16.00	
1 doz. single cots, 4 doz. mattresses, second hand		75.30	
Tent, 9x9, second hand	$ 7.00		
Tent, 16x20, second hand	20.00		
Two tents, 14x20, new	38.92		
		65.92	
Cooking utensils, etc.		42.97	
Oil lamps		3.50	
Canvas		9.08	
Miscellaneous		4.40	
Labor		100.00	
Total cost of camp		$522.56	
Less probable salvage value		150.00	
		$372.56	
Per meal			0.061
Grand total per meal			$0.266

An attempt was made to check the above quantities against the army ration, but about the only item on which the check would be of value is the meat. According to Holbrook & Dunne there should be 125 lbs. of fresh meat or 75 lbs. of bacon to every 100 rations, or if both are used they should be in that proportion. At this rate 2,033 rations would require 2,542 lbs. fresh meat or its equivalent 1,525 lbs. bacon. Taking the actual fresh meat used, which was 1,210 lbs., we should have used 799 lbs. of bacon to fill out the meat ration, and there was actually used 754 lbs. Or the other was around starting with actual use of 754 lbs. bacon we should have used 1,285 lbs. fresh meat against actual use of 1,210 lbs. It will be noted that while the men were working harder than is usual for soldiers in garrison they consumed less meat, but this can be accounted for in two ways. In the first place the army ration is large enough to allow the men to make a saving on most any item so that they can buy luxuries not listed in the ration, and also because in this case beans take the place of meat to a large extent with the average common laborer. During the month of November some wild game was added to the bill-of-fare on Sundays and Mondays, but this had little effect in reducing the amount of meat bought.

The reader will note the lack of fresh vegetables from the above list which was due to inability to obtain them except at exorbitant prices. Notwithstanding the fact that there was a large dairy farm adjacent to the camp a good price was paid for the butter, eggs, skim milk and buttermilk bought and it was necessary to resort to evaporated milk for coffee. Everything else was shipped by freight from town every Tuesday morning.

As a good example of the variation in prices paid for supplies it might be stated that when the camp was started, which was soon after the European war broke out, sugar cost $8 per 100 lbs., and the price varied between that and $6.25 during the whole three and one-half months.

In regard to the high proportionate cost of commissary clerk it might be argued that $65 was too much to pay per month for a camp of this size. However, one man did all the office work and kept time and cost data as well and it was judged that about that proportion of his time was spent on matters pertaining to the camp and commissary. For instance, it takes two or three times as long to work up the payrolls when there are deductions for board and supplies as it does when there are no such deductions. However, for estimate purposes this item can be estimated accurately enough in advance and it is merely listed here to show what it cost in this case.

In the cost given for the camp equipment there is no charge made for the pipe line except a few dollars labor in placing it. The reason for this is because it will be used later as a pipe railing in the building. The main 3-in. water line which feeds the 1½-in. line to camp and the pump and tank were installed by the county free of cost to the contractor in accordance with agreement before contract was made for the construction of the building.

The matter of salvage value of camp equipment is merely an estimate, for at this time the camp is still in use. There is chance for securing contract for another building near this one, in which case the value of the camp in place is more than estimated. But leaving that out of consideration, the writer believes $150 in cash can be realized on the whole outfit, if not more.

Considering that $150 can be realized from the equipment on hand there was total money loss of $372.56 from the camp and commissary, which amounts to about 4.5 per cent of the payroll of men boarding there. The writer believes this was a good investment in that it secured more and better work from the men as they were well and contented and were on the job fresh each morning and were not tired out by dissipation of the night before or by making the trip to town and back. The difference could be seen very plainly in the men on Monday mornings after they had spent Sunday in town.

It will be noticed an average of 20 men were fed during this period, though during the period of working full gang 30 to 35 were fed daily. The camp was designed to accommodate about 50 in all, and had it been run to capacity the item of cook and clerk would have been nearly cut in two, meaning a saving of at least $0.04 per meal.

Methods and Costs of Planting a Small Park to Grass, Making Paths and Planting Hedge.

Contributed by H. R. Ferriss, 203 Times Block, Victoria, B. C.

The following labor costs are given for planting a small triangular park, and for making paths. The park contains 7,826 sq. yds., of which 1,000 sq. yds. are in paths and drives, 6,085 in grass and the remainder in offices and enclosures. The costs include only the lawns, paths and hedge. The water system, grading, etc., are not considered.

No set specifications were made for this work, which was accomplished with day labor. As finally completed, however, the lawns were made with 1 ft. of rich black loam over a nearly level subsoil of dense white clay. The paths, as shown in Fig. 1 were made with well rolled "screenings" covered with a thin layer of clay, into which was rolled coarse sand. By "screenings" are meant small stones, etc., raked out of the soil preparatory to planting with grass. Both sides of the path are lined with dwarf box hedge. The paths have proved very satisfactory. They have required no repairs whatever, although some trouble has been experienced with weeds. No drains have been needed, notwithstanding the heavy character of the soil, as the paths, owing to their construction, furnish an efficient drainage system for the park. The following brief description of the manner in which the work was done may prove of interest to those engaged in similar improvements:

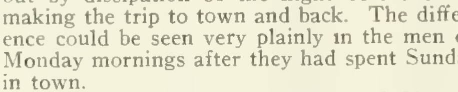


Fig. 1. Cross Section of Path.

The entire area was first graded and rough leveled in the fall. Work was then discontinued owing to rain. About the last of the following March the ground was plowed, the paths excavated, and the natural surface soil evenly leveled over that part of the area designed for lawns. The surface was then thoroughly harrowed with spike-tooth harrows and the screenings raked into convenient piles, which were afterward spread and rolled in the paths.

While the surface was being harrowed and raked the soil for the box hedge was sifted and tamped into place ready for the plants. The grass seed and the hedge were both planted at the same time, 4 to 6 men with fine rakes were engaged in seeding, and 2 gardeners and 2 to 4 laborers helping were used for planting the hedge.

After the hedge was completed the screenings were leveled in the paths, thoroughly water-soaked, and well rolled with a heavy hand roller. On top of this was spread a thin layer of clay which was also water soaked. This was covered with sand and then well rolled. The sand had been previously dug from a bank about 200 ft. from the center of the park and deposited at convenient points with wheel scrapers, from which it was afterwards handled with wheelbarrows. The clay was dug from the bottom of the paths.

It must be borne in mind that the company was put to no expense for materials other than for grass seed and box hedge. The ground for a depth of 1 ft. is composed of the finest kind of soil for lawns, although heavily sprinkled with small stones. The sand used in surfacing the paths was conveniently located. Some shifting of soil was necessary during the leveling of the park, but this item has been included in the cost of grading. Paths as outlined above might not be economical, except under similar conditions. The design saved, of course, the cost of gathering up the screenings and carting them a considerable distance, and the cost of excavation was also almost entirely offset by the sale of the surface soil.

It may be mentioned that we found during heavy rains that the surface of the paths showed a tendency to wash. Small inlets were made at frequent intervals, consisting of loose brick boxes filled with clean gravel, and no further trouble has been experienced from this cause.

TABLE I. COST OF CONSTRUCTING WALKS AND PLANTING GRASS AND HEDGE.

		Cost per 100 sq. yds.	Cost per cu. yd.
Walks and Drives:			
Foreman, 24 hrs. at 35 cts.	$ 8.40	$ 0.828	$0.040
Excavation, 480 hrs. at 20 cts.	96.00	9.467	.457
Rolling paths, 90 hrs. at 20 cts.	18.00	1.775	......
Surfacing, 70 hrs. at 20 cts.	14.00	1.380	......
*Drainage, 16 hrs. at 20 cts.	3.20	.315	......
	$139.60	$13.765	......
Lawns:			
Foreman, 80 hrs. at 40 cts.	$ 32.00	$0.527	
Plow and harrow, 10 hrs. at 70 cts.	7.00	0.115	
Leveling surface, hand labor, 100 hrs. at 20 cts.	20.00	0.329	
Raking and seeding, 805 hrs. at 20 cts.	161.00	2.652	
Temporary fencing, 14 hrs. at 20 cts.	2.80	0.046	
	$222.80	$3.669	
		Cost per 100 lin. ft.	Cost per cu. yd.
Box Hedge:			
Sift, place and tamp earth, 620 hrs. at 20 cts.	$124.00	$3.543	$0.775
Gardeners planting hedge, 380 hrs. at 35 cts.	133.00	3.800	
	$257.00	$7.343	
Engineering—Stake paths, etc.			$15.00
Supervision			20.00
Tools, depreciation, etc.			7.50
			$42.50

*Drainage consisted of 100 ft. of 6-in. tile drains at various points which were used to carry seepage from the paths to catchbasins in the streets.

Comparative Methods and Costs of Preparing Rock for Steam Shovels.

Contributed by Charles C. Phelps, Weehawken, N. J.

When a steam shovel encounters chunks of very soft rock that are too large to enter the bucket, the simplest means of disposing of them is often by sledging and sometimes by dropping them upon another rock. If the rock is of harder nature, however, blasting must be resorted to. In rock excavation work, the material may be shattered to such an extent that all subsequent breaking will be unnecessary if the blast holes are spaced sufficiently close and if relatively heavy charges of explosives are employed. This procedure will, however, so greatly increase the cost of operations as usually to make it prohibitive. The plan generally adopted, therefore, is to drill so that the bulk of the material will enter the jaws of the bucket and then employ a gang of men to go ahead of the steam shovel and break up all the rock that is over-size.

Generally speaking, there are two ways of blasting such boulders, i. e., by applying surface blasts to the rock and by exploding charges in shallow holes drilled in the rock, the latter being known as pop-shooting or block-holing. In surface blasting, a stick of dynamite is placed against the rock and, after being properly wired up, it is covered with a "mud-cap," "plaster," or "dobie" of mud or mortar. Naturally the breaking effect by this method is much less than with a charge in the body of the boulder, and the cost of powder for blasting a rock of any size in this way is very much more than for pop-shooting.

Four ways of accomplishing block-hole drilling are open to the contractor or quarryman, namely: (1) With sledges and hand steels; (2) With mounted tripod drills; (3) With non-rotating plug drills operating with compressed air, and (4) With steam or air operated hand drills of the self-rotating type.

The last type operates satisfactorily on steam as well as on compressed air. Formerly plug drills were not constructed to employ any other power than compressed air, therefore the development of the steam type has greatly broadened the field of the hand drill, one of the most important applications being its use as an adjunct to a steam shovel.

In order to compare the relative advantages of the four methods, we will consider an average case where the rock is a very hard limestone and where it is necessary to drill pop-holes averaging 12 ins. in depth. The holes put in by tripod drills would probably be a little over 2 ins. in diameter and those made by the first, third and fourth methods would probably be under 2 ins. in diameter, but this difference can be left out of consideration because the smaller holes would be amply large for their purpose. The cost of sharpening steels can also be left out of consideration, for this would be nearly the same per foot of hole in all four cases. The wages for drill operators range from $1.50 to $4 per shift in various parts of the country and from $1.50 to $3 per shift for helpers. We will therefore use in our calculations the average wage of $2.75 for drill runners and $2.25 for helpers per eight-hour shift.

A medium size piston drill will require about 125 cu. ft. of free air per minute at 90 lbs. pressure, or if operating on steam will require about eight boiler horsepower at a corresponding pressure. Both of the small types of hand drills will require less than half of this amount of power. In the most advanced type of oil-engine driven air compressor, air can be compressed to this pressure for a fuel cost of about 4 cts. per 1,000 cu. ft., with kerosene at 8 cts. per gallon. The cost of steam at this pressure would be about 9/10 cts. per boiler horsepower per hour with coal at about $3 per ton, assuming 6 lbs. of coal required per hour per boiler horsepower.

The cutting speeds referred to below are only approximate, being based on a large number of actual cases that have come to the attention of the writer. The cutting speed of five minutes per foot has been applied to cases two, three and four to be on the safe side in estimating, although a slightly better speed should be attained in case three and a still greater speed should result in case four, for reasons to be explained later.

DRILLING WITH SLEDGE AND STEEL.

Labor cast per shift, 1 drill man	$2.75
Labor cost per shift, 2 sledge men	4.50
Total	$7.25
Time required to cut 12-in. hole, about, minutes	15.0
Cost per 12-in. hole	$0.227

DRILLING WITH MOUNTED PISTON DRILLS.

Labor cost per shift, 1 driller	$2.75
Labor cost per shift, 1 helper	2.25
Total	$5.00
Cost for steam (assuming drill in actual operation during 2/5 of shift)	0.23
Cost for labor and steam per shift	$5.23
Cost for air (assuming drill in actual operation during 2/5 of shift)	$0.96
Time required to cut 12-in. hole, about, minutes	5.0
Time required to move drill from previous setting and to adjust (5 to 10 minutes), average, minutes	7.5
Total per hole, minutes	12.5
Labor and steam cost per 12-in. hole	$0.136

DRILLING WITH ORDINARY PLUG DRILLS.

Labor cost per shift, 1 driller	$2.75
Cost for air (assuming drill in actual operation during 5/6 of shift and air consumption ½ of mounted drills)	1.00
Cost for labor and air per shift	$3.75
Time required to cut 12-in. hole, about, minutes	5.0
Time required to shift and for small delays, minutes	1.0
Total per hole, minutes	6.0
Labor and air cost per 12-in. hole	$0.047

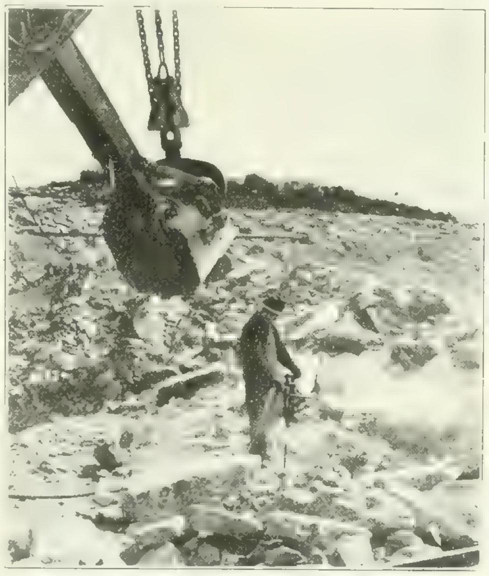


Fig. 1. Self-Rotating Jackhamer Drill Operating With Steam Directly From Steam Shovel Boiler.

DRILLING WITH AUTOMATICALLY ROTATED HAND HAMMER DRILLS.

Labor cost per shift, 1 driller	$2.75
Cost for steam (assuming drill in actual operation 10/11 of shift and steam consumption ½ of mounted drills)	0.26
Cost for labor and steam per shift	$3.01
Time required to cut 12-in. hole, about, minutes	5.0
Time required to shift position, minutes	0.5
Total per hole, minutes	5.5
Labor and steam cost per 12-in. hole	$0.035

Comparing the above estimates of cost, it appears that drilling with sledge and steel is extravagantly expensive. Drilling with mounted drills is also very expensive for this class of work, due mainly to the fact that more time is consumed in setting up the drill than in actual cutting. The choice of equipment would, therefore, seem to lie between the two types of hand drills. The difference in cost of operation between the two latter types does not appear to be so great from the above estimate, but there are other considerations of equal importance which point to the automatically rotated hand hammer drill as the ideal type for steam shovel work. In the first place it operates on steam taken directly from the boiler of the steam shovel, whereas the ordinary plug drill is adapted for operation on air only. This eliminates the initial and upkeep cost of a compressor mounted on the steam shovel boiler or a separate compressing plant and any charges that there might be for attendance to such a unit. This one consideration has been the determining factor in a large number of cases where the automatically rotated hand type has been adopted for drilling pop-holes in connection with steam shovel excavation. Another important advantage of the latter type is the fact that the hole is quickly started and the steel is scarcely ever known to stick due to the positive rotation mechanism. On the contrary, ordinary plug drills frequently cause trouble and delay in these respects, especially when they are operated by inexperienced workmen, and the amount of muscular energy required to rotate a plug drill back and forth soon tires the operator, so that he is incapable of keeping up to the pace which we have adopted as our standard.

The drill shown in Fig. 1 has an 18-in. piece of ¾-in. pipe screwed into the exhaust to carry the steam away from the operator, and wooden handles are fitted to the machine, so the drill is perfectly comfortable to handle. In this case there is a 60-ft. length of hose and the boiler pressure gage registers about 110 lbs. In other cases the drill operates as far as 400 or 500 ft. away from the shovel. In such cases poorer results are to be expected, especially in cold weather, due to the condensation of the steam in the line, even when it is covered with insulating material. The steam operated drill may be used for cutting either wet or dry holes. In the latter case hollow drill steel is often employed, together with a special type of throttle valve on the exhaust which can direct the steam through the steel at the will of the operator to blow the cuttings out of the bottom of the hole. It is customary to use a slightly smaller piston with a drill operating on steam in order to allow for the expansion. Likewise only the best quality of steam hose should be used for conveying the steam to the drill. Proper lubrication is of even greater importance when operating with steam than when using air and a heavier oil should be used with a steam drill than with one using air. It will pay to remove the steel from the chuck occasionally and squirt a few drops of oil on the bottom of the piston. This, in addition to the regular automatic lubrication, will result in a drill of this type operating practically as well with steam as with air.

These little machines use the hammer principle and operate at a very high speed, perhaps 1,000 blows per minute or more.

An interesting and puzzling case occurred recently in which drills of the self-rotating hand hammer type were condemned by a quarry superintendent because the steels were constantly getting stuck. The rock was a rather soft limestone and a six-point drill bit was used. The drill was examined for defects but none were found. Then four-point bits were substituted and that helped matters a little, but the trouble continued. The bits were then removed and flattened on the bottom until they were quite blunt, which resulted in ending the difficulty. The trouble had been due to the pointed bits cutting so fast that they would soon become embedded in the cuttings, preventing the rotation of the steel and, of course, interfering with the action of the piston. This case is mentioned simply to show that, in applying this novel type of drill, difficulties may be encountered under unusual conditions, but the exercise of a little ingenuity in adapting the machine to the conditions will generally overcome them easily.

The new type has become popular with the drill runners, because they are so much easier to handle. In many cases their adoption has resulted in increased earnings for the men. In one notable instance, where hundreds are in operation, the drill runners are earning nearly 20 per cent more in wages while the profits of the owners are increasing correspondingly due to increased production and lower operating costs.

ROADS AND STREETS

Methods and Costs of Building a Macadam Road Using an Industrial Railway.

Contributed by R. P. Mason, County Engineer, Delta County, Michigan, Escanaba, Mich.

In my road building experience it early became apparent that the cost of hauling materials was out of all proportion to the total cost of road and that some substitute for the slow and costly team and wagon method would be very desirable.

On taking charge of the road building for this county an opportunity was presented to put into effect a method I had long desired to see tried out. We had a very considerable stretch of macadam road to build and, in anticipation of a continuous program covering several years, a Koppel hauling outfit was purchased consisting of a 30 H. P. locomotive, 50 cars (Fig. 1), a tracklaying car and four miles of 24 in. gage portable track with curves and switches. This track is 20 lb. rail made up in 15 ft. sections with seven steel ties to the section. This unit is readily handled by two men. It is necessary to have track that is really portable and for this reason this type was selected. Owing to the very narrow gage a low centre of gravity locomotive is very desirable and the selection of the above type with the water tank beneath proved to be wise, as it kept the rails on occasions when a less stable engine must have capsized. The cars have roller bearings and are extremely easy running.

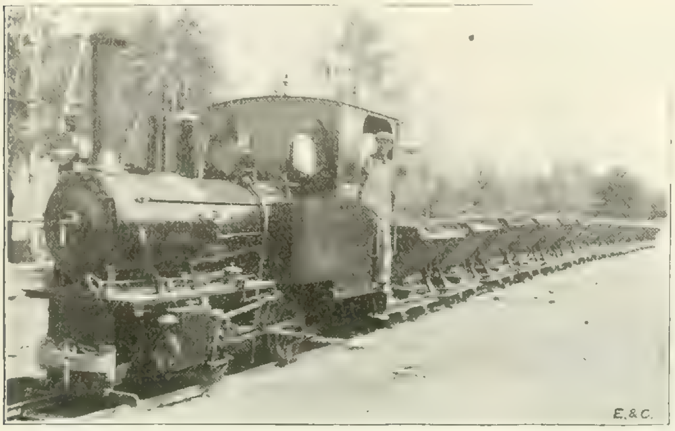


Fig. 1—Locomotive and Koppel Cars Hauling Stone.

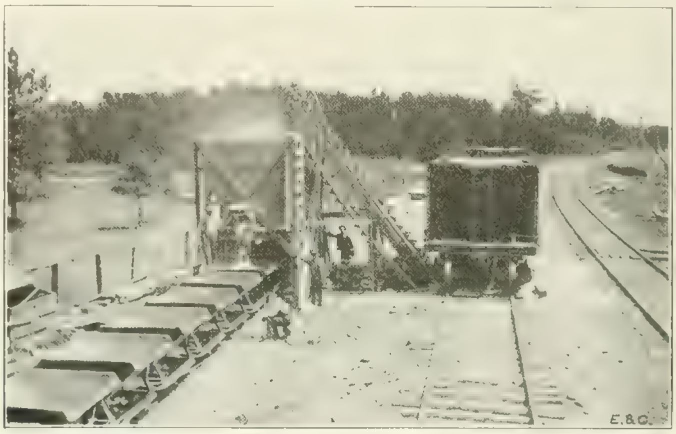


Fig. 2—Plant for Unloading Stone from Railway to Koppel Cars.

Our season's work was 9.5 miles of 16-ft. macadam 6 in. in depth compacted, laid in two courses, on what is known as the Manistique Trunk, or the road connecting Escanaba with Manistique.

We contracted for a sufficient supply of stone to keep the outfit busy to maximum capacity, to be delivered in hopper bottom cars; and I would say here that this is a matter not to be overlooked, there must be a sufficient and constant supply of stone and, if shipped to the job, the railroad equipment must be in proportion and of proper and uniform type of cars to facilitate rapid unloading, or the efficiency of the work will suffer. The total output of a good sized quarry is required to keep this outfit busy and, as we have handled over 400 cu. yds. per day on short and medium haul, it is evident that no small crushing plant or undeveloped quarry would keep things going.

By thus contracting for a large volume of stone, we were enabled to get very favorable prices, much lower than had prevailed in this locality before, which fact is responsible for considerable of the saving on the total cost of the road.

A loader consisting of a 24-ft. belt elevator carrying 16-in. steel buckets, driven by a 6 H. P. gas engine, carries the stone from a pit beneath the standard track into two small bins—one for the large stone and one for screenings—the stone being deflected into the proper bin by a hinged door. A powerful winch with steel cable, driven by the same engine, is used to spot the cars, both standard and small. The pit mentioned is fitted with a sliding door to control the flow of stone to the belt. The capacity of this loader is about 600 cu. yds. per day. Figure 2 shows the loading plant.

The portable track is laid under the bins with a siding to take care of the empty train. Suitable doors in the bins furnish the means of filling the train and the average time of filling a 25-car train is one-half hour. Train was supposed to be always loaded and ready when the locomotive returned with the empties.

Tracklaying is handled generally by three to four men and a car of steel is sent out as needed at the head end of the stone train, carrying 20 sections, or 300 ft. of track. As our day's work seldom exceeded one-eighth of a mile, two to three cars per day were sufficient. The track is laid on the shoulder after the grade is complete and made as permanent as possible, for it is found that it pays to have the track well leveled and solid in order to make time with the train. At least one man was kept going over the track constantly, especially in wet weather, to keep it in shape. As fast as any considerable section of road was finished the track was thrown to the centre of the metal, thus giving a perfect roadbed for the long haul.

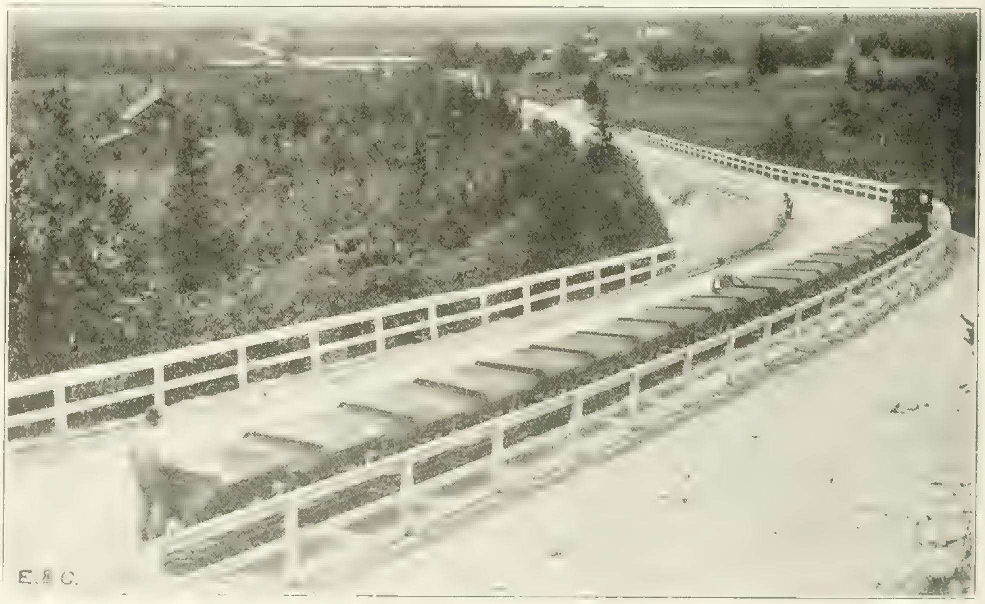


Fig. 3—View of Stone Train on Hill with 5.1 Per Cent Grade and 16° Curve.

The speed of the train was about 10 miles per hour, though that was not maintained as an average on account of a number of railway grade crossings where a watchman was stationed and where a short section of track had to be placed and removed for the passage of every train. Trains of 20 cars were hauled on the start and five cars were added later, making 25-car trains, and it is the intention to haul 30-car trains this season, as we find that the locomotive will easily handle that many on our ordinary grades. Cars were loaded with 1¼ cu. yds. which, when dumped at a standstill, just made one course of the large stone. The loaded train is always pushed in order to have the locomotive back of the dumped stone. The haul was about 3½ miles each way from the set-up; season's average nearly eight trains per day and 236 cu. yds. per day of stone.

The spreading was done with a road machine hauled by two teams. When the cars were dumped there was always some stone left in them, but as the machine cut close to the cars, after the second trip the remainder was removed with a rake in a moment and the train was free to pull out. The unloading did not consume to exceed 10 minutes.

The road machine finished the spreading while the train was making another trip and a very little trimming with rakes left the road in perfect condition for rolling. I am of the opinion that the machine spreading gives a more uniform distribution and, by planing the road fore and aft, results in a smoother roadway than comes from any other method. However, it is only by handling a large volume of stone per day that this system can be made profitable. It is necessary that all units of the force be proportioned and kept busy and as it takes two teams to handle the road machine it is essential that they have enough stone to make it an object.

After the preliminary rolling a train of screenings is poured from the train in motion, making a windrow near the track sufficient to cover the course and spread by hand. This pouring, with the help of the spreaders, takes about the same time as dumping the stone.

Three 10-ton rollers worked constantly and by utilizing all the lost time of the train due to bad weather, moving, and shortage of stone and occasionally working nights, they were able to keep up their end. Two sprinklers, filled by a gas rotary pump, were used and, as the water was convenient along the road they furnished abundance and it was not always necessary to work them both.

All the ordinary hazards of road building entered into this job, wet weather, soft subgrades and a number of railroad crossings which meant delay as well as extra expense for watchmen. A hill 5.1 per cent, 1000 ft. long with a 16° curve about the centre (shown in Fig. 3) made it necessary to put in a spur at the foot and take the train up in two to three sections. As this work was entirely new to this locality an entire crew had to be broken in and it is evident that costs can be materially lessened in the future, now that the organization is complete. The fastest mile was laid in six days towards the end of the season, compared with the first mile on the same haul which took fourteen days. The crew required was about as follows:

Loader	4 men
Train	2 men, engineer and brakeman
Spreading	2 teams and teamsters
Spreading	5 to 7 men
Rolling	3 men
Sprinkling	2 teams and teamsters
Foreman	1
Watchmen	1 or more
Tracklaying	4

Wages were $2 per day for laborers, $5 for teams with teamsters, $3 for rollermen, engineer, $90 per month.

Compared with team haul the method described shows a saving of about 30 cts. per cubic yard, or nearly $700 per mile. We also save 39 cts. on our stone and 10 cts. on the unloading, making a total of about $1,800 per mile over previous prices. The saving on haul alone would be more marked on a longer haul. We also used the outfit in grading where material had to be moved some distance and found it extremely convenient and economical. Another very decided advantage of road building by this method is seen in the fact that there is no hauling over the road during construction and it is opened to traffic in perfect condition. It is also easier to keep the subgrade from being cut up and therefore takes less stone for a given thickness.

From this experience it is evident that as a good business proposition it pays to handle road work in large units and on a continuous program in order to take advantage of the increased efficiency of the proper machinery and the ability to make profitable material contracts. Building a mile here and a mile there as is so often done, is extremely wasteful, and if road funds could be provided with more continuity to keep the work going on year after year on a consistent program, the result would be bound to show great savings.

The costs in Table I include everything that is a proper charge to the work, the cost of moving outfit from one point to another, laying up, and tracklaying includes taking up as well. Loading includes setting up loader and in one case building a siding 1,000 feet long. The number of watchmen makes the hauling cost high; a greater output will cut down the spreading and the overhead in this case is high on account of the short season.

TABLE I.—MACADAM COST SHEET, DELTA COUNTY, MICHIGAN.

No. of days worked	93
Miles of finished road	9.44
No. yards stone used	21,920
No. yards stone used per mile	2,310
No. days to build mile of road—average	9.4
No. yards stone per day	236
Cost of tracklaying per mile of finished road	$108.19
	Cost per cu. yd.
Cost of stone at our siding	$0.860
Loading trains	.052
Tracklaying	.047
Engineer	.020
Brakeman	.013
Watchmen	.017
Coal	.012
Oil, grease and waste	.002
Repairs	.003
Total	$0.114
Interest and depreciation on hauling outfit	.052
Spreading	.114
Sprinkling	.043
Rolling	.082
Foreman and timekeeper	.030
Total	$0.269
Int. and dep. on all other machinery	.040
General expense	.031
Total	$0.071
Total cost per yard (loose) of finished road	$1.418
Cost per mile	$3,275.58

Dry Rubble Retaining Walls for Highway Embankment in Hawaii.

The belt road of Hawaii, which is the main highway on the island, approximately parallels the coast line entirely around the island, a distance of about 250 miles. A part of this distance is through a barren waste of sandy soil or disintegrated cinder ash. It is very difficult in this section to maintain a satisfactory road way on account of the extremely dry condition and lack of fine material for binder in the immediate neighborhood. The government has been engaged for the past two or three years in constructing a water bound macadam road, 20 ft. wide, through this section. The labor used has been convict labor taken from the territorial penitentiary and consists of Japanese, Chinese, Hawaiians, Porto Ricans, Filipinos and others. On account of the great scarcity of soil and finer material, a somewhat novel plan has been adopted in order to obtain a good grade without excessive cost in the fills. Along each side of the road a rough, dry stone wall, Fig. 1, is constructed with common labor along the outer line of the macadam. These dry walls retain the fills which need be only the width of the surfacing. The laborers become experts in laying up this class of dry walls.

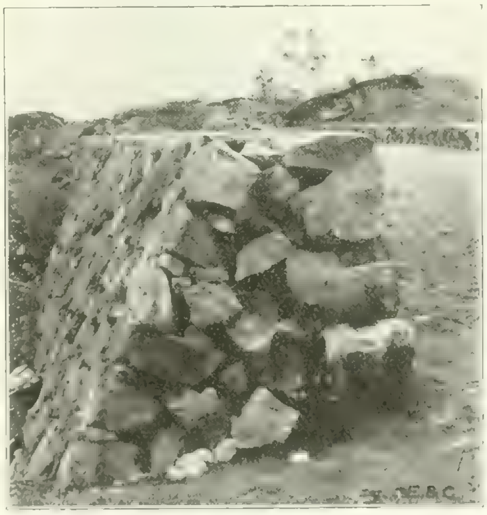


Fig. 1—Dry Rubble Retaining Wall for Road Embankment, Hawaii.

These data are taken from a paper before the Association for the Advancement of Science by Mr. H. K. Bishop, formerly chief engineer.

A Road Contract of a Hundred Years Ago.

The old National Road built nearly a century ago has come into especial notice within a year or two because of the work of reconstruction undertaken by the Federal Government. An account of this improvement with some notes on the history of the original construction were published in our issue of March 10, 1915. There has come to us a photograph copy of one of the contracts for one of the sections of the old National Road and at this time when many contractors are signing documents of like purpose it will perhaps interest them to read how Evans & Ramsey were bound by contract in 1815, and we reprint the old agreement here with capitals, spelling and punctuation as they appear in the original:

Articles of Agreement made and fully concluded on this Fifth Day of September in the year of our Lord Eighteen Hundred and Fifteen Between Gabriel D. Evans and Andrew Ramsey of the one part and David Shriver Jun^{r}. Duly Authorized in behalf of the united states of the other part Whereas the said Gabriel D. Evans and Andrew Ramsey agreed for an in consideration of the payments herein after mentioned to make and complete in a workman like manner a certain part of the road Leading from Cumberland in the state of Maryland to Brownville in the state of Pennsylvania as the same has been laid out and confirmed in pursuance of An Act, Entitled "An Act to regulate the laying out and making a road from Cumberland in the state of maryland to the State of Ohio" and of the Act Entitled an "Act in addition to the Act to regulate the Laying out and making a road from Cumberland in the State of Maryland to the State of Ohio", which part of the said road thus contracted for by the said Gabriel D. Evans and Andrew Ramsey an herein after described it to be made and completed by the said Gabriel D Evans and Andrew Ramsey in the following manner and on the following Conditions That is to Say The trees to be cut down and cleared the width of Sixty-Six feet according to the fourth section of the above mentioned Act the Stumps to be grubbed and the bed of the road to be levelled thirty two feet in width the Hills to be cut down the Earth Rocks and Stones removed the Hollows and Valleys and all the Abutments of Bridges and Culverts to be filled so that the whole of the road on the aforesaid width of Thirty Two feet to be reduced in such manner that there shall not in any instance be an elevation in said road when finished greater than an Angle of Five degrees with the Horizon, nor greater than the gradation fixed by the commissioners who laid out the road, or such as has since been made and confirmed by the President of the United States in conformity with the provisions of Act of Congress, for that purpose and so that the surface of said road shall be adopted to the marks or Stakes made or to be made by the person appointed Superintendant of the said road by the President of the United States, where the earth is to be raised the sides are to slope at an Angle not exceeding Forty Five degrees the Base or Bottom part thereof to be of such width as to secure to the road a complete Surface of Thirty two feet, in width a proper allowance to be made for the Setting of made earth according to the directions of the Superintendant, and no stumps Logs or wood of any Kind. to be permitted in the filling, in all situations on sides of Hills or otherwise where it may be necessary to fill but where the nature of the ground will not in the superintendants opinion admit filling with such Slope as above mentioned and where the wall will be built at the expense of the United States the contractor is to fill four additional feet in width so as to give Thirty Six Feet Surface to the road, where the Hills are cut through or the road dug along side of Hills the Bank or Banks to be cut of such Slope as is necessary to prevent the earth from falling or Slipping in upon the said Surface of Thirty Two feet, the Superfluous Earth to be removed to the nearest filling and then spread so as to increase the Breath of the road eaqually on each side from the commencement of the filling to the end of it unless otherwise permitted or directed by the Superintendant, What may be deficient in order to fill the Bridges, Culverts or Hollows to be dug out of the aforesaid Thirty two feet or from the Banks in such away as to increase the width of the road eaqually through the nearest cutting unless otherwise permitted or directed by the Superintendant—nor in any instance the earth to be dug without such permission or direction more than one foot below the surface of the pavement within the aforesaid breadth of Sixty Six feet. Valeys or Sewers above the surface of the ground necessary to give vent to the waters on the side of Hills to be made in all parts where and in such manner as shall be designated by the Superintendant The road to be covered Twenty Feet in width with Stone Eighteen Inches in depth in the middle and diminishing to twelve inches at the upper Six inches thereof to be broken to such a size that each particle thereof will pass through a ring three inches in diameter and the remaining or Lower Stratum to be Broken so as to pass through a seven inch ring. No Stone to be used for said pavement but such as may be approved of. In all cases where Bridges or Culverts are Built the pavement to extend twelve inches deep from the extremity of the aforesaid breadth of Twenty feet to each side wall the whole length of the said walls, unless otherwise directed by the Superintendant for which additional pavement the contractors shall in addition to the price Stipulated in the Article of Agreement hereto Annexed received an allowance at the rate of one Dollar for every Fifty Superficial Square Feet, of such additional pavement The whole of the said artificial Stratum of Broken Stones to be made in a compact manner and to be supported on each side by good and Solid Shoulders and its surface to be formed as Smoth and even as may be and of such convexity as the Superintendant may direct each grade of the road to be perfectly levelled and brought to the proper degree and approved before any stone are put on and levelled and approved before the upper stratum passing through a three inch ring are put. In every instance the Contractor to find at his own expence the Stone or material necessary to complete his part of the road. The side roads on each Side of the pavement to be dug as low and deep in the cut parts of the road and particularly through rocks as the superintendant may direct. The fillings of the side roads where the same is necessary to be raised as high as may be directed by the Superintendant, and the Surface of the said side road both in the filling and cut parts to be compleatly cleaned of rock or Stone, so as to be smooth and even. No contractor is to interfere with the stone of the contractor for the adjacent Sections of the road for which purpose a line at right angles with the road at the end of each section will be considered as dividing the right to the stone unless otherwise directed by the Superintendant, on account of the want of stone within the limits of any one Section Masons or other persons who may contract with the United States for the Building of Bridges Culverts or any other species of mason work on the road or any other Article necessary to complete the road Such as Stone, Lime sand timber or any other material to be permitted by the contractor to take and select such Stone, sand, Timber, or other Article or material within his division as such mason or other person may think proper and haul the stone along the parts of the road levelled by the contractor or elsewhere to the place where such stone, Lime sand timber or other Article or material may be wanting without any interuption. Whenever the new road meets with or runs along the course of any road theretofore used a sufficient width of road to be kept open for Waggon and all kinds of carriages to pass and repass without delay whilst the new road is making. The contractor shall not in any instance let or transfer his contract to any part thereof to any other person without the Superintendants consent, and in every instance where such sub-contract may be made the price per perch to be allowed to such sub-contractor Shall be fixed with the said Superintendants approbation and shall be paid by him to such sub-contractors out of the first monies which may become due to the principal Contractor according to the provisions for payment stipulated in the Article of Agreement. The contractor shall not employ any workman or Laborer who commits depredations in the neighborhood or insults travellers, and he shall on the application of the superintendant immediately discharge any such workman or Laborers in his employ The contractor shall commence working on his section at the end nearest to Cumberland unless a deviation in that respect be assented to by the Superintendant Now This Agreement made and concluded on this Fifth day of September in the year of our Lord Eighteen hundred and Fifteen Between Gabriel D Evans and Andrew Ramsey of the one part and David Shriver, Junr. Duly authorised in behalf of the United States of the other Part Witnesseth that the said Gabriel D Evans & Andrew Ramsey for themselves there Heirs executors and Administrators Jointly and Severally hereby covenant promise and agree to and with the said David Shriver Junr. duly authorised in behalf of the United States that they the said Gabriel D Evans and Andrew Ramsey shall and will well and faithfully and in a workmanlike manner on or before the first day of November in the year of our Lord Eighteen Hundred and Sixteen make finish and complete in a workmanlike manner and on the conditions herein before mentioned all that part of the road which is designated by the name of the Twenty second section. Beginning at the end of the twenty First section at a Black oak tree marked 44 miles and 22 Chains from Cumberland in Maryland and ending for the same at a white oak tree marked 45 miles & 94 chains from Cumberland containing one mile and one Hundred and Fifty perches for the said section more or less In consideration whereof the said David Shriver Junr. duly Authorised in behalf of the United States as aforesaid doth hereby covenant promise and agree to and with the said Gabriel D. Evans and Andrew Ramsey their Heirs Executors or Administrators, that the said United States, shall and will for doing and performing the work aforesaid, well and truly pay or cause to be paid to the said Gabriel D Evans and Andrew Ramsey their Executors or administrators at the rate of Twenty Dollars for each and every perch in length of the said twenty Second Section in the following manner "Viz" when forty perches in length of said road are finished and approved by the Superintendant the United States will pay to the said Gabriel D. Evans and Andrew Ramsey their Executors or Administrators for twenty perches and after that they will pay them on the completion of every twenty perches, at all times reserving the amount due for the first Twenty perches until the whole of the section aforesaid hereby contracted for shall have been finished and compleated to the satisfaction of the Superintendant, agreeably to the contract when the Ballance due will be paid to the said Gabriel Evans and Andrew Ramsey and the said Gabriel D Evans and Andrew Ramsey for themselves there Heirs Executors and Administrators further covenant and agree to and with the said David Shriver Junr. Duly Authorised in behalf of the United States that in case the said Gabriel D Evans and Andrew Ramsey shall not well and truly from time to time comply with and perform all the covenants and conditions herein Stated and Stipulated on their part to be done or performed and complied with in the manner and form and within the time herein before mentioned or in case it Should appear to the Secretary of the Treasury of the United States for the time being or the superintendant of the road for the United States, that the work does not progress and go on with Sufficient speed so as to be finished and compleated in the time herein Specified that then the aforegoing agreement on the part of the United States and every part thereof shall become Null & Void, and the United States shall be at liberty and have full right and Authority any thing herein to the contrary notwithstanding to employ and Set to work or Contract with any person or persons whomsoever in the place and Stead of said Gabriel D Evans and Andrew Ramsey and without any interuption or interference whatsoever from the Said Gabriel D Evans and Andrew Ramsey their heirs executors or Administrators In Witness whereof the said David Shriver Junr. duly authorised in behalf of the United States hath hereunto subscribed his name and affixed his seal and the said Gabriel D. Evans and Andrew Ramsey hereunto set their hand and Seals the day and year first above mentioned

Signed Sealed and Delivered
in presence of
Saml Lowdermilk
James Shriver
David Shriver Junr.
Duly authorised in behalf (Seal)
of the United States
Gabriel D. Evans (Seal)
Andrew Ramsey (Seal)

It is hereby provided that no member of Congress shall be admitted to any share or part of this Agreement or contract or to any benefit arising therefrom

Witness
Saml Lowdermilk
James Shriver.

Sept. 25, 1815
approved
James Madison
Gabriel D Evans
Andrew Ramsay

Street Cleaning at Springfield, Ohio, with Motor Driven Apparatus.

Contributed by George L. Rinkliff, Secretary to the City Manager, Springfield, Ohio.

As a result of the experience of the City of Springfield, Ohio, with motor driven apparatus in its street cleaning department since July 1, 1914, the administration of that city has adopted as a permanent policy the use of that type of equipment for street cleaning purposes.

Three advantages over horse drawn apparatus are claimed for the motor driven equipment. There has been a marked reduction in the operating cost, the efficiency of the street cleaning department has been increased, and the opportunities for estimating both the amount and the cost of the work have been greatly improved. The present plans of the Service Department of this city for 1915 provide for the complete motorization of all equipment. Two pieces of apparatus were installed last year, a motor driven pick-up sweeper and a motor dump truck.

The problem of street cleaning in Springfield has been a serious one for several years past. In 1912 the street cleaning department expended $30,000. In 1913, owing to a reduction of revenues, the cost was cut down to approximately $25,000, and it was necessary to suspend operations two months before the close of the year to prevent the incurring of further liabilities. The cost of street cleaning in the business section of the city during the remaining two months was borne by the merchants. At the first of the year 1914 the form of government in Springfield was changed to the commission-manager plan and the appropriation for street cleaning purposes amounted to $25,000.

Out of this appropriation there was expended approximately $6,500 for new apparatus, reducing the funds for operating purposes to less than $19,000. Despite this reduction the street cleaning department was able through the use of motor driven apparatus to keep its operating cost down to slightly more than $18,000 for the entire year. In this amount was included the cost of removing some 40,000 cubic yards of rubbish which had been accumulating in the back yards and alleys of Springfield for several years. The secret of the method by which this saving was effected was the increased efficiency of the department through the use of motor driven apparatus.

The street sweeper installed in Springfield sweeps an 8-ft. swath, the broom operating at right angles to the direction in which the sweeper moves and throwing the sweepings forward into an elevator which carries them upward into a diamond shaped bin of a capacity of 3 cu. yds. The sweeper carries a 180-gal. water tank, from which water is sprayed by atomizers upon the pavement directly in front of the broom, keeping down the dust, except upon such places in the streets as the accumulations are unusually heavy. The sweeper will clean within 8 in. of the curb, and it has been found that one laborer with a broom can sweep the gutters in a street nine yards or more in width while the machine cleans the remainder of the surface. The motor sweeper has established a record of from 100,000 to 120,000 sq. yds. per eight hour day, and the streets are swept twice weekly.

Previous to the installation of the motor driven apparatus the streets were swept once a week with the horse drawn apparatus, three two-horse sweepers and a sprinkler being used for this purpose. To haul away the sweepings five two-horse wagons were required. The following tabulation shows a comparison of the cost of horse drawn and motor driven apparatus in an eight hour working day:

Horse drawn apparatus	
1 team and driver on sprinkler	$ 4.00
3 teams and drivers on sweepers at $4.00	12.00
3 laborers at $2.00	6.00
Total	$22.00
Motor driven apparatus:	
Operator	$ 3.00
1 laborer	2.00
Gasoline and oil	1.50
Total	$ 6.50

The motor truck used in hauling away the sweepings is equipped with a 3 cu. yd. dump bed and one operator and four laborers are required to man it. The chauffeur acts as a sub-foreman. Not only is the time-waste reduced to a minimum in the haul to the dump and the return, but it has been demonstrated that the districts where the dirt is collected in small piles at intervals of a few yards, the sweepings can be loaded much more rapidly than when horse drawn equipment is used, by running the truck at a low rate of speed and loading the sweepings without stopping the machine. The comparative cost of horse drawn and motor driven apparatus per eight hour day is shown by the following tabulation:

Horse drawn apparatus:	
5 teams and drivers at $4.00	$20.00
5 laborers at $2.00	10.00
Total	$30 00
Motor driven apparatus:	
Chauffeur	$ 3.00
4 laborers at $2.00	8.00
Gasoline and oil	1.50
Total	$12.50

The total cost of street cleaning for the year 1914 is as follows:

Wages	$17,233.21
Supplies, including gasoline, oil, etc.	651.87
Maintenance of equipment	377.05
Total	$18,262.13

The truck in use at the present time has a wheel base of 144 ins., which has been found too long to enable it to turn at alley intersections. During the coming year a smaller truck of the same type, having a wheel base of 120 ins., which will turn at alley intersections, will be used for removing rubbish from back yards and alleys. This portion of the work has formerly been done by horse drawn apparatus, and it is expected that a still further saving in the operating cost of the street department will be shown as soon as this piece of equipment is put to work. Another truck will be used for street repair work, it being demonstrated that practically the same advantage can be secured in so far as the distance of hauling and rapidity of unloading is concerned.

The estimate of the cost of the operation in the street cleaning department for the year 1915 as prepared by City Manager Charles E. Ashburner, and as adopted by the City Commission in the appropriating ordinance for the present year was $21,885, in which amount is included $2,700 for the purchase of the truck for use in alleys. The appropriation for this year provides for the cleaning of a considerable larger area than formerly, the area of paved streets in Springfield having been increased one-third in the last year.

In the foregoing comparisons no estimate of depreciation is included, but it is felt that $3 per day is sufficient to cover the repairs, depreciation and the interest on investment.

Bituminous Concrete Pavement Construction in Washington, D. C.

Contributed by Mark Brooke, Captain, Corps of Engineers, U. S. A., and Assistant to the Engineer Commissioner, District of Columbia.

In 1910 two experimental pieces of bituminous concrete pavement were laid in Washington, D. C., under a specification prepared in the office of the engineer commissioner. Additional pavement has been laid each succeeding year until at present there are about 90,000 sq. yds. in use.

This pavement appears to possess all the good qualities and but few of the defects of sheet asphalt, a fact which together with its lower first cost has decided the engineer department to continue its use on a larger scale on streets for which sheet asphalt has heretofore been considered the most suitable type of pavement.

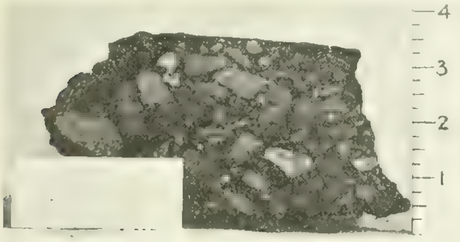


Fig. 1. Sample of Bituminous Concrete Laid Under District of Columbia Specifications for 1911.

In composition this pavement is practically a sheet asphalt pavement, the binder and top courses of which have been consolidated into a single course by combining a sheet asphalt surface mixture with a binder course composed of run-of-crusher stone, in such proportions that the surface mixture fills the voids in the stone.

The proportions of coarse and fine aggregate for this concrete were fixed after a number of sieve tests of local sand and trap-rock at about 2 parts by volume of stone to one of sand, to which is added about five per cent of dust to supply the deficiency in fine material of the stone aggregate.

The specifications for bituminous concrete surfacing provide for laying both on a concrete base, similar to that used for sheet asphalt, and on a broken stone or gravel base. The ingredients consist of crushed trap rock devoid of dust and varying in size from 1 in. to screenings, sand, mineral dust and asphaltic cement. A hard grained moderately sharp sand is used. Upon sifting at least 25 per cent must be caught on a 20-mesh sieve and 5 per cent pass an 80-mesh sieve. A deficiency in fine sand may be corrected with mineral dust, which consists of any fine Portland cement or limestone dust at least 85 per cent of which passes a 100-mesh screen and the whole of which passes a 30-mesh. A refined fluxed asphalt is used free from water and having a penetration of from 40 to 70 when tested on a Dow machine at 77° F. with No. 2 needle, 100 grams for 5 seconds. The penetration and percentage of cement used is varied to fit condition of traffic and variation in material but in no case is more than 7 to 9 per cent of bitumen soluble in carbon bisulphide used.

The paving mixture is prepared in an asphalt paving plant. The sand and stone after being heated in separate dryers to about 300° F., are conveyed to the box used for mixing binder stone where the hot asphaltic cement and cold limestone dust are added and the whole thoroughly mixed. The method of laying is described in the specifications as follows:

The mixture will be hauled while hot to the site of the work and shall be covered until deposited on the street. The temperature at the time of dumping shall not be less than 220 degrees. The hot mixture shall be evenly spread with hot tools upon the base to such a thickness as will make a layer 2 ins. in thickness after rolling. It shall then be rolled with a steam roller weighing not less than one ton per foot of tread of roller, until no further compression occurs. After the rolling of the asphaltic-concrete wearing surface has been completed there shall be spread over such surface a thin coating of asphaltic cement as used in surface not to exceed on an average ¼ gal. to the square yard, of such consistency as shall be approved, which shall be thoroughly brushed into the wearing surface so as to fill all voids and smooth out any minor unevenness of the said surface. There shall then be spread over and rolled into this flush coat a thin layer of trap screenings, so far as practicable, devoid of dust, in size from ⅜ in. down, to secure a gritty, non-slippery surface.

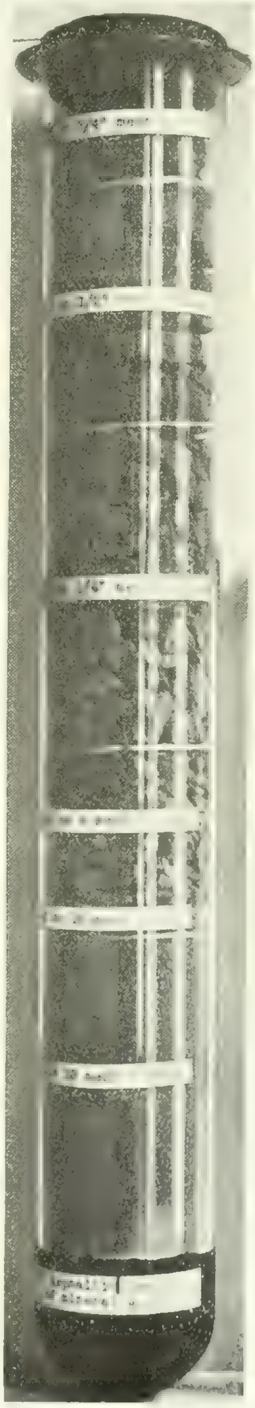


Fig. 2. Typical Sample of Bituminous Concrete Mixture Showing Proportions of Different Ingredients.

TABLE I. — AVERAGE GRADING BITUMINOUS CONCRETE MIXTURE, WASHINGTON, D. C., 1910-1914

Retained on square mesh.	1910.	1911.	1912.	1913.	1914.
1-in. mesh	1.0	0	0.3	0.0	0.0
[illegible] in. mesh	[illegible]	20.2	12.8	5.0	0.0
2-in. mesh	30.0	18.0	[illegible]	13.7	17.6
4-in. mesh	19.2	21.2	26.3	19.2	25.2
8-in. mesh	2.6	9.6	9.5	17.0	14.6
10-in. mesh	0.3	1.0	1.3	3.8	2.8
20-in. mesh	1.3	3.0	4.9	10.2	8.0
40-in. mesh	10.7	6.6	8.0	13.0	12.3
60-in. mesh	10.7	7.0	7.0	6.1	5.8
80-in. mesh	6.2	3.6	3.5	3.2	3.2
100-in. mesh	1.6	1.7	1.2	1.0	0.8
Passing 100 mesh	3.2	7.8	6.3	8.0	8.8
Spc. gr. stone	2.85	...	2.93	2.97	2.86
Spc. gr. sand	2.69	...	2.70	2.70	2.68
Per cent of voids in aggregate	26.4		21.98	20.76	21.39
Per cent bit. sol. in CS_2 (not including flush coat)	7.1	6.8	6.9	7.35	1.80
Average penetration of asphaltic cement	60	60	60	60	60

This material, particularly if there is a slight excess of cement, tends to separate during the haul to the street, the fine material and cement working to the bottom of the wagon.

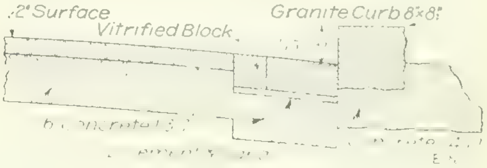


Fig. 3. Partial Section Used for Bituminous Concrete Pavement in Washington, D. C.

In cold weather it is essential that the material arrive on the street amply hot, as the slightest chill stiffens it and makes it very difficult to spread and roll. For these reasons, aside from other considerations motor trucks have been found to be better than carts or wagons for the hot haul.

Some difficulty has been experienced in applying the flush coat in sufficient quantity to seal the surface without causing the formation of a mat which would cover up the stone aggregate and produce a slippery surface.

The specification originally provided for the application of a thin coat of hot asphaltic cement. On several streets the hot cement used in the paving mixture was tried. It was poured from pots, broomed and squeegeed and a small hand spreader was used but notwithstanding the care taken to get it on thin it was found impossible to prevent the formation of a mat which became very slippery in spite of the application of the stone chips. On one street this surface was so objectionable that it has been necessary to sand it each summer. The effect of the coarse sand and the partial wearing off of the mat and consequent exposure of the stone are gradually curing this slipperiness.

After this experience the hot application was abandoned for an asphaltic emulsion which is applied cold, broomed in and then covered with chips. After the evaporation of the water and emulsifiant (ammonia) a light coating of asphalt is left. This method gives the rough mosaic surface which is desired but it is questionable if there is sufficient body of cement to bind the fine material and effectually seal the surface.

I believe it would be practicable to get a satisfactory flush coat by applying a lighter cement with a power distributor such as used in macadam surface and penetration work and the engineer department intends to try this method.

An apparent defect in this specification is the lack of any requirement as to grading of the stone. It is evident that the composition of the mixture might vary within wide limits. However, from Table I, showing the average of the tests of the mixtures actually laid in five working seasons, it will be seen that the aggregate runs fairly uniformly.

The sand is tested before use for compliance with the specification for that material but no attempt is made at selection, or separation or grading of any sort of the run-of-crusher stone. The material below the 8-mesh is fairly uniform due no doubt to the sand entering into this part of the mixture. The increase in material passing 100-mesh from 1910 to 1911 is due to a change in specifications increasing the amount of mineral dust. In the 1910 mixture only about one per cent of dust was added whereas not less than 5 per cent has been used since.

The stone used up to this year was a trap from a quarry near the Potomac about thirty miles above Washington. The 1914 stone is a different stone from a quarry on the Susquehanna near Havre de Grace, Maryland.

The average price of this pavement laid to a thickness of two inches after compression, including a six-inch gravel concrete base and grading for same, has been $1.79, which includes a five-year guarantee. The average price for the pavement without base has been $0.97, including guarantee. The average cost of macadam base has been $0.345, making cost of bituminous concrete pavement on macadam base $1.31.

The average price of standard sheet asphalt with base during the same period was $1.84 and exclusive of base $1.06, with same guarantee.

Bituminous concrete surfacing has been laid on both concrete and macadam base, the latter usually consisting of an old macadam roadway shaped to a proper cross section. The use of a well bonded macadam roadway as a base has not in practice effected as great a saving as might have been expected as the work of scarifying, building up on the quarters and rolling, necessary to bring the macadam to a cross section two inches below and exactly parallel to the finished surface has always proved much greater than was anticipated. Moreover this shaping of the old roadway very largely destroys its bond, one of the valuable assets of the old pavement. For these reasons the use of macadam base has been discontinued save in exceptional cases.

It is too soon to determine the ultimate economy of this pavement or its relative value as compared with sheet asphalt with which it is in competiton in Washington. Its first cost is slightly less than that of sheet asphalt; it apparently requires less traffic to keep it in condition, and will carry heavier traffic than sheet asphalt. It has been notably free from the defect of creeping or rolling which has become more significant since the advent of fast moving motor traffic, and it has an ideal surface for horse traffic.

On the other hand it is not so dense as a sheet asphalt top mixture and may not prove as durable.

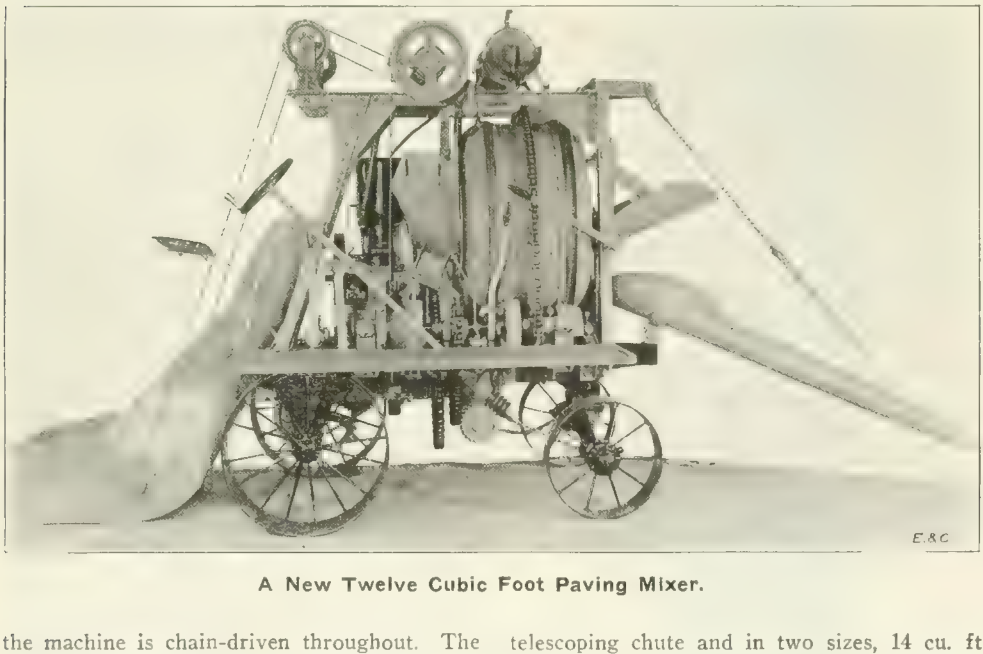
As far as can be judged from the limited experience of our five seasons' work, this pavement will prove satisfactory and its use will be continued on an increasing scale.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A New Twelve Cubic Foot Road Mixer.

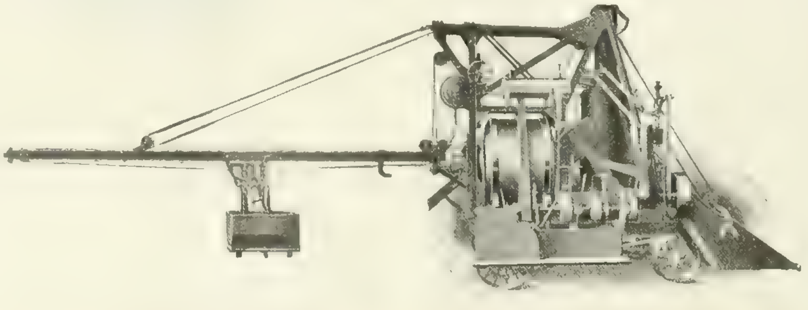
The mixer illustrated is complete for road work, having a power-charging hopper, discharge chute, water tank, traction drive, batch counter, and all the other usual appliances. Equipped with gasoline engine, the net weight is 8,500 lbs.; with steam engine it weighs 10,500 lbs. Except for the gear-driven traction, the machine is chain-driven throughout. The main frame is 7x4 ft. of steel channels; the wheels have 12-in. tread, and are 36 ins. and 26 ins. in diameter. The wheel base is 6 ft. The height from ground to center of drum is 5 ft. 5 ins., which gives nearly a 1 on 2 pitch to a 10-ft. chute. Either a 5-ft. or a 10-ft. chute may be carried. The traction speed is one-half mile per hour. The water tank is 16 gals. size, with 2-in. tank inlet and 3-in. supply to the drum; a special arrangement permits hopper to turn on water at the proper time in charging. The hopper loads drum in 12 seconds; it automatically throws out hoisting clutch when it has reached proper heights to discharge. For steam operation the engine is 6 hp., reversing link motion, and the boiler is 5 hp.; the gasoline engine is 5 hp. All bearings are babbitted and fitted with hard oil grease cups. One man will operate the mixer, but two men are recommended for maximum results. The mixer is made by the Atlas Engineering Co., 782 30th St., Milwaukee, Wis.



A New Twelve Cubic Foot Paving Mixer.

A Newly Designed Street Paving Concrete Mixer.

The mixer illustrated is built with boom and bucket distribution as shown or with telescoping chute and in two sizes, 14 cu. ft. and 22 cu. ft., both operated by steam or by gasoline engine according to choice. The frame is made of channels with riveted angle connections. It has two supports on the rear axle and one on the front axle designed to permit swiveling and rocking. Extra wide tread steel wheels are used. The boom type machine illustrated has a boom of two parallel channels separated by spacers; this gives a wide track for the bucket trolley. The boom swings both ways to a right angle with the mixer and it may be raised or lowered. The bucket travel and dumping operations are controlled by rope haul by the operator who can dump at any point along the boom. In returning the empty bucket is automatically closed as soon as it comes under the discharge spout of the drum. The chute discharge of this mixer is novel in that it telescopes by means of a hand wheel and rack. The drum and fixtures are those regularly employed with mixers of this make. The traction has two speeds ahead and one reverse. Stopping and starting are controlled by a multiple disk clutch. The power charging hopper is wide and is fitted with a dumping bar. All other parts are those of the standard mixers made by the firm which is the Oshkosh Manufacturing Co., Oshkosh, Wis.



New Street Paving Mixer with Boom and Bucket Discharge.

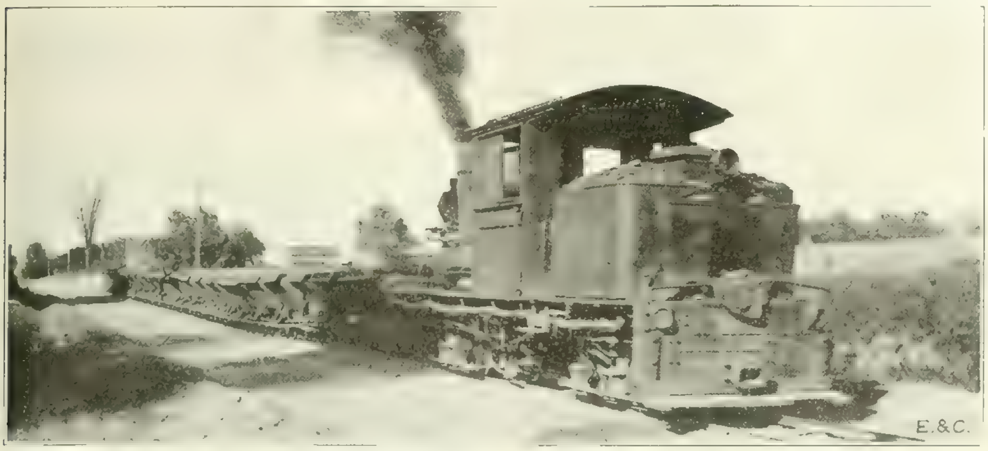
Small Shay Locomotive for Contractor's Service Railways.

(Contributed.)

A 13-ton Shay locomotive designed for construction work is shown by the accompanying cut hauling on portable railway material for road construction. The general dimensions of this locomotive are: Weight in working order, 13 tons; two cylinders, 6x10 ins.; rigid wheel base, 48 ins.; total wheel base, 8 ft. 10 ins.; eight drivers, 22 ins. in diameter; 400-gal. water tank; ¾-ton coal bunker, and 6,050 lbs. tractive power.

This locomotive is a special type and is characterized by its ability to take curves of a very small radius, and by its great tractive power. The cylinders on this locomotive are vertical and drive a pinion shaft which engages with gear rims on the driving wheels.

The boiler has an unusually large and deep firebox, which provides for the combustion of practically all the gases from the fuel, and, therefore, is most economical in the use of fuel. On the right hand side the steam bracket is fastened to the boiler by means of studs, and the cylinders are bolted to this bracket. The frames supporting the boiler are rigidly attached to the firebox end with provision for expansion at the smoke box. These frames are of I-sections, with deep truss-rods and posts. Over the trucks the frames are provided with cross-bolsters bearing center plates, which rest on the truck center plates.



Shay Locomotive Weighing 13 Tons for Construction Work Hauling.

The trucks are 4-wheel, all wheels being drivers. Their only connection is through the center plate and they are free to curve, adjusting themselves to considerable variations in the surface of the track.

The cylinders and cylinder frames are cast in one piece. The pistons and crossheads are solid cast iron; the connecting rods are forged solid without welds. The crank of this locomotive is double-throw.

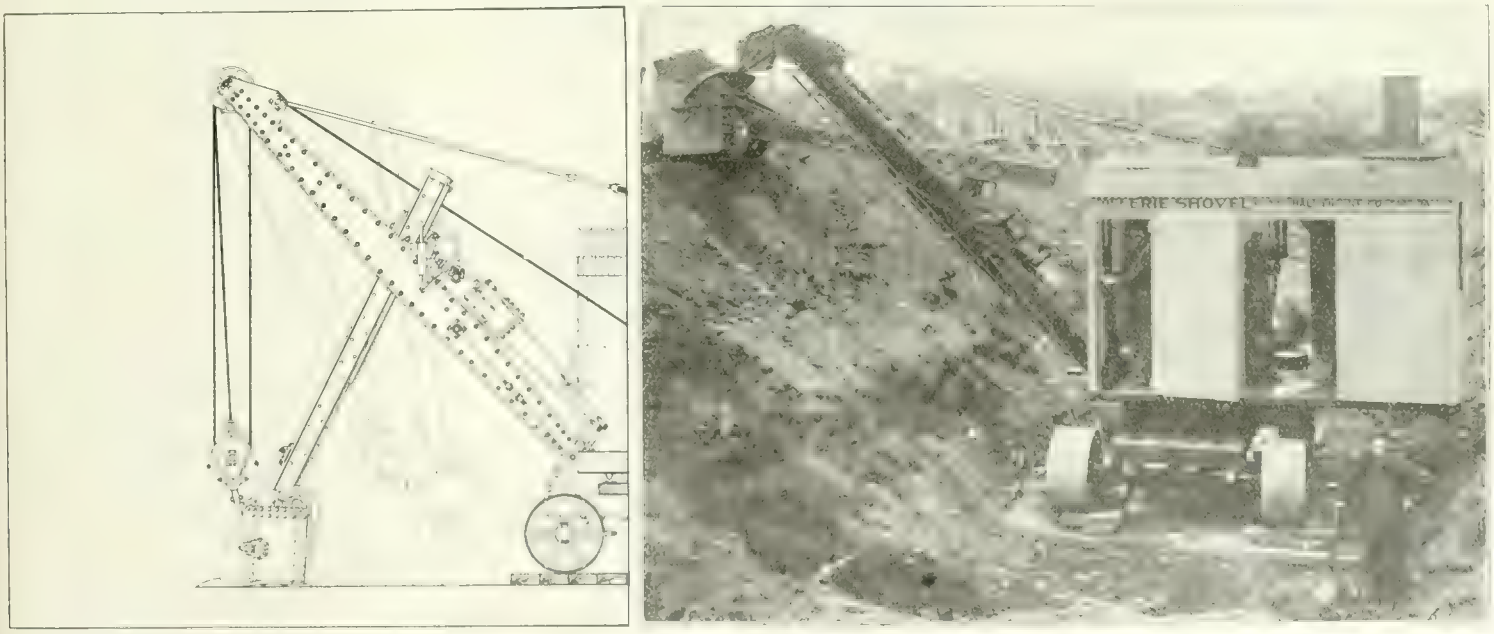
The wheels are driven by means of pinion shafts, the pinions engaging with gear rims keyed and bolted to the wheels at the right hand side of the engine. This driving shaft is equipped with Shay compensating joints. This consists of two universal joints with slip joints between. These slip joints are composed of a forged steel square shaft and a sleeve. When a corner is being turned which equally on the opposite sides of the longitudinal center line would require the driving shaft to be shorter, the shaft slips farther into the sleeve; when turning the other way, the shaft slides further out of the sleeve.

The engine is so built that the weight is evenly distributed; the boiler is set over to the left, the amount necessary to balance the cylinders on the right side. Since all the wheels are driving wheels, all the weight rests on the drivers and is used for adhesion. This gives the locomotive great pulling power without slipping on the rails.

This new small Shay locomotive is built by the Lima Locomotive Corporation, Lima, O

A New Revolving Steam Shovel with Horizontal Crowding Motion.

A ¾ cu. yd. dipper steam shovel having full revolution and a horizontal crowding motion, with special automatic features, is illustrated here. The halftone indicates very clearly the truck construction and the high lift possible with the dipper, and the line drawing indicates the horizontal movement of 8½ ft. of the dipper. Tracks, boom, dipper and dipper handle, steering device and engines are all of special design and remarkably compact. Incidentally the shovel is so designed that a long dipper handle can be substituted for trench work, or a special boom and apparatus substituted for handling grab buckets. The range of operation is a cut 35 ft. wide on the bottom with one cut; an 8-ft. horizontal cut ahead without moving up; teams or cars can be loaded 23 ft. from the center of the shovel; teams can be loaded on a bank 8 ft. above the pit bottom.



Revolving Steam Shovel with Automatic Crowding Device and Three Lever Control

The crowding device operates on a standard shipper shaft; it automatically controls the crowding engines. Briefly, while the power from the hoisting engines lifts the dipper through the material, the dipper is automatically forced into the material by the crowding engines at the proper rate to cause the dipper teeth to follow the floor bottom in a straight line. After the load is deposited the dipper automatically returns to the grade on which the shovel is operating, and does not have to be adjusted. Also by changing the notch of the automatic contact latch lever the grade can be changed. Once a grade is fixed the dipper returns to and cuts to that grade absolutely without manipulation by the operator.

The shovel is operated by three levers and a foot brake. No craneman is required. One lever handles all operations of hoisting, one operates the crowding engine, and one the swinging engines, and the foot brake lowers the dipper. The shovel is absolutely "one man" operated, and it is claimed that, owing to the automatic control, any reasonably clever man, experienced in handling road rollers, traction engines or similar machinery, can be trained to operate.

The ¾ cu. yd. shovel illustrated is truly ¾ cu. yd. machine in all details. It is primarily designed and built throughout to carry a real ¾ cu. yd. dipper without overtaxing the machine and without imposing greater duties upon the parts of the operating mechanism than they should be called upon to stand. The advantages of this size of shovel are stated as follows: Two dippers of material completely fill the ordinary 1½ cu. yd. wagon or car, while but three trips are required to load a 2-yd. wagon to its maximum capacity. The great advantage over the ⅝ cu. yd. dipper is readily apparent. When loading either 1½ or 2-yd. wagons, of course, one less trip is required than with a ⅝ cu. yd. machine, thus saving from 33⅓ to 50 per cent of the loading time.

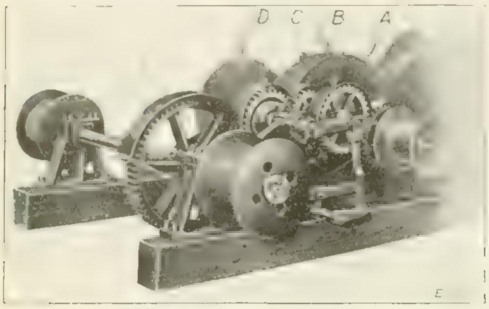
The shovel is known as the "Erie," and is made by the Ball Engine Co., Erie, Pa.

An Improved Reversing Gear Boom Swinger.

(Contributed.)

The cut illustrates a mechanism which can be attached to any hoist, by having the front drum shaft extended on which a pinion can be fastened. The swinging arrangement consists of a cast iron frame and brace with end bearings, on driving drum shaft and on swinging drum shaft, in order to keep them in line, and make it impossible for the gears to get out of mesh. The driving gear is on a long shaft to which two grooved drums are fastened. The frame supports the shaft bearings, gears, pinions and frictions. The construction is compact and self-contained, leaving a clear space for the ropes to the main drums.

The rope speed on the small drums can be varied according to conditions. To accomplish this a change in gears *A* and *B* in the cut will increase or decrease the speed. Gear *A* is the driving gear meshing into gear *B*, which is keyed to a shaft revolving the gear *C*, the latter meshing into gear *D*. When the swinging drums are revolved in one direction the gear *D* acts as a friction drive; when the swinging drums are reversed, it becomes an idler or means for reversing, meshing into a similar friction gear directly under it. On the friction gear shafts are pinions that drive the large gear. The frictions are cone type, so as easily to adjust and replace the blocks, and are operated by levers through right and left hand friction nuts. These levers are connected through stubs and shafts to the main control lever, in easy reach of the operator. Since the main drums always revolve in one direction, by moving the lever forward or backward, the small drums are revolved in either direction. In this mechanism there are only two revolving shafts, the one driving the gear *C* and the swinging drum shaft. The shafts on which the friction parts revolve remain stationary (the wheels revolve), so that while the swinging drums are in motion or at rest the friction on bearings and gearing is greatly reduced and little power is required to operate them. Thus the most important requisites in geared boom swingers, saving of time and power of operation, are assured.

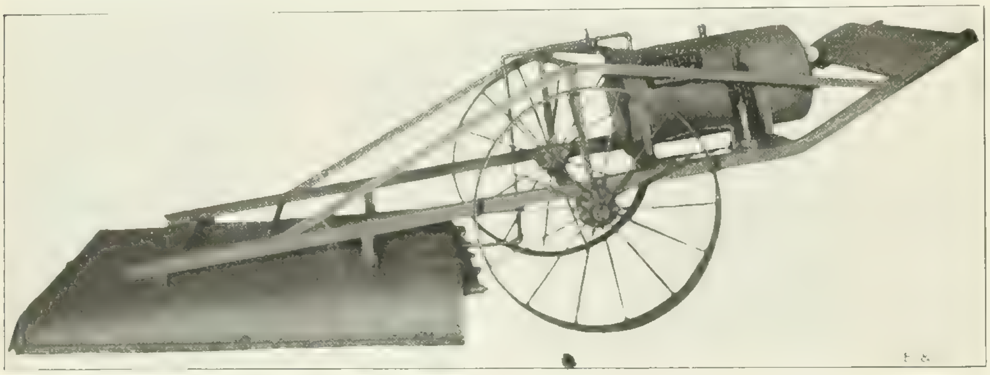


Improved Reversing Gear Boom Swinger.

The improved reversing gear boom swinger is the Werner, Flory patent and is manufactured by S. Flory Manufacturing Co., Bangor, Pa.

Surface Heater for Asphalt Pavement Repairs.

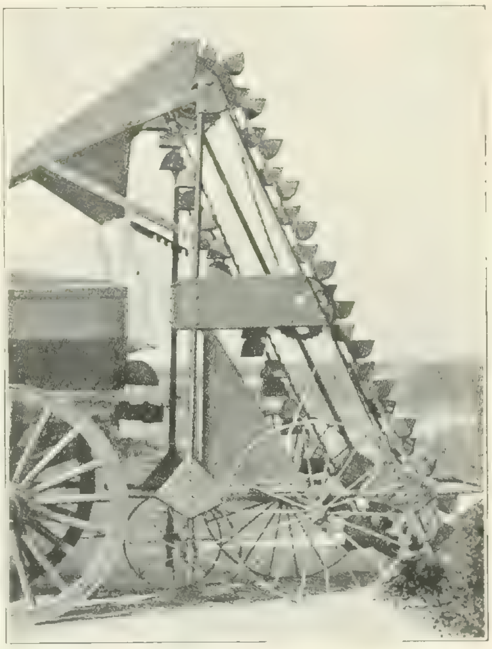
The illustration shows a surface heater, six of which have recently been purchased by New York City for asphalt pavement repair work. By this heater a thin patch can be perfectly welded to the old pavement, or a hump or ridge can be softened and removed, or any repair completed with perfect adhesion between old and new material. In operation the heater is wheeled over the part to be replaced, and when the surface has been heated, which takes only a few minutes, it is scraped clean and the new material is added, and in the usual manner finished smooth. The heater uses kerosene; the tank is 25 gals. capacity, and compression is by a hand lever and pump with a 3-in. barrel. The wheels are 30 ins. in diameter, with staggered spokes, and the frame is heavy iron construction. The hood is 48x60 ins. and stiffened by angles. A modification of this heater known as type N is constructed for work in which the flame is not desired to come into direct contact with the pavement. These heaters are made by The Macleod Co., 211 Pearl St., East, Cincinnati, O.



Kerosene Surface Heater for Repairing Asphalt Pavement.

Portable Wagon Loader with Duplex Bucket Elevator.

The wagon loader illustrated was designed to meet the demand for a high capacity machine which can be operated by two men or in case of an emergency by one man. This loader instead of one row of buckets has two rows; the buckets in one row are "staggered" with the buckets in the other row. In taking material from stock pile, therefore, this loader takes twice the number of bites that a single line of buckets takes, and each bite is smaller and thus the torque on the motor is halved.

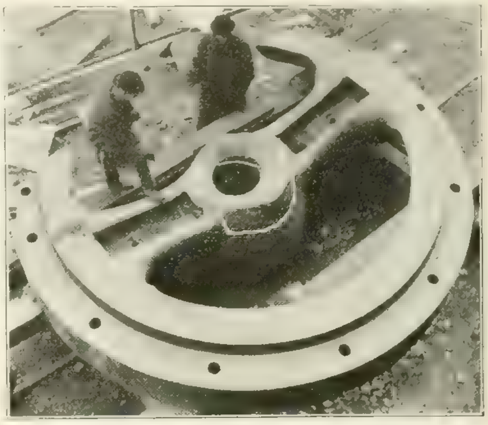


Portable Wagon Loader with Duplex Bucket Elevator.

In discharging onto the screen also the feed is more even and uniform and each charge is smaller, so that screening is more rapid and perfect. All elevator and chain shafts have ball bearings. These features combine to give light construction and minimum motor power. The machine weighs only 1,400 lbs., and a 2-hp. motor operates it at a rate of 50 to 60 tons of anthracite coal per hour. It handles as readily sand, gravel and broken stone. Electric or gasoline power is provided as desired and both screen and solid loading chutes are provided. The list price is $350 f.o.b. works. This loader is made by the Hudson Machinery Co., 15 Park Row, New York City.

Oxy-Acetylene Welding a Broken Crusher Spider.

The oxy-acetylene torch for welding and cutting metal has attained such general use in recent years that novelty is becoming limited to records of unprecedented tasks, one surpassing another, performed by this device. In the accompanying view is shown a break which occurred in a 40-ton spider of a large gyrating crusher. To replace the part of the spider shown, which weighed 30 tons, would have cost $2,300. The break was welded by the oxy-acetylene process in 60 hours continuous work of two men. The welding was done by the Oxweld Acetylene Co., of Chicago, Ill.



Oxy-Acetylene Weld of Break in Crusher Spider.

Steel Sheet Piling in India.—American steel sheet piling is now being extensively used in India for supporting the sides of sewer trenches in place of the more usual wooden timbering for such purposes.

The engineering supplement of the *Times of India*, Bombay, describes the use of this piling in Madras and Bombay as follows:

> In connection with the Madras drainage scheme, the special reason for using the sheet piling in the sewer trench is that at 14½ ft. below ground a black muddy subsoil is encountered. This is very difficult to excavate as it is fluid. As a matter of fact, it has been necessary to strap the bottom of the excavation down in order to make any progress at all. As the level of the mud inside the trench is lowered, very considerable load is produced on the timbering. It was possible to do the first 5 ft. of excavation without timbering. The piles were then placed in position and afterwards kept driven down about 2 ft. ahead of the excavation until the mud was reached, and into this the piling was driven to its available depth.
>
> In the manhole the piling was driven about 7 ft. into the mud before any serious attempt was made to remove the latter. No machinery has been used, and the whole of the piling has been driven in at first by a maul and afterwards by a heavy piece of timber used as a monkey.
>
> In Bombay, where sewerage work is being carried out on a large scale, this steel piling has also been brougnt into use.

A measure has been introduced in the Ontario Legislature which will make owners of heavy motor trucks and wagons liable for rutted roads, and will give municipal corporations power to recover the amount of damage from them, by appeal to a county judge.

Ontario has built over 3,000 miles of waterbound macadam roads since the introduction of the county road system in 1901.

Engineering and Contracting

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Gives details of a new type of reinforced concrete floor designed by the Minnesota Highway Commission for beam spans. This floor is designed to replace a wooden floor without requiring the use of heavier joists. Also gives details of the standard reinforced concrete floor now in use for beam spans. E. & C., April 7, 1915; 1½ cols.

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Gives unit cost for excavating 292½ cu. yds. and for hauling, spreading and backfilling excavated material. E. & C., April 7, 1915; ½ col.

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Describes a small economically handled construction camp. Gives details of selection of site, drainage, water supply, etc.; the kind of labor employed, and method and costs of feeding the men. E. & C., Apr. 7, 1915; 5½ cols.

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Methods and Cost of Planting a Small Park to Grass, Making Paths and Planting Hedge 320

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Dry Rubble Retaining Walls for Highway Embankment in Hawaii........ 323

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FOREIGN TRADE NOTES

The following foreign trade apportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409, U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank Bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should eb made to the file numbers.

Mining Machinery.—Firm has been established in American consular district in Sweden which will devote its attention to the importation of American goods, especially mining machinery. No. 16256. [For address see first paragraph.]

Motor Cars.—Ministre de fomento of Spain has been authorized to call for open bids for 46 motor cars, suitable for inspectors of roads. Proposals, with all details, and prices must be filed with the Ministerio de Domento, "Direcion General de Obras Publicas," Madrid, Spain. Statements must be written in Spanish. No. 16274.

Timber Preserving Plant.—Trading company in India wishes to be placed in touch with American firms specializing in the manufacture and installation of plants for the treatment of timber such as railway ties. The company states that it is considering establishing a plant for the treatment of not less than 100,000 broad-gage ties per annum. No particular process of treatment has yet been decided upon, and the company wishes to receive suggestions from American firms manufacturing plants for preserving timber. Correspondence may be in English. No. 16280. [For address in first paragraph.]

Railway Supplies.—The manager of a railway company in the East Indies desires to be placed in communication with American manufacturers of rolling stock, rails, ties, and railway supplies of all kinds. Full descriptive matter, prices, f. o. b. shipping ports or c. i. f. destination, should be submitted at once. Correspondence may be in English. No. 16285. [For address see first paragraph.]

Cement Mills.—A number of capitalists in Russia are contemplating the erection of mills to manufacture cement, paper, veneer woods, and chair seats. It is stated that the cement plant is to have a capacity of about 1,000 barrels per day. The company also wishes to erect a plant for making barrels. Prices should be quoted in Russian equivalents and c. i. f. Russian ports. No. 16286. [For address see first paragraph.]

Drilling Machinery.—Business man in Russia desires to be put in communication with American manufacturers of drilling machines similar to an illustration which may be examined at the Bureau and its branch offices. Prices, weights, etc., should be stated in Russian equivalents, and quotations should be made c. i. f. Russian ports. Correspondence may be in English. No. 16211. [For address see first paragraph.]

Tramway.—Firm in Central America is negotiating for a concession to build and operate a 3-mile tramway in a town of about 7,000 inhabitants. The motive power is to be either electricity or gasoline motors. No. 16197. [For address see first paragraph.]

Blasing Caps.—Company in Switzerland desires to communicate with American manufacturers of detonators or blasting caps to be used in stone quarries. No. 16203. [For address see first paragraph.]

INDUSTRIAL NOTES

The executive offices of the Concrete Steel Co., after April 15, will be located at 42 Broadway, New York City.

The Denver, Colo., office of the Sullivan Machinery Co. following May 1 will be located at 837 Equitable Bldg. Mr. George W. Blackinton is manager.

The Link Belt Co. of Chicago is manufacturing a new drag line excavator which it is claimed embodies the most advanced design of this type of earth handling machinery.

The Newport Culvert Co., Inc., has succeeded the Harry Bros. Co., Inc., of Newport, Ky., the change taking place the first of the year. The Newport Culvert Co. will continue the manufacture of "Genuine Open Hearth Iron" culverts for railroad and county use.

Mr. A. P. Robinson has been appointed manager of sales for the Insley Mfg. Co., Indianapolis, Ind. Mr. Robinson until recently was connected with the W. E. Austin Machinery Co. of Atlanta, Ga., as vice president and chief engineer.

The Chas. T. Topping Machinery Co. of Pittsburgh, Pa., dealer in contractors', mine and quarry equipment, has removed its offices to Suite 928 Oliver Bldg., Pittsburgh. It will continue as direct representative in Western Pennsylvania and Northern West Virginia for Koehring concrete mixers; Clyde hoisting engines and derricks; Wylie concrete distributing systems; the Cement-Gun; McKiernan-Terry pile hammers and rock drills; Negley slack-cable excavators; Buchanan rock and ore crushers; crushing rolls and magnetic separators; Patten electric builders hoists; Easton industrial cars and railway systems; converse portable sand screens; Hotchkiss steel forms; and other well known lines of machinery and equipment.

NEW CATALOGUES

Surveying Instruments.—Paper, 6x9 ins.; 90 pp. Kolesch & Co., 134 Fulton St., New York city.

Extract from the general catalogue, comprising the section devoted to surveying instruments. It is fully illustrated, and contains complete data and descriptive matter.

Threshing Machinery. — Paper, 10½x7½ ins.; 64 pp. Nichols & Shepard Co., Battle Creek, Mich.

Fully illustrated descriptive catalogue of the weighers, wagon loaders, steam traction engines, plow engines, straw burners and oil and gas tractors of the company.

Waterproofing Paste.—Paper, 3¼x5½ ins.; 4 pp. Sandusky Portland Cement Co., Sandusky, Ohio.

Circular describing Medusa waterproofing in paste form, which is now being manufactured by the company. Gives directions for use and information as to price, shipping, etc.

Grader and Wagon Loader.—Paper, 10½x 7½ ins.; 8 pp. The Austin-Western Road Machinery Co., Chicago.

Circular of Austin elevating graders and wagon loader. Describes in detail and illustrates the New Era grader with Austin disc plow, offset engine pole, sand or dust pan cleaning attachment, reversible deflector, etc.

Bitumen Distributor.—Paper, 6½x4 ins.; Standard Mfg. Co., Cypress St., Worcester, Mass.

Describes the Johnson apparatus for heating, transporting and spraying bitumen. Shows the various models of oil and tar sprayers and tank wagon, and gives data as to quantities and application.

Motor Trucks.—Paper, 7¾x10½ ins.; 20 pp. The Thomas B. Jeffrey Co., Kenosha, Wis.

The "Jeffrey Quad," a motor truck designed for haulage over difficult country or heavy roads, is dealt with in this book. The truck drives, brakes and steers on all four wheels and can be used as a tractor. Descriptions and photographs of severe tests are included, together with tables of costs, diagram of construction and specifications.

Road Machinery.—Paper, 10x8 ins.; 12 pp. Austin-Western Road Machinery Co., Chicago.

"Circular of Road Tools," showing Western Township wheeled scrapers, drag scrapers, buck and tongue scrapers, road plows, road drags and graders. Comprehensive descriptive matter and full dimensional data accompany the cuts.

Riensch-Wurl Screen.—Paper, 8x6¼ ins.; 28 pp. The Sanitation Corporation, 50 Church Street. New York city.

Consists of photographs showing the design, application and operation of the Riensch-Wurl Screen. The views shown are almost all from the sewage treatment plant at Dresden, Germany, and show the screen in actual service. A partial list of foreign installations is also given.

Cement-Gun.—Paper, 9x12 ins.; 4 pp. Cement-Gun Co., Inc., 30 Church St., New York City.

Bulletin No. 40, entitled Protection of Structural Steel on the P. R. R. Cortlandt Street Ferry Terminal, New York City. Describes and illustrates the method of applying a thin coating of Gunite without reinforcing for the protection of a steel sub-structure from corrosion and rust.

Road Machinery.—Paper, 10¾x7¾ ins.; 24 pp. Good Roads Machinery Co., Kennett Square, Pa.

"Good Roads. The Machinery to Make Them," is the title of this book, which shows the different types of road machinery manufactured by the company. The list includes the Improved Steel Champion Bucket and National Hercules reversible road machines. Fort Wayne crushers, Monarch roller and traction engine, oil distributors, heating kettles, sweepers, sprinklers, brooms, scrapers, culvert pipe and numerous other machines and devices.

CATALOGUE REVIEWS

Water Main Cleaning.—Paper, 6x9 ins.; 3 booklets, 3 folders. National Water Main Cleaning Co., 50 Church St., New York.

Several publications of value to water works superintendents, engineers, city officials or others interested in water distribution systems have been received from the National Water Main Cleaning Co. Two of these are reprints of articles. The first, "The Restoration of Old Distributing Systems," by Burt B. Hodgman, a paper read at the 1911 convention of the American Water Works Association, is 54 pages in length, is illustrated by views and charts showing the results obtained by cleaning old water mains, and also contains the discussion following the reading of the paper.

The other is a reprint of an article by Caleb M. Saville, which appeared in the Journal of the New England Water Works Association. The article describes the cleaning of water mains at Hartford, Conn., where Mr. Saville as chief engineer of the Board of Water Commissioners had charge of the work. This is also illustrated and contains considerable data as to sizes of pipes, increase of floor, etc. Also gives specifications under which the work was done, views of the machine used and diagrams of operation. An interesting discussion of the paper concludes the pamphlet. The third book is a treatise on the subject of water main cleaning, giving full information as to the machine and methods used, letters from superintendents or engineers testifying to the efficacy of the process, and directions for testing capacity. This is also well illustrated. Several folders of the follow-up type point out the advantages of the increased water supply, the economy and necessity of cleaning the water mains and efficiency of the company's process.

CURRENT NEWS

The Doings of the Week.

Developments of the past week indicated very clearly that the business and finances of the country were approaching the normal. There was a further distinct recovery in business activities. Trade in bonds and stocks during March was well above that for the corresponding month of the previous year. Export business continued to show an increase, the foreign orders for steel for the last two weeks being the largest since the commencement of the war. Confidence in the business situation is shown by the action of the U. S. Steel Corporation in resuming construction on its new $10,000,000 plant at Duluth, in the decision of the steel interests to expend something like $10,000,000 for improvements and additions in the Pittsburgh District, and the steps taken by the Anaconda Co. for expending $6,000,000 for improvements in the copper section of Montana. The French government has arranged for $50,000,000 credit in this country, and negotiations are underway for a like amount for Russia and twice as much for England. All of this $200,000,000 is to be expended for purchase of materials here. In the construction field the principal feature of interest of the past week was the awarding of some large construction contracts for the railways. More big work for the carriers has been placed under contract in the last few days than has been let during the previous 6 months. In the municipal field not so much work appears to have reached the call for bids stage as in previous weeks. Many good sized contracts, however, particularly in the paving field, are now being advertised, and a great mass of work is projected to come up in the next few days. The apportionment of the $30,000,000 River and Harbor bill has been completed, and the government engineers probably will at once commence calling for proposals on many important undertakings. In the iron and steel trade current developments were notably good. There was an increase in inquiries from the railroads and other large consumers. Rail orders in March amounted to 267,000 tons, and the export sales for war orders of the month aggregated about 600,000 tons. Merchant sales of pig iron for the month were about 600,000 tons. The U. S. Steel Corporation is now working at about 72 per cent capacity. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending March 31 were as follows:

Finished Iron and Steel.	Mar. 31	Mar. 24.
Per lb. to large buyers	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.15	1.15
Iron bars, Pittsburgh	1.10	1.10
Iron bars, Chicago	1.12½	1.12½
Steel bars, Pittsburgh	1.15	1.15
Steel bars, New York	1.319	1.319
Tank plates, Pittsburgh	1.10	1.10
Tank plates, New York	1.269	1.269
Beams, etc., Pittsburgh	1.15	1.15
Beams, etc., New York	1.269	1.269
Skelp, groooved steel, P'gh	1.12½	1.10
Skelp, sheared steel, P'gh	1.17½	1.15
Steel hoops, Pittsburgh	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No. 28, P'gh	3.40	3.40
Wire nails, Pittsburgh	1.60	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, P'gh	1.40	1.40
Barb wire, galv., P'gh	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 to 1.20 cts.

Railways. The biggest week of the year in the railway construction field has been pulled off. Several large contracts have been let in the last few days, and bids have been opened on other big jobs. The Norfolk & Western Ry. awarded the contract for its new 36½ mile low grade line from Burkesville to a point near Pamplin, Va. Robert Grace Contracting Co., Pittsburgh, Pa.; Paterson, Moran & Co., New York City; Rinehard & Dennis, Charlottesville, Va,, and J. J. Sheahan, Roanoke, Va., secured the work. The contract for the Williamsport, Nesle & Martinsburg Ry. was let to Claybourne, Johnson & Co., Baltimore, Md. This is an 18-mile line, costing about $2,000,000, and will be a branch of the Western Maryland Ry. The San Diego & Arizona Ry. is reported to have awarded the contract for the last 34 miles of its line, and requiring many short tunnels and a considerable amount of heavy rock work. The Chesapeake & Ohio R. R. opened bids Saturday on the first 28 miles of its connecting line in Ohio. This contract will not be awarded for several days. O. S. Hord and A. Keathley, Cincinnati, O., were awarded the contract for the 21-mile extension of the Ohio Valley Traction Co., from Sciotoville to Ironton.

Roads and Streets.—Not much state highway work appears to have come up for advertising during the past week. New York is calling for bids on 21 repair contracts. Several good-sized county undertakings are ready for estimates. San Bernardino county, California, is calling for proposals on 8.3 miles of concrete road; County Freeholders at Trenton, N. J., open bids on April 20 on 5 miles of highway estimated to cost $118,000. County Commissioners at Seattle, Wash., are asking bids on a $75,000 road job. Greensboro, N. C., is calling for bids on 75,000 sq. yds. of street paving. Most of the other advertised municipal jobs in this line, however, are for comparatively small yardages. Eagle Grove, Ia., awarded a $69,430 contract; Hunterdon county, New Jersey, let a 3-mile road, at $53,715; low bidders on the Winona county, Minnesota, highway work were as follows: Wm. B. Hutchison. Michigan City, Ind., Road No. 85, $107,626; Hanlon & Okes, 319 Lumber Exchange, Minneapolis, Minn., Road No. 86, $103,810, Road 88, $29,733, Road 95, $22,576, Road 96, $53,132; Cameron, Joyce & Co., Keokuk, Ia., Road 87, $47,118, Road 90, $18,911.

Drainage and Irrigation.—No especially large undertakings in either the drainage or irrigation fields appear to have come up for advertising during the past week. The Cripple Creek Drainage & Tunnel Co., Colorado Springs, Colo., is calling for bids for the extension of its mine drainage tunnel. Widdell Construction Co., Mankato, Minn., was awarded the contract, at $72,975, for a judicial ditch for Murray and Cottonwood counties, Minnesota.

Bridges.—Most of the bridge construction advertised in the last few days is for small structures. In Illinois alone bids are being asked on 18 or 20 reinforced concrete bridges. Iowa counties awarded many contracts for county bridges and culvert construction. The Canton Bridge Co., Canton, O., secured the contract for a state aid bridge at North Platte, Neb., at $43,975. The Manitoba Bridge & Iron Works, Ltd., Winnipeg, Man., was awarded a contract, at $253,824, for a bridge over Red River to connect St. Boniface and Winnipeg.

Water Works.—Bids are now being asked on a number of contracts for constructing water works, extensions or other improvements for smaller municipalities. Among the larger works are a concrete reservoir for Duluth, Minn., and water works for Manning, S. C., the latter undertaking calling for 2,800 ft. pipe, reinforced concrete reservoir, tank and towers and pumping equipment. Fostoria, O., opens bids April 20 on a 175,000,000-gal. reservoir of earth embankment, the work involving 113,000 cu. yds. excavation and 20,000 cu. yds. riprap or concrete lining. The Fred R. Jones Co., Cleveland, O., was awarded the contract for the excavation for the new $1,000,000 Baldwin reservoir for the city of Cleveland.

Sewerage.—Few important undertakings in the sewerage field appear to have reached the call for bids stage during the past week. Borough of Brooklyn, New York City, is calling for proposals on work calling for 2,737 ft. of 162-in. sewer in tunnel. Manning, S. C., and Georgetown, S. C., are asking bids on fair sized sewerage jobs.

Street Paving in 1914.

Municipal paving is an unfailing source of construction opportunities. There may be years when less work in this line is undertaken, but no matter what adverse conditions may prevail there always is something going on in the street improvement field. Last year was not a particularly propitious period for construction undertakings. Nevertheless 268 cities in this country and Canada reported an aggregate expenditure of $46,662,000 for paving work. This, of course, represents only a portion of the pavement construction last year. No figures were obtainable regarding the sums expended by many large cities in which extensive paving programs were carried out. Of the cities reporting in this matter Chicago leads with an expenditure of $5,998,000; Los Angeles comes next with $3,005,000, and Philadelphia is third with $2,196,000. Pavement construction in 1914 cost Detroit, Mich., $1,702,000; Portland, Ore., $1,513,000; Cincinnati, O., $1,182,000, and Toronto, Ont., $1,270,000. In some cities especially large yardages of certain types of pavement were laid last year. Of the cities furnishing information on the subject Chicago heads the list for asphalt paving with 820,000 sq. yds.; Los Angeles, Cal., is a close second with 800,000 sq. yds., and the Borough of Brooklyn, New York City, is third with 680,000 sq. yds. Chicago also leads in the amount of brick pavement constructed last year, its total being 523,768 sq. yds.; Columbus, O., laid 216,195 sq. yds., and Akron, O., laid 188,711 sq. yds. The largest yardage of concrete pavement reported by any one city was for Kansas City, Mo., where a total of 365,323 sq. yds. was laid. Detroit, Mich., paved 170,160 sq. yds. of street with concrete and Chicago laid over 101,000 sq. yds. Of the 52 cities reporting the construction of stone block pavement, 34 are in the New England and Middle Atlantic states. In the Borough of Brooklyn, New York City, 112,000 sq. yds. of this type of paving were laid; Lawrence, Mass., constructed 82,600 sq. yds., and Elizabeth, N. J., 81,828 sq. yds. For bituminous concrete, Philadelphia reported the largest amount, its total being 269,207 sq. yds.; Chicago was second with 268,442 sq. yds., and Detroit third, with 190,610 sq. yds. Chicago reported that it constructed 580,594 sq. yds. of bituminous macadam; Boston, Mass., was next with 376,593 sq. yds., and Los Angeles was third with 360,000 sq. yds. St. Paul, Minn., reported that it laid 269,969 sq. yds. of wood block pavement in 1914; Detroit, Mich., laid 262,969 sq. yds., and Minneapolis, Minn., 204,655 sq. yds.

Railway Contracts.

There is something doing at last in the railway construction field. Several big jobs have been let in the last few days. The Norfolk & Western has awarded the contracts for its low grade line in Virginia, the work calling for 36½ miles of fairly heavy construction, that will require an expenditure of several million dollars. The San Diego & Arizona Ry. is reported to have awarded the contract for the last 34 miles of its line. This section requires much rock work and numerous street tunnels. The contract for an 18-mile railway in Maryland has been let to a firm of Baltimore contractors. This line, presumably a Western Maryland branch, is estimated to cost about $2,000,000. In addition, officials of the Chesapeake & Ohio R. R. opened bids Saturday on the first section of the Chesapeake & Ohio Northern Ry., which will be the connecting link between the C. & O. at South Portsmouth and the Hocking Valley at Columbus. More railway work was placed under contract in the last two weeks than was let in the previous six months.

STATISTICS OF PAVEMENT CONSTRUCTION IN 1914 IN UNITED STATES AND CANADA.

Amounts, Unit Prices and Details of Asphalt, Bitulithic, Brick, Concrete, Bituminous Macadam, Bituminous Concrete, Stone Block and Wood Block Paving Laid Last Year in Several Hundred Cities.

The following tabulations contain data on several million yards of pavement constructed last year in cities of the United States and Canada. These tables, our seventh annual compilation of the sort, are made up from information furnished by officials of the municipalities represented. In collecting these statistics no attempt was made to pile up yardages in an effort to show the total amount of street paving accomplished in 1914 in this country. The purpose, rather, has been to furnish information on average unit costs, details of construction and local conditions for this class of work for representative cities in various localities.

In certain cities and in certain sections of this country an exceptionally large amount of pavement was laid in 1914. In other localities the work done was far below the average. Taking the country as a whole, 1914 does not appear to have been an especially heavy yardage year. This, of course, was due in great measure to the unusual conditions that prevailed during this period. At the beginning of the season the widespread financial depression then prevailing caused many municipalities to hold down their construction programs. Later on the demand for municipal securities became better, but just when conditions were returning to the normal the European war began.

It has been impossible to collect any complete statistics as to the amount of paving that will be undertaken this year. In many cities the construction programs for the present season had not been made up in March at the time our blanks were sent out. Enough information on this point, however, was obtained to indicate that the outlook for paving activities in 1915 is very encouraging. In all 229 cities reported on their contemplated work for the present season. The aggregate probable expenditure of these cities alone is over $37,600,000. Many municipalities that expended large sums last year for paving gave no estimate on their work for 1915. It is possible that the majority of these places will undertake fully as much work this year as they did in the previous 12 months. Then, too, many small cities that finance their improvements by bond issues have now been able to dispose of their securities and as a consequence will undertake their work this season.

Tables showing the character and cost of paving work done in previous years by representative cities of this country and Canada were published in our issues of March 27, 1907; April 1, 1908; April 6, 1910; April 5, 1911; April 3, 1912; April 2, 1913, and April 8, 1914.

TABLE I. MILEAGE OF PAVEMENT LAID IN 1914 IN A NUMBER OF CITIES AND MILEAGE OF PAVEMENT PROPOSED FOR 1915.

	Pavement laid in 1914. Miles.	Pavement laid in 1914. Cost.	Pavement contemplated for 1915. Miles.	Pavement contemplated for 1915. Cost.
New England Division:				
Maine—				
Portland ...	1.5	$27,840		....
Massachusetts				
Adams		.....	.25	$ 5,000
Belmont	.5	1,500	1.	3,000
Cambridge	4.239	...	...	......
Fall River .	...	......	.	115,000
Haverhill	4.2	57,855	5	70,000
Lawrence	3.84	229,451		....
Lowell ..	....	......	...	150,000
Lynn	3.06	78,000	3.2	70,000
Manchester ...	.5	11,000	2.5	40,000
New Bedford	10.3	.....		220,000
Newton	5	40,000	4.5	35,000
Revere . ..	.25	4,000	3.	25,000
Spencer		...	.1	5,000
Springfield ...	4.17	190,498	.	....
Taunton ..	4.	45,000	...	45,000
Waltham	1.24	.....	1.5	....
Westfield .	8	12,817	....	....
Winchester ...	.72	6,681	.48	17,850
Worcester ...	4.26	...		..
Connecticut—				
Bridgeport	.78	104,000	10.	300,000
Bristol		......	.5	....
Derby		......		10,000
East Windsor	1.3	12,314		....
Greenwich	6.	39,441	6	100,000
Hartford	1.	36,136	1.	65,000
Killingly .	7	9,000	.	....
Middletown ..	.48	8,051	.34	5,000
New Haven ..	12.04	337,972	..	....
Torrington ..	.	....	1	....
Wallingford ...	....	.	.5	12,000
Waterbury ...	.13	.		......
Rhode Island—				
Pawtucket ...	.75		.	..
Middle Atlantic Division:				
New York—				
Ballston Spa	.16	10,000		
Buffalo	20.	902,700	.	..
Binghamton ..	3.20	101,187	3	125,000
Carthage	2.	.....	....	.....
Elmira	1.57	74,854	.5	23,000
Endicott	..	....	.54	25,000
Fairport .	.5	13,978	.	....
Fulton	1.5	81,189	.	
Gloversville		...	.45	30,000
Gouverneur ...	1.	....	.75	....
Jamestown ...	4.08	142,000	5	...
Johnstown	1.75	52,440	8	17,000
Niagara Falls	2.4	132,358	5	300,000
Norwich .	1	40,000	1.	....
Olean	1.	34,000	2.5	85,000
Oneonta		....	.75	19,551
Oswego	3.10	99,619	4.	117,000
Poughkeepsie	2	....		....
Plattsburgh ..	2.2	32,000	3	26,000
Port Jervis .	.28	14,200	.34	17,000
Rochester .	.15.	707,282	13.	600,000
Salamanca .	.72	33,000	1.14	50,000
Schenectady	5.2	226,406	4.	180,000
Syracuse ...	9.62	573,138	15.	850,000
Tonawanda	1.25	50,000	1.	35,000
Utica .	2.48	140,000	2.	140,000
Watertown	5	32,000	.34	26,000
New Jersey—				
Atlantic City .	9.6	318,000	1.3	109,000
Bayonne .	.88	49,129	8.3	300,000
Camden ...	7	....	7	....
Elizabeth	2.5	200,000	7.2	420,000
Jersey City ...	....	....	.	....
Newark	17.15	1,166,880	...	......
Plainfield ...	.96	11,795	...	....
Ridgewood ...	1.1	5,200	1.55	56,000
Roselle Park .	.85	27,100	1.12	30,900
Trenton	4.3	......	....	75,000

TABLE II.—AMOUNT, AVERAGE PRICE AND SOME DETAILS OF BRICK PAVEMENT LAID IN 1914 IN VARIOUS CITIES.

	Sq. yds.	Kind of filler.	Depth sand cushion, ins.	Av. price per sq. yd., including base and grading.	Guarantee, years.	Price per cu. yd. for grading if paid separately.	Total thickness pavement, ins.	Concrete Base. Thickness, ins.	Concrete Base. Proportions.
New England Division:									
Massachusetts—									
Cambridge	2,950	Grout	1½	$3.75	..	.....	11	5	1:3:5
Malden	2,230	Cement	1	2.55	5	.....	11	6	1:2½:5
Pittsfield	1,130	Cement	1½	2.90	5	.....	11½	6	1:3:6
Connecticut—									
Meriden	4,170	Cement	1	2.51	5	.....	11	6	1:2½:5
Middle Atlantic Division:									
New York—									
Ballston Spa	4,013	Grout	2	2.55*	5	$0.60	12	6	1:2:4
Binghamton	35,257	Cement	1½	1.98	5	.....	11½	6	1:2:4
Buffalo	40,467	Grout	1½	3.29	10	.....	10½	6	1:10
Carthage	7,500	Cement	1	2.49	..	.....	11	6	....
Elmira	27,691	Grout	2	2.28	5	.....	..	6	1:3:6
Fairport	4,870	Cement	2	2.25*		.50	11	5	1:3:6
Fulton	4,222	Grout	1½	2.18	0	.60	11½	6	1:3:6
Gloversville	4,788	Grout	2	2.80[1]	..	.....	11	..	....
Fulton	38,380†	Grout	2	1.62*	..	.....	..	5	1:2½:5
Niagara Falls	6,167	Cement	1	2.50	5	.....	11	6	1:3:6
Norwich	......	Cement	1½	2.25	.	.50	12	6	1:2:5
Olean	......	Cement	2	1.75*	2	.50	11	..	....
Oswego	28,150	Cement	1½	2.45	5	.....	11½	..	....
Plattsburgh	5,420[2]	Grout	1½	3.05	..	.50	11½	6	1:2½:5
Poughkeepsie	25,924	Cement	2	2.50	5	.....	11¾	6	1:3:6
Port Jervis	5,790	Grout	1½	2.26	2	.50	11½	6	1:3:6
Rochester	78,791	Grout	1½	1.83	5	.....	11½	6	1:3:6
Salamanca	800†	Pitch	1½	2.25	..	.....	11½	6	1:2:4
Schenectady	7,500	Grout	1	2.30	5	.10[3]	11	6	1:3:6
Syracuse	87,720	Grout	1	2.19	2	.60	11½	6	1:3:6
Watertown	7,500	Grout	1½	2.53	5	.....	11½	6	1:3:5
New Jersey—									
Atlantic City	14,690[4]	Grout	1½	2.60	5	.	11½	6	1:3:6
Camden	611	Grout	1	2.10	.	...	.		....
Elizabeth	10,000	Grout	1½	2.11	..	.....	..	6	....
Jersey City	8,649	....	..	2.20	5	.....	11	5	1:3:6
Newark	33,389	Cement	2	2.29	..	.....	..	..	....
Trenton	7,022	Grout	1½	2.24	1	.....	10½	5	1:3:6
Pennsylvania—									
Bloomsburg	6,500	Sand	1½	1.45	0	....	..	.	......
Carlisle	2,493†	Cement	1½[5]	1.38	..	.....	..	.	....
Clairton	2,358	Tar	2	1.53	1	.65	14	.	....
Clearfield	3,900	Tar	2	1.85	..	.....	11	6	1:3:6
Connellsville	5,670	None	2	1.36*	5	.40	14	..	....
Corry	6,455	Cement	1½	2.15	3	.....	10½	5	1:3:5
Du Bois	8,645	Grout	2	2.16½	3	.....	12	6	1:3:6
Edwardsville	9,000	Grout	2	2.28*	5	.40	12	6	1:3:5
Erie	1,583	Cement	1½	1.67	5	....	10½	5	1:2½:7
Farrell	5,564	Tar	2[6]	1.45	..	.....	16		....
Franklin	16,000	Cement		1.90	0	.50	10½	5	1:8
Greenville	2,567	....	1	1.67*	3	.40	10	5	1:3:6
Hanover Township	22,793	Cement	2	2.43	..	.....	12	6	1:2:5
Hazleton	1,556	Cement	2	2.27	5	...	..	6	1:2:5
Johnstown	34,713	Cement	2	2.23	..	.....	12	6	1:3:6
Kingston	12,430[7]	Grout	2	2.24[8]	3	.....	12	6	1:3:8
Lancaster	1,206†	.....	..	....	..	.....	..	..	....
Meadville	69,277	Cement	2	1.98	3	...	10½	5	1:3:5
Monangahela City	......	Slag	1½	1.95*	2	.82	12	..	....
New Brighton	16,000	Sand	2	.....	..	.....	..	..	....
North East	5,217	Pitch	2	2.02*	5	.50	12	6	1:2½:5
Philadelphia	80,762	Grout	1½	2.74	5	....	11½	6	1:3:6
Pittsburgh	3,696	Bituminous	1	1.83*	1	.57	11½	6	1:3:6
Pittsburgh	11,829	Bituminous	1	2.01	1	.....	11½	6	1:3:6
Scranton	935	Cement	2	2.20	5	.....	12	6	1:3:6
Somerset	2,250	Sand	2	1.32	..	....	16[9]	..	....
West Hazleton	14,691	....	1	2.39	5	.....	11	6	1:3:6
Wilkes-Barre	18,070	Cement	2	2.30	5	.....	12	6	1:3:6
Wilkes-Barre Township.	9,500	Grout	2	2.34*	5	.40	12	6	1:2½:5
Williamsport	15,552	Grout	2	2.04	1	.....	12	6	1:3:6
East North Central Division:									
Ohio—									
Akron	188,711	Cement	2	1.47*	2	.25[10]	10	4	1:2:4
Alliance	16,000	Cement	2	1.75	1	....	12	..	....

TABLE II.—BRICK PAVEMENT, CONTINUED.

	Sq. yds.	Kind of filler.	Depth sand cushion ins.	Av. price per sq. yd. including base and grading.	Guarantee, years.	Price per cu. yd. for grading if paid separately.	Total thickness pavement, ins.	Concrete Base. Thickness, ins.	Concrete Base. Proportions.
Ashtabula	7,660	Asphalt	2	1.64*	5	.31	12	6	1:3:6
Barberton	1,139	Tar	2	1.65*	1	.30	12	6	1:3:5
Bellefontaine	9,873	Cement	1	1.49*	5	.25	11	6	1:8
Bryan	4,000	Cement	2	1.74*	5	.40	12	6	1:3:5
Canton	100,728	Tar[10]	2	1.63	1	.35	11	5	1:3:5
Chillicothe	5,000	Cement	1	1.41	5	.....	..	..	1:10
Cincinnati	99,411	Cement	2	2.28	2	.....	12	6	1:3:6
Columbus	216,195	....	1½	1.75*	5	.50	11½	6	1:3:5
Conneaut	1,500	Grout	1½	1.50*	3	.35	10½	5	1:3:6
East Liverpool	14,110	Sand	2	1.35*	1	.40	14	6	1:2:5
Geneva	5,308	Grout	1½	1.65*	3	.45	10½	5	1:3:6
Ironton	27,000	Pitch	2	1.33*	5	.40	12	6	1:3:7
Lorain	22,188	Grout	1½	2.45	5	.....	11½	6	1:3:6
Mt. Vernon	9,000	Tar[11]	2	1.80*	5	.40	12[12]	6[13]	1:4:8
Marietta	19,094	Sand	2	1.15	5	.....	..	..	....
Newark	......	Grout	2	1.45	1	.40	12[14]	.	....
Oberlin	9,400	Grout	1½	1.65*	0	.40	9½	4	1:3:6
Ottawa	8,000	Grout	1½	1.97		.45	..	5	....
Tiffin	7,400	Grout	2	1.85	3	.45	14[15]	.	....
Tippecanoe City	17,200	Cement	2	1.76		.....	..	6	1:7
Tippecanoe City	5,000	Cement	2	1.82	.	.....	..	6	1:7
Toledo	68,514	Asphalt	1½	1.87*	5	.35	10½	6	1:3½:6
Van Wert	6,900	Sand	.	....		....	..	..	....
Indiana—									
Bremen	......	Grout	2	2.02[16]		.....	..	4½	....
Crawfordsville	11,275	Grout	2	1.30	5	...	10½	4	1:3:5
Decatur	18,015	Sand	2	2.15*	2	.....	12	..	....
Evansville	12,102	Cement	2	1.78	5	.....	11	..	1:3:6
Fort Wayne	66,550	Grout	2	.....	5	.50	12	6	1:3:6
Frankfort	5,764	Cement	1½	1.68	5	.....	10½	5	1:2½:5
Gary	22,540	Cement	2	2.15	5	.38	12	6	1:3:5
Muncie	3,910	Cement	2	1.82	5	.....	12	6	1:3:5
Noblesville	4,804	Grout	2	1.33	4	....	..	.	....
Portland	10,550	Cement	2	2.36	5	.25	11	..	....
Salem	4,383	....	.	2.32	5	.....	..	..	....
South Bend	10,116	Sand	1	1.40½*	..	.50	11	..	....
Illinois—									
Alton	40,092	Grout	1½	1.61	1½	...	9½	4	1:3:6
Anna	27,750	Cement	2	1.98	0	.....	11	5	1:3:6
Chicago	523,768	Cement	1½	1.61	5	.35	11½[17]	..	....
Danville	44,174	Cement	2	1.70*	0	.45	11	6	1:3:6
Decatur	40,000	Grout	2	1.66*	5	.40	11	5	1:3:5
Dixon	57,915	Asphalt	2	1.64	0	.....	12[17]	..	....
East St. Louis	21,487	Pitch	2	2.21*	5	.....	12	6	1:3:6
Farmer City	7,700	Cement	1½	1.75	5	.35	9½	4	1:2:4
Forest City	10,000	Grout	1½	1.79*	1	.33[18]	11½	6	1:3:6
Galesburg	51,372	....	1½	1.81*	1	.....	9½	4[19]	1:3:6
Herrin	18,663	Asphalt	2	2.02*	0	.39½	12	6	1:3:6
Hillsboro	26,000	Sand	1½	1.80	..	.....	10½	5	1:3:5
Kewanee	600	Asphalt	1½	1.75*	0	.30	10½	5	1:3:6
Lawrenceville	13,892	Grout	2	1.84*		.40	12	6	1:7
Marion	1,600	Asphalt	2	2.04	0	.35	10	4	1:3:6
Mattoon	6,000	Cement	1½	1.58	.	.30	10½	5	1:3:7
Moline	66,619	Asphalt	2	2.11*	5	.37	11	5	1:3:6
Murphysboro	12,000	Grout	2	2.02	0	.....	11	5	1:3:6
Oak Park	12,006	Asphalt	2	2.07*	5	.25	12	6	1:3:6
Pana	34,000	Cement	2	1.67*	0	.30	11	5	1:8
Pana	29,000[21]	Cement	1½	1.60*	0	.25	9½	4	1:7
Paris	......	Cement	1	1.60*	.	.25	11	6	1:9
Peoria	63,838	Grout	2	1.47*	2	.42	11	5	1:3:6
Rockford	58,818	Asphalt	1½	1.90	..	.....	10	5	1:3:6
Venice	18,008	Cement	1½	2.00		..	10½	5	1:3:5
Waukegan	29,800	Cement	1½	2.06*	2	.40	11½	6	1:3:6
Wilmette	16,000	Sand	2	1.35	..	.....	..	..	....
Wilmette	17,250	Sand	2	1.78*	5	.32	12	..	....
Michigan—									
Ann Arbor	2,350†	Cement	1½	1.75*	.	.....	11½	6	1:8
Battle Creek	44,329†	Cement	1½	1.67	..	.....	11	6	......
Benton Harbor	6,000	.....	1½	1.60	5	.30	9½	4	1:6
Detroit	33,365	Grout	1	3.13	0	.50	11	6	1:3:6
Flint	48,891	Grout	2	2.01*		.40	12	6	1:3:6
Grand Rapids	42,099	Cement	1½	1.85*	5	.50	11½	6	1:3½:7
Kalamazoo	3,700	Asphalt	2	1.80	..	.....	11½	6	1:8
Niles	10,000	Asphalt	2	1.52	10	...	..	..	....
Wisconsin—									
Eau Claire	3,600	Cement	1½	2.34	..	.....	10½	6	1:3:6
Fond du Lac	3,095	Cement	1½	2.34	5	.	10½	5	1:3:6
Grand Rapids	7,612	Cement	2	2.11	5	.....	11	5	1:5
La Crosse	1,615	..		2.23	0	.	11½	5	1:2½:5
Oshkosh	3,195[23]	Cement	1½	2.90	5		..		1:3:6
Racine	81,010	Grout[24]	2	2.03	5	...	.	5	1:3:5
Reedsburg	9,000	Sand	2	1.30*	.	..	6	.	....
Sheboygan	7,693	Grout	1½	1.98	0	.....	11½	6	1:3:5
West North Central Division:									
Minnesota—									
Duluth	61,612	Grout	2[26]	2.25*	0	.60	12	6	1:3:6
Minneapolis	10,634	Asphalt	1	2.25	..	.....	10	5	1:3:6
St. Paul	15,600†	Asphalt	1½	2.60	..	.....	10½	5	1:3:5
Winona	9,469	Sand[25]	2	1.50	..	.....	10	4	1:3:4
Iowa—									
Anamosa	20,000	Asphalt		2.00*	5	.50	9	5	1:3:5
Des Moines	15,132	Asphalt[24]	2	1.85*	5	.	11	5	1:3:6
Missouri Valley	......	Asphalt	2	1.74*	5	.	.	4	.....
Oskaloosa	2,784	Grout	1½	2.05	1	.	9½[27]	4[28]	1:4
Waterloo	5,138[29]	Sand	1	..	..	.....	30	24	......
Missouri—									
Brookfield	1,760	Cement	3	1.40*	3	.29		..	....
Jefferson	900	Asphalt	2	2.00*	0	.10	9	4	1:3:5
Kansas City	45,282	.......[30]	2	2.03*[31]	5	.....[32]	..	6	1:3:6
Mexico	4,225	Sand	2	1.67*	0	.50	10	4	1:3:5
Sikeston	12,500	Asphalt	1½	2.24*	2	.30	10½	5	1:3:5
University City	2,616	Grout	1	1.89*	5	.70	12	6	1:3:6
University City	8,730	Grout	1	1.80*	5	.55	11	5	1:3:6
Warrensburg	10,000	Asphalt	1½	1.93	.	..	9½	4	1:2:6
Nebraska—									
Auburn	11,500	Asphalt	1½	2.10		.	10½	5	1:3:6
Grand Island	11,000	Asphalt	2	1.91			..	.	......
Havelock	9,000	Asphalt	1½	2.12	1		10½	5	1:3:6
Lincoln	15,221	Grout	2	[illegible]	1	.....	11	5	1:3:6
Seward	......	Asphalt	1½	2.07	1	.	9½	4	1:2:5
South Omaha	52,213	Sand	1½	2.02*	.	.	..	..	1:3:6

TABLE I.—MILEAGE AND COST OF PAVEMENTS, CONTINUED.

	Pavement laid in 1914. Miles.	Pavement laid in 1914. Cost.	Pavement contemplated for 1915. Miles.	Pavement contemplated for 1915. Cost.
W. New York	.	250,000	. .	......
Woodbine	6.	. .		......
Pennsylvania—				
Beaver Falls	.	. .	. .	300,000
Bloomsburg	.3	10,760	.5	12,000
Carlisle	.14	3,386	1.	24,092
Catasauqua	.11	2,166	.17	4,500
Chambersburg	....	.....	....	......
Clairton	.14	7,200	....	....
Clearfield	.4	11,000	.1	4,000
Connellsville	.38	10,866	2.22	106,000
Corry	.47	18,522	.49	20,082
Dorranceton	1.8	55,726	....	....
Du Bois	.87	30,684	.93	27,400
Edwardsville	.7	26,000	.8	32,000
Erie	5.26	176,834	2.5	....
Farrell	.	....	.67	17,500
Franklin	.75	27,000	1.	24,000
Greenville	.28	7,432	.45	27,368
Harrisburg	3.61	110,500	5.	115,000
Hanover		..	2	......
Hanover Twp.	2.5	80,000	1.5	45,000
Hazelton	.11	4,415	.35	18,000
Juniata	.17	1,305	.34	2,700
Kingston	1.	30,000	.6	15,000
Larksville	1.2	65,000	. .	....
McKees Rocks		..	...	.....
Meadville	4.57	163,425	.5	6,000
Monongahela City		.	.5	11,000
New Brighton	1.	16,000	...	.....
Philadelphia	77.13	2,196,563	..	. .
Pittsburgh	12.69	.....	....	......
Scranton	5.44	230,926	5.	225,930
Swoyersville	....	....	2.	...
West Hazleton	....	....	....	......
Wilkes-Barre	4.	162,582	7.	300,000
Wilkes-Barre Township	.9	34,000	...	....
Williamsport	1.09	45,385	1.6	59,600
East North Central Division:				
Ohio				
Akron	11.93	448,408	8.67	. . .
Alliance	2.	33,400	5.	132,000
Amherst	.9	26,000	....	....
Ashtabula	.44	15,767	.9	39,000
Barberton	.15	2,616	1.4	58,150
Bellefontaine	.70	23,000	. .	... ...
Bryan	.25	.....	....	... ...
Cambridge	.25	8,000	....	....
Canton	6.51	327,543	8.	400,000
Chillicothe	.41	9,543	.83	12,500
Cincinnati	15.54	1,182,947	10.	750,000
Columbus	22.02	. .	. .	....
East Liverpool	....	....	2.	....
Galion	..	. .	1	54,000
Geneva	.6	22,018	.33	13,260
Hamilton	1.	33,511	4.	200,000
Ironton	1.1	33,000	2.8	80,000
Fostoria	1.75	40,000	....	....
London	.34	26,254	.46	20,000
Lorain	3.61	176,604	2.5	110,000
Marietta	1.1	29,482	....	....
Miamisburg	.....	....	.75	20,000
Mt. Vernon	.6	30,000	.5	20,000
Newark	2	..	1	. ...
Newcomerstown		.....	.25	8,000
Oberlin	.76	23,500	.2	6,500
Orrville	.	...	1.5	10,500
Ottawa	.5	10,000	1	....
Painesville	....	....	1.5	45,000
Ravenna	.		1	6,500
Tiffin	2.	.	2.	....
Toledo	11.35	413,344	21.	800,000
Indiana—				
Bremen	.	.	1	28,000
Crawfordsville	.14	15,485	.	9,000
Crown Point	....	.	1	5,000
Decatur	1.3	39,488		..
Evansville	4.6	147,796		. .
Fort Wayne	10.2	405,270	5	200,000
Frankfort	1.52	50,557	.94	37,375
Fulton	.	....	.75	
Gary	6.41	295,000	.	
Greencastle			1.63	19,000
Lafayette	.34	8,617	.5	....
Logansport	3.1	122,500	.14	24,000
Muncie	1.5			.
Portland	.65	[illegible]		
Princeton		....	2.5	40,000
Rushville	10.	53,000	10.5	57,750
Salem	.18	11,000		.
South Bend	3.	83,368		.
Illinois—				
Alton	2.75	[illegible]	1	31,680
Centralia	.		.	500,000
Charleston	.16	3,640	...	. .
Chicago	159.41	5,998,130	150.	5,000,000
Clinton	.			
Danville	2.	88,789	2.5	110,000
Decatur	2.4	166,000	2.	200,000
East St. Louis	....		.	....
Galesburg	3.	[illegible]	2.	68,250
Granite City		....	1.74	30,000
Herrin	1	51,000	.	20,000
Hillsboro	2	60,000		5,000
Kewanee	2.5	[illegible]	.25	....
Lake Forest	1.	21,000	3.	60,000
Lawrenceville	....	....	1.1	34,627
Marion	1.5	35,000	....	....
Moline	5.6	200,000	8.4	300,000
Mattoon			.75	. . .
Murphysboro	4.75	[illegible]	....	....
Oak Park	12.18	424,055	15.	600,000
Pana	2.5	82,000	....	
Paris	.	13,820	.38	8,257
Peoria	4.49	131,712	5.	150,000
Riverside			2.35	74,000
Robinson	....		.5	12,000

TABLE I.—MILEAGE AND COST OF PAVEMENTS, CONTINUED.

	Pavement laid in 1914. Miles.	Pavement laid in 1914. Cost.	Pavement contemplated for 1915. Miles.	Pavement contemplated for 1915. Cost.
Rockford	8.24	232,264	4.	....
Venice	1.05	46,773	....	....
Waukegan	1.9	98,484	2.	35,000
Wilmette	3.5	96,000	....	200,000
Michigan—				
Ann Arbor	1.	19,374	1.5	34,300
Battle Creek	3.45	103,089	2.	65,000
Benton Harbor	....	....	2.8	....
Detroit	42.86	1,702,146	53.	2,005,000
Flint	7.73	242,959	7.87	308,000
Grand Rapids	9.	280,000	9.	275,000
Hillsdale	....	....	.1	15,000
Highland Park	5.75	227,000	....	200,000
Holland	.75	10,000	....	....
Kalamazoo	1.55	....	....	....
Manistee	.6	5,341	.25	....
Monroe	....	....	.5	17,000
Petoskey	....	....	....	....
Port Huron	.5	....	.25	....
Saginaw	2.68	101,082	3.	120,000
Wisconsin				
Berlin	.32	7,200	.51	14,000
Chippewa Falls	.51	15,000	.13	8,200
Eau Claire	.9	....	1.	....
Edgerton	.4	....	.4	6,000
Fond du Lac	3.08	86,729	3.	85,000
Grand Rapids	.32	16,042	....	....
Green Bay	3.5	117,467	....	....
Janesville	.5	10,665	1.	....
Kaukauna	....	....	1.	40,000
La Crosse	....	....	....	....
Lake Geneva	.67	48,000	.25	4,000
Marinette	.75	20,736	.63	19,000
Oshkosh	....	....	....	....
Port Washington	....	....	.34	....
Racine	5.33	....	....	....
Sheboygan	3.03	94,016	5.	150,000
Superior	4.29	192,658	4.8	165,000
Watertown	....	....	....	....
West North Central Division:				
Minnesota				
Cloquet	.5	13,766	.5	10,000
Duluth	8.13	408,456	4.5	215,000
Mankato	1.5	20,247	1.5	35,000
Minneapolis	18.1	650,000	15.	500,000
New Ulm	.5	37,301	....	....
Owatonna	.5	25,000	....	....
Rochester	1.6	66,035	1.	30,000
St. Cloud	.58	14,500	....	....
St. Paul	22.	817,000	26.	900,000
Virginia	.86	44,929	....	....
Winona	....	....	....	....
Iowa—				
Anamosa	2.5	40,000	....	....
Atlantic	....	82,935	....	....
Boone	4.	140,000	3.	100,000
Cedar Falls	....	....	2.7	....
Cedar Rapids	2.83	80,000	4.00	100,000
Charles City	....	....	....	....
Cherokee	1.5	80,000	....	....
Des Moines	11.36	309,388	11.36	309,388
Eagle Grove	....	....	3.	113,000
Iowa Falls	....	....	1.1	....
Marshalltown	.34	7,300	2.	....
Missouri Valley	....	57,816	....	....
Muscatine	....	....	2.	50,000
Oskaloosa	1.6	61,500	....	....
Rock Rapids	....	....	.27	11,000
Pella	1.34	77,530	....	....
Waterloo	5.83	177,682	2.25	70,000
Missouri—				
Brookfield	.12	3,077	....	....
California	....	....	1.	....
Cape Girardeau	3.25	73,549	5.	112,500
Columbia	.6	17,321	....	....
Faribault	.07	2,099	....	....
Independence	....	....	1.	17,000
Jefferson	4.	135,000	3.	100,000
Kansas City	34.88	704,659	30.	700,000
Kirksville	.78	....	1.25	55,000
Kirkwood	2.84	24,040	2.	16,500
Macon	.66	....	....	....
Mexico	.8	7,805	....	....
Nevada	2.	35,000	3.	50,000
Sedalia	....	....	2.	50,000
Sikeston	1.	42,000	....	....
University City	1.8	67,550	.7	20,000
Warrensburg	.57	19,300	....	....
South Dakota—				
Huron	....	....	.5	14,438
Lead	.75	900	.5	16,800
Watertown	.88	38,721	....	....
Yankton	....	....	.8	38,000
Nebraska—				
Chadron	....	....	.57	....
Havelock	.27	17,660	.37	23,000
Lincoln	7.58	299,567	7.5	300,000
Nebraska City	1.	13,413	1.5	....
Norfolk	....	....	6.	150,000
Seward	....	31,000	....	36,000
South Omaha	6.1	224,895	4.3	145,000
Superior	....	....	....	....
Kansas				
Abilene	2.86	65,380	1.	23,000
Arkansas City	4.78	....	....	....
Beloit	....	....	....	....
Chanute	1.	15,000	1.	15,000
Emporia	1.25	56,000	1.25	56,000
Ft. Scott	.5	13,000	1.	26,000
Girard	....	....	.24	5,000
Herington	....	....	1.	27,000
Iola	1.2	175,000	1.	16,000
Junction City	3.	100,217	1.	....
McPherson	3.5	83,000	2.	50,000
Larned	....	....	....	....
Neodesha	1.4	39,000	1.5	13,000
Newton	.75	16,100	2.	35,000
Osawatomie	1.25	26,987	1.	20,000
Ottawa	2.06	53,500	2.	50,000
Parsons	.5	16,000	....	....
Pittsburg	5.31	136,700	2.	50,000
Rosedale	1.	40,000	2.5	125,000
Salina	1.6	64,000	2.	75,000
South Atlantic Division:				
District of Columbia—				
Washington	8.8	287,850	8.8	287,850
Virginia—				
Clifton Forge	....	....	.34	3,600
Farmville	....	....	.25	4,000
Newport News	.68	6,000	....	....
Pocahontas	.3	....	....	....
West Virginia—				
Moundsville	....	....	....	10,000
Weston	.25	....	.25	....
North Carolina—				
Asheville	....	160,800	....	....
Charlotte	1.75	65,000	.75	29,000
Durham	.6	13,668	1.2	....
Greensboro	1.25	38,000	3.	100,000
Rocky Mount	2.6	....	....	....
South Carolina—				
Columbia	3.5	80,443	1.2	80,000
Georgia—				
Cordele	2.4	106,500	....	....
Rome	....	....	2.	....
Florida—				
Lake City	.57	10,000	1.7	30,000
Orlando	5.	20,000	5.	20,000
Palatka	....	....	....	37,500
East South Central Division:				
Kentucky				
Dayton	.25	....	.75	....
Lexington	2.5	81,495	5.6	224,000
Louisville	11.2	494,883	12.32	....
Owensboro	....	....	1.2	34,000
Tennessee—				
Bristol	....	....	3.	15,000
Lebanon	3.	8,000	....	....
Memphis	....	....	....	....
Newport	....	20,000	1.3	....
Nashville	4.69	250,000	12.	430,000
Alabama—				
New Decatur	....	....	....	....
Troy	....	....	.68	....
Mississippi—				
Clarksdale	.13	5,500		..
Vicksburg	1.6	103,019		.
West South Central Division.				
Arkansas—				
Jonesboro	.75	22,000		....
Pine Bluff	....	....	6	250,000
Louisiana—				
New Orleans	6.7	318,000	8.6	348,450
Oklahoma—				
Cushing	....	....	2	....
Durant	....	....	1.	22,755
Shawnee	1.	50,000	2	85,000
Tulsa	....	....	3	60,000
Texas				
Denison	2.	65,703	2.	....
Greenville	7.5	255,000		....
Houston	38.5	....	..	....
Laredo	36.	28,800	.	.....
Lufkin	....	....	.73	40,173

TABLE II.—BRICK PAVEMENT, CONTINUED.

	Sq. yds.	Kind of filler.	Depth sand cushion, ins.	Av. price per sq. yd., including base and grading.	Guarantee, years.	Price per cu. yd. for grading if paid separately.	Total thickness pavement, ins.	Concrete Base. Thickness, ins.	Concrete Base. Proportions.
Kansas—									
Chanute	10,000	Asphalt	1½	1.51	..	.....	8½	4	1:2½.5
Emporia	10,000	Grout	1	1.75*	5	.43	9	4	1:3:5
Fort Scott	6,700	Asphalt	1½	1.63	5	.....	8½[35]	4	1:3:5
Iola	640	Asphalt	1	1.65*	1	.40	9½	4	1:2½:5
Neodesha	22,600	Asphalt	1½	1.41	5	.30	9½[36]	..	....
Newton	6,000	Asphalt	2	1.85*	1	.40	10½	5	1:3:5
Ottawa	10,158	Grout	2	1.55*	2	.35	10	4	1:3:5
Parsons	700[37]	Asphalt	1½	3.50	2	.....	11½	6	1:3:5
Pittsburg	80,129	Sand	1½	1.46*	0	.38	9½	4	1:1½:5
Rosedale	4,356	Asphalt	1½	1.85	5	.25	9½	5	1:3:6
Salina	13,000	Asphalt	1½	1.76*	5	.33	9½	5	1:3:6
South Atlantic Division:									
District of Columbia—									
Washington	7,115[38]	Cement	½	1.35*[39]	..	.....	..	6	1:3:7
Virginia—									
Pocahontas	3,200	Grout	2	2.10	..	.75	12	..	1:3:5
West Virginia—									
Moundsville	8,545	Sand	2	1.05*	1	.35	12	..	....
North Carolina—									
Asheville	7,040	Pitch	1½	2.45	5	.35	10	4	1:2½:5
Florida—									
Orlando	43,900[40]	....	...	1.35	0	.....	..	..	....
East South Central Division:									
Kentucky									
Lexington	4,167	Grout	1	2.25	5	.....	11	6	1:3:6
Louisville	82,962	Grout	1½	1.78*	5	.496	11½	6	1:3:7
Tennessee—									
Nashville	4,936	Cement	2	2.23	5	.....	12	..	....
Mississippi—									
Vicksburg	27,739	Grout	1½	2.25	5	.50	11½	6	1:3:7
West South Central Division:									
Arkansas—									
Jonesboro	10,000	Cement	2	1.96*	5	.18	10	4	1:3:5
Texas—									
Denison	3,310	Asphalt	2	2.27	5	.....	10	5	1:2½:5
Greenville	80,000[41]	Asphalt	...	1.70*	5	.32	8	4	1:7
Houston	42,590[41]	Asphalt	1	.....	..	.....	..	..	....
Houston	21,658	Cement	1	.....	..	.....	..	..	....
Pacific Coast Division:									
California—									
Los Angeles	15,000	....	...	2.50*	..	....	9½	4	.....
Pasadena	510	Grout	1½	2.97	..	.....	9½	4	1:3:6
San Francisco	2,262	Cement	1½	3.53	0	.....	11½	6	1:2½:7
Oregon—									
Portland	34,184	Grout	1	2.34*	20	.35	11	6	1:3:6
Washington—									
Seattle	73,771	Grout	1½	....	.	.50	....		1:3:6
Tacoma	525	Cement	1	.....	..	.....	..	5	1:3:6
Canadian Division:									
Ontario—									
London	6,399	Grout	1½	.....	10	.....	11½	6	1:8
Toronto	38,417	Grout	1½	2.07*	10	.65	10½[42]	5	1:3:7
Welland	6,148	Cement	1	2.50	5	.45	10½	5	1:6
British Columbia—									
New Westminster	......	Cement	1	4.75*	5	.75	12	6	1:7
Vancouver	13,958	Grout	1½	3.83*	5	.77[43]	11½	6	....

*Does not include grading. †By day labor.

[1] 2,915 sq. yds. at $2.80; 1,873 sq. yds. at $3.20. [2] State highway. [3] 10 cts. per sq. yd. [4] Brick gutters, 33-in. wide. [5] Limestone dust. [6] Slag cushion. [7] 2,550 sq. yds. repaving on old concrete base at $1.64. [8] 5,290 sq. yds. at $2.24; 4,690 sq. yds. at $2.12. [9] 6-in. broken stone, 4-in. furnace slag, 2-in. sand, 4-in. brick. [10] 10 cts. to 43 cts. [11] Tar and grout. [12] 10-in. and 12-in. [13] 6-in. and 4-in. [14] Includes 6-in. gravel foundation. [15] Stone foundation. [16] Done in 1913. [17] Includes crushed rock base. [18] Excavation; 45 cts. for fill. [19] Some 5-in. base. [20] Contracted for 1915. [21] 16-ft. brick country road built near Pana. [22] Resurfacing on old macadam. [23] Street railway. [24] Asphalt and grout. [25] 1½-in. to 2-in. [26] Asphalt on gutters and sand. [27] 9½-in. to 10½-in. [28] 4-in. to 5-in. [29] Track paving put in by traction company. [30] Bitumen and sand. [31] $2.03 for 4-in. block; $1.75 for 3-in. block. [32] $2.28 per lineal foot of street. [33] Includes grading below top of curb; grading above top of curb and in sidewalk spaces cost 40 cts. to 50 cts. per cu. yd. [34] Extra grading 20 cts. to 35 cts. per cu. yd. [35] 8½-in. and 9½-in. [36] Includes 5-in. crushed rock base. [37] Nearly all between street car tracks, which accounts for high cost. [38] In gutters. [39] Plus cost of blocks. [40] On sand base. [41] Vertical fibre brick. [42] 10½-in. and 11½-in.; concrete base 5-in. or 6-in. [43] 77 cts. to $1.

TABLE I.—MILEAGE AND COST OF PAVEMENTS, CONTINUED.

	Pavement laid in 1914.		Pavement contemplated for 1915.	
	Miles.	Cost.	Miles.	Cost.
Mineral Wells	2.	75,000	3.	60,000
Walde	....	....	....	20,000
Mountain Division:				
Montana—				
Bozeman	1.75	76,000	2.	87,000
Butte	.77	69,675	.37	51,427
Dillon	....	....	2.	....
Great Falls	5.6	230,300	.52	24,500
Idaho—				
St. Maries	1.8	22,667	....	....
Sand Point	....	....	1.	75,000
Pocatello	....	....	....	....
Ogden	3.07	162,469	.86	60,000
Salt Lake City	11.28	699,993	12.	700,000
Colorado—				
Grand Junction	....	....	....	2,000
Leadville	.37	....	....	....
Longmont	....	....	.34	14,000
Pueblo	....	....	8.5	140,000
Wyoming—				
Cheyenne	.57	14,786	1.	....
Pacific Coast Division:				
California—				
Hollister	1.22	35,460	.75	20,000
Los Angeles	70	3,005,812	.70	3,000,000
Monrovia	2.5	14,214	4.	24,000
Modesto	.59	27,955	.75	28,000
Oakland	56.48	876,648	57.	900,000
Oxnard	.26	3,750	1.1	6,000
Palo Alto	2.25	58,000	2.	50,000
Pasadena	10.5	180,000	10.	135,000
Pomona	.22	3,895	9.34	160,000
San Francisco	15.9	800,485	20.	....
Santa Ana	7.36	161,000	....	..
Santa Barbara	4.4	93,775	....	....
Oregon—				
Corvallis	1.2	39,428	...	....
Eugene	1.9	....	...	.....
Hood River	.5	9,000	....	....
McMinnville	4.65	129,898	2.	50,000
Portland	32.59	1,513,207	15.97	602,995
Washington—				
Aberdeen	1.1	....	...	...
Everett	2.1	114,700	....	......
Port Angeles	....	....	1.	......
Seattle	18.36	728,660	15.	600,000
South Bend	1.25	43,798	.25	15,000
Tacoma	3.14	71,598	...	....
Walla Walla	.7	21,027	3.5	125,000
Canadian Division:				
Nova Scotia—				
Halifax	.16	9,000	....	....
Prince Edward Island—				
Charlottetown	....	4,900	..	5,000
Quebec—				
Lake Megantic	1.8	....	....	....
St. Lambert	1.18	23,588	4.63	139,477
Westmount	1.78	51,747	....	....
Ontario—				
Berlin	2.79	121,933	2.	40,407
Belleville	.5	47,000	.5	30,000
Kingston	.54	....	....	....
London	3.65	126,167	5.5	210,000
Oshawa	1.13	12,500	.5	5,000
Ottawa	9.8	680,000	6.	450,000
Sudbury	..	115,613	...	....
Toronto	31	1,230,050	...	....
Welland	.57	45,615	.	....
Windsor	7.8	...	.	....
Manitoba—				
St. Boniface	.58	....	....	.....
Saskatchewan—				
Regina	3.2	.	..	......
Alberta—				
Edmonton	5.23	.	...	......
Lethbridge	.	....	.34	18,000
British Columbia—				
New Westminster	.5	18,000	1.3	87,000
South Vancouver	2.76	510,409	4.5	632,000
Vancouver	23.69	766,382	.	....
Victoria	7.	......	.	....
New Brunswick—				
St. John	1.34	52,798	1.	20,000

TABLE III.—AMOUNT, AVERAGE PRICE AND DETAILS OF STONE BLOCK PAVEMENT LAID IN 1914 IN VARIOUS CITIES.

	Square yards.	Kind of filler.	Average price per sq. yd., including base and grading.	Guarantee, yrs.	Total thickness, ins.	Concrete Base.	
						Thickness, ins.	Proportions.
New England Division:							
Maine—							
Lewistown	1,000[1]	Grout	$1.75	.		.	......
Portland	3,549	Cement	2.15	.			....
Portland	1,099	Sand	1.45	..		..	....
Massachusetts—							
Boston	61,326[4]	Grout[5]	3.50	5	.		1:3:7
Cambridge	8,584	Grout	3.75	..	13	6	1:3:5
Fall River	8,405	Grout	3.60	5	10	4	1:4[2]
Haverhill	1,177	Grout	3.00	..	..	..	....
Haverhill	14,430[3]	Grout	.80	..	..	..	......
Holyoke	3,400†	Grout	....	.	.	..	....
Lawrence	82,600[1]	Grout	2.74	..	10	..	....
Lowell	23,798	Cement	3.25	..	12	6[5]	1:4:10
Malden	13,388	Cement	2.96	5	10[6]	5	1:2½:5
New Bedford	15,830	Cement	...	.	10	4	....
Springfield	4,979†[7]	Cement	3.30 2/5	..	10	5	1:3:6
Springfield	1,306†[8]	Cement	1.96½	..	10	5	1:3:6
Worcester	20,601	Grout	3.35		10	5	1:3:6
Connecticut—							
Ansonia	20,075	Sand	1.74	5	11½	5	1:3:6
Bridgeport	13,292	Cement	3.25	.		6	1:3:6
Waterbury	9,796	Cement	2.37[9]			.	....
Rhode Island—							
Pawtucket	862	Sand	..			.	....
Providence	10,327	Grout[10]	3.34[11]		12	6	1:3:6
Woonsocket	12,000	......	3.65	5		5	1:3:6
Middle Atlantic Division:							
New York—							
Buffalo	5,892	Grout	3.96[12]	10	15	6	1:10
Buffalo	5,388[13]	Grout	4.50[12]	10	15	6	1:10
New York, Brooklyn Borough	112,622	Tar[14]	3.46	1	.	6	1:3:6
New York, Queens Borough	27,150[15]	Tar	3.75	1	12	.	...
New York, Queens Borough	63,625[16]	.	2.40	1			......
Rochester	7,480	....	2.61	5	14	6	1:3:6
Schenectady	1,700	...	3.35	5	15	6	1:3:6
New Jersey—							
Elizabeth	81,828	Grout	3.35	5	13	6	1:3:6
Jersey City	9,502	Tar[14]	2.80			..	....
Jersey City	16,693	Tar[14]	3.37		.	6	....
Newark	57,923	.....	3.18			6	....
Newark	25,714	.....	2.57			6	....
Passaic	1,803	Cement	3.60		13	5	1:3:6
Trenton	1,516	Cement	3.90[18]	1	12	5	1:3:6
West New York	6,000	Cement	2.50	1		5	1:3:5
Pennsylvania—							
Johnstown	2,500	.....	3.50		16	6	1:3:6
Philadelphia	10,742	Grout	3.75	5	13½	6	1:3:6
Pittsburgh	19,761	Bitu.	3.18	1	15	6	1:3:6
Pittsburgh	5,293	Bitu.	3.06	1	15	6	1:3:6
Scranton	9,675	Sand	2.51½	5			......
East North Central Division:							
Ohio—							
Akron	1,455	Tar	3.20*	2	..	4	1:2:4
Cincinnati	79,565	Granite	3.43	2	12½	6	1:3:6
Columbus	2,520[21]	Cement	3.52*	5	12	6	1:3:5
Illinois—							
Chicago	40,340	Pitch	3.78*	2	12	6	1:3:6
Wisconsin—							
Sheboygan	1,680	Grout	3.28	0	13½	6	1:3:5
West North Central Division:							
Minnesota—							
Duluth	6,258[22]	Grout	2,75*	0	13	5	1:3:6
Minneapolis	7,931	Sand	2.28†	..	.	..	....
St. Paul	1,300[20]	Cement	3.30†	.	13	5	1:3:5
Nebraska—							
South Omaha	651	Sand	2.65*	.	15	5	....
East South Central Division:							
Tennessee—							
Nashville	5,529[7]	Pitch	2.75		[illegible]		.....
Pacific Coast Division:							
California—							
San Francisco	22,049[24]	Asp.&Grv.	3.28	0	11	6	1:2½:7
Oregon—							
Portland	2,426	Grout	2.60*	20	12	[illegible]	1:3:6
Washington—							
Seattle	3,694[25]	Grout					1:3:6
Canadian Division:							
Nova Scotia—							
Halifax	2,200	..	4.25			6	1:3:5
New Brunswick—							
St. John	6,020	Cement	4.05	2			....
Quebec—							
Westmount	1,448	Cement	4.53	.			....
Ontario—							
Ottawa	15,000	———	4.25	10	12	6	1:3:6
Saskatchewan—							
Regina	2,203[23]	Cement	5.45	15	12	6	1:6
British Columbia—							
New Westminster	.....	Bitu.	5.00*	0	8	6	1:7

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*Does not include grading. †Done by city.

[1] On sand base. [2] Hassam grout. [3] Stone block relaid. [4] Granite recovering; old block, removed, recut and relaid. [5] Hassam base. [6] 10-in. to 11-in. [7] 4-in. granite block. [8] 6-in. second-hand granite block. [9] Does not include base. [10] Some laid with sand filler. [11] $2.50 per sq. yd., with sand filler and sand base. [12] Includes curb, drains and grading. [13] Repaving. [14] Tar and gravel. [15] Improved granite. [16] Granite block on sand. [17] Napped block. [18] $3.90 to $4.00. [19] Repaving; limestone block used. [20] Medina. [21] Salisbury. [22] Kettle River sandstone. [23] Sandstone. [24] Basalt block. [24] Granite and Hassam. [25] Pitch filler on 1,541 sq. yds.; grout on 23,593 sq. yds.; gravel on 36,192 sq. yds.

TABLE IV. AMOUNT, AVERAGE PRICE AND DETAILS OF BITUMINOUS CONCRETE LAID IN 1914 IN VARIOUS CITIES.

	Square yards.	Average price per sq. yd., including base and grading.	Guarantee, yrs.	Total thickness pavement, ins.	Concrete Base.	
					Thickness, ins.	Proportions.
New England Division:						
New Hampshire—						
Laconia	1,145	$1.65	5	7	5	1:2:4
Massachusetts—						
Pittsfield	30,567	1.94	5	8	5	1:3:6
Southbridge	1,700	1.22	.	8		.....
Springfield	[illegible]	[illegible]				.
Springfield	[illegible]	[illegible]				..
Westfield	6,766	.				...
Connecticut—						
Bridgeport	1,360*	1.20*				...
Middle Atlantic Division:						
New York—						

TABLE IV.—AMOUNT, AVERAGE PRICE AND DETAILS OF BITUMINOUS CONCRETE LAID IN 1914—CONTINUED.

	Square yards.	Average price per sq. yd., including base and grading.	Guarantee, yrs.	Total thickness pavement, ins.	Concrete Base. Thickness, in.	Concrete Base. Proportions.
Schenectady	63,200	1.50	5	8	6	1:3:6
Utica	4,502*†	1.92	5	9	6	1:3:7
New Jersey						
Camden	58,872	2.85	..	..	.	....
Elizabeth	80,000	1.10	5	2[23]		....
Trenton	50,183	1.47	5	7	5	1:3:6
West New York	34,700	2.00	5	7½	5	1:3:5
Pennsylvania						
Catasauqua	1,550	1.40	.	7½	5	1:3:4
Dorranceton	26,710	1.58		7	5	1:2:4
Lancaster	8,470	1.40	.	..	..	....
Philadelphia	269,207	1.20	5	7	4[22]	1:3:6
Phoenixville	4,600†[5]	.85		..	..	....
Williamsport	7,834	1.20	1	.	.	....
East North Central Division:						
Ohio—						
Ashtabula	11,050[7]	1.60*	5	7	5	1:3:6
Cincinnati	4,206*†	2.27	2		.	.....
Indiana—						
Fort Wayne	55,307	...	5	8	6	1:3:6
South Bend	15,086	1.53*	5	7	5	1:2:5
Illinois—						
Chicago	268,412	1.47*	5	8	6	1:3:6
Kewanee	28,000	1.47*	0	7	5	1:3:6
Lake Forest	12,000*†	1.00*	5	5[8]	.	....
Oak Park	131,103	1.35½*	5	8	6	1:3:6
Waukegan	10,834	1.58*	2	7	5	1:3:6
Michigan						
Battle Creek	13,221*†	1.67	5	8	6	....
Benton Harbor	21,000	1.35	5	7	5	1:6
Detroit	190,610*†	2.51	5	8	6	1:3:6
Grand Rapids	22,226	1.70*	5	8	6	1:3½:7
Highland Park	38,973	1.49½*	5	8	6	1:3:5
Kalamazoo	19,230[10]	.90[11]	..			......
Kalamazoo	8,949	.85[11]	10	8	6	1:8
Manistee	5,151†	1.32		8	6	1:3:6
Wisconsin						
Oshkosh	9,944	1.38	5	7		1:3:6
West North Central Division:						
Minnesota						
Minneapolis	42,622*†	1.75†		7	5	1:3:6
Minneapolis	958	1.70†		10	..	....
Rochester	12,814*†	1.54	.	7	5	1:3:5
St. Paul	9,166†	1.65		7	5	1:3:5
Iowa						
Boone	70,000*†	1.54½		.	5	1:3:4
Cedar Rapids	15,130*†	1.95*		8½	6	1:3:5
Cherokee	40,547*†	1.66	-	6	4	1:5
Des Moines	5,965*†	1.92*	5	8[12]	.	1:3:6
Waterloo	6,440*†	1.69	5	7	5	1:3:6
Missouri—						
Kansas City	2,057	1.25*	5	8		.
South Dakota—						
Watertown	21,351	1.73	5	7	5	.[13]
Nebraska						
Lincoln	95,646	1.62	5	7	5	1:3:6
Kansas—						
Emporia	35,000	1.40*	5	6	4	1:3:5
Junction City	66,000	1.31*	5	7	5	1:3:5
McPherson	47,886*†	1.27*	5	6	4	1:3:5
Parsons	10,000	1.24	5	6	4	1:3:5
Salina	19,000*†	1.60*	5	7	5	1:3:6
South Atlantic Division:						
North Carolina—						
Greensboro	33,247[14]	1.05	.	..	.	.....
South Carolina—						
Columbia	48,901	1.44	5	6	4	1:3:5
East South Central Division:						
Kentucky—						
Louisville	14,700	.788*	[illegible]		..	....
Alabama—						
New Decatur	64,600	1.53*	5	6	4	1:3:5
West South Central Division:						
Texas—						
Greenville	30,000	1.59*	5	6	4	1:7
Houston	85,708	....	5	8[15]	5	1:2½:5[16]
Mineral Wells	20,000	1.62	5	6	4	....
Pacific Coast Division:						
California—						
South Pasadena	73,791*†	1.332	0	5	..	....
Oregon—						
Corvallis	16,050[17]	1.43*	0	5½	4	1:2½:1½
Portland	7,291*†[18]	1.25*	10	6½	.	....
Portland	92,536*†[19]	1.04*	10	4	.	....
Portland	139,471*†[20]	1.28	10	5	..	......
Washington						
Aberdeen	2,727*†	1.45*	0	8	6	....[21]
Canadian Division:						
Ontario—						
Belleville	19,330*†	2.38	10	8	5	1:3:6
Alberta—						
Edmonton	64,568[7]	2.53	5	8	6	1:3:7
British Columbia—						
Vancouver	98,401*†	2.29*	5	8	6	.....
Vancouver	7,406*†	1.65*[22]	5	10	-	......

*Does not include grading. †Done by day labor. *†Asphaltic concrete.

[1] 2-in. bituminous concrete, machine mixed, on concrete base. [2] 2-in. bituminous concrete, machine mixed, on old macadam base. [3] Warrenite; laid on old macadam base. [4] \$1.26 to \$1.47. [5] Base is natural macadam. [6] Resurfacing sheet asphalt with asphaltic concrete. [7] Stone-filled sheet asphalt. [8] On old macadam base. [10] Resurfacing with asphaltic concrete. [11] Price for top only. [12] 7½-in. and 8-in. [13] 1 bag cement to 6 cu. ft. concrete in place. [14] On old macadam base. [15] 8-in. to 9-in.; 5-in. to 6-in. concrete base. [16] Old specifications; new one calls for 1:2½:6. [17] 1,678 sq. yds. of this on bituminous base; 1½-in. top; 3½-in. base. [18] On crushed rock base. [19] Redress. [20] On bituminous base. [21] 1 sack cement in each 12 sq. ft. base. [22] Excluding concrete base. [23] Laid on Telford base. [24] 4-in. or 5-in.

TABLE V.—AMOUNT, AVERAGE PRICE AND DETAILS OF ASPHALT PAVEMENT CONSTRUCTED IN 1914 IN VARIOUS CITIES.

	Square yards.	Thickness binder, inches.	Thickness surface, inches.	Average prices per sq. yd., including base and grading.	Guarantee, yrs.	Price per cu. yd. for grading if paid separately.	Concrete Base. Thickness, ins.	Concrete Base. Proportions.
New England Division:								
Massachusetts—								
Boston	[illegible]	1½	1½	\$3.00	5		6	1:3:7
Holyoke	17,227		2	1.73			4	1:3:6
Connecticut								
Bridgeport	3,205	1½	1½	2.01	.		.	1:3:6
Derby	15,218	1½	1½	2.15	5	..	6	1:3:6
Hartford	27,880	1½	1½	1.69*	.	\$0.80	6	1:3:6
New Haven	54,175	1½	1	1.68	5		6	1:3:6
Rhode Island—								
Pawtucket	1,276							....
Providence	24,909	1	.	[illegible]	.		6	1:3:6
Middle Atlantic Division:								
New York								
Buffalo	[illegible]	1½	.	3.53[4]	10		6	1:10
Buffalo	141,106[5]	1½	2	3.26[4]	10		6	1:10
New York, Brooklyn Borough	680,877	1	-	1.758[6]	5	.65	6	1:3:6
New York, Queens Borough	66,665	1	2	1.85	5	.50		1:3:6
Poughkeepsie	7,350	1	2	2.44	5	.	6	1:3:6
Rochester	96,466	1	2	1.76	5	.	6	1:3:6
Schenectady	7,300	1	.	1.95	5		6	1:3:6
Syracuse	50,780	1	2	1.87	10	.60	6	1:3:6
New Jersey—								
Atlantic City	150,572	1½	1½	1.75	.	.	6	1:3:6
Bayonne	16,333	1	1½	1.84*	10	.77	6	1:3:6
Camden	34,754	1	2	1.90	.	.		..
Jersey City	5,251	1½	2	2.24	10	..	5	.....
Newark	11,947	1½	2	2.04	.	.....	..	......
Passaic	14,547	1½	1½	1.71	5	.	5	1:3:6
Pennsylvania—								
Erie	96,580	1½	1½	1.53	5	.	5	1:2½:7
Harrisburg	58,010	1	2	1.90	5	.	6	1:2:6
Johnstown	29,435	1	2	2.05	5	.	6	1:3:6
Larksville	17,000			2.28*	10	.45	6	1:3:6
Philadelphia	314,778	1	2	1.91	5	..	6	1:3:6
Pittsburgh	3,604	1½	1½	2.26*	5	.93	6	1:3:6
Pittsburgh	10,412[5]	1½	1½	2.53	5	..	6	1:3:6
Scranton	29,610	1	2	1.96	5	....	6	1:3:6
Wilkes-Barre	43,887	1½	2	1.99	10	...	6	1:3:6
East North Central Division:								
Ohio—								
Amherst	11,050		2	1.60*	5	.46	5	1:3:6
Canton	13,709	1	1½	1.73	5	.....	5	1:3:5
Cincinnati	15,850	1½	1½	2.53	5	.....	6	1:3:6
Columbus	130,187	1		2.00*	5	.55	6	1:3:3
Hamilton	15,000	1	1½	1.40	5		6	1:7
Lorain	27,453	1	1½	2.16	.	.	6	1:3:6
Sandusky	32,000	1	2	1.80*	5	.60	6	1:3:6
Toledo	31,343	1½	2	2.10*	5	.40	6	1:3½:6
Indiana								
Evansville	44,420	1	2	1.90	5		5	1:3:6
Fort Wayne	56,478	1	1½	.	5	.50	6	1:3:6
Gary	10,150	1	1½	1.50*[7]	5			....
Logansport	53,000	1	1½	1.95	5		-	1:2:5
South Bend	23,999	½	1½	1.555*	5	.15	5	1:2:5
Illinois—								
Chicago	820,000	1½[8]	2[8]	1.68*	5		6	1:3:6
Oak Park	43,667	1½	1½	1.42*	5	.19	6	1:3:6
Peoria	6,657	1	1½	1.65*	2	.70	4	1:3:6
Michigan—								
Detroit	21,698	1	2½	3.14	5	.50	6	1:3:6
Flint	25,191	1	1½	1.87*	5	.50	6	1:3:6
Highland Park	45,485	1	1½	1.624	5	.43	6	1:3:5
Saginaw	46,686	1	1½	2.18	5	.40	6	......
Wisconsin—								
Green Bay	51,373	1	1½	1.90[9]	5		6	1:3:5
Racine	9,055	1	2	2.03	5		5	1:3:5
Superior	54,629	1	1½	1.74*	5		5	1:2½:5
West North Central Division:								
Minnesota—								
Duluth	1,832	1½	2	2.30*	[illegible]	.60	6	1:3:6
St. Paul	23,657†[10]	1	2	1.25	.	..	..	....
Iowa								
Cedar Rapids	15,130	..	2	1.95*	.	.60	6	1:3:5
Des Moines	55,299	1	1½[11]	1.92*	5	....	5	1:3:6
Waterloo	12,145	1	2	2.20	5	.....	6	1:3:6
Waterloo	74,008	1	1½	1.90	5	....	5	1:3:6
Missouri								
Kansas City	78,564	..	2	1.67½	5	..	6	1:3:6

TABLE V.—AMOUNT, AVERAGE PRICE AND DETAILS OF ASPHALT PAVEMENT CONSTRUCTED IN 1914—CONTINUED.

	Sq. yds.	Thickness binder, inches.	Thickness surface, inches.	Average prices per sq. yd. including base and grading.	Guarantee, yrs.	Price per cu. yd. for grading if paid separately.	Concrete Base. Thickness, Ins.	Concrete Base. Proportions.
Nebraska –								
Lincoln	7,712	1½	1½	1.85	5	.50	5	1:3:6
South Atlantic Division:								
District of Columbia								
Washington .	28,282	1½	1½	1.69*	5	.55	6	1:3:7
North Carolina—								
Charlotte	40,000	1	2	1.54*	5	.38	4	1:3:6
Rocky Mount.	45,520	1½	1½	1.58*	5	.30	4	1:3:6
Georgia—								
Cordele	58,662[12]	..	..	1.82	..	.....	5	....
East South Central Division:								
Kentucky—								
Lexington ...	29,955	1[13]	2	1.90	5	.....	6	1:3:6
Louisville	97,275	1	2	1.74*	5	.496	6	1:3:7
Nicholasville.	48,000	..	..	2.17	5	.....	6	....
Tennessee –								
Memphis	18,855	..	.	2.01	5	.39	.	......
Nashville	10,142	..	..	1.03	5	.25	..	....
Mississippi—								
Vicksburg ...	25,371	..[14]	2	2.07½*	5	.50	6	1:3:7
West South Central Division:								
Louisiana—								
New Orleans..	11,738	..	2	2.25	5	...	6	1:3:6
Oklahoma—								
Shawnee	16,000	1	1½	1.90*	7	.20	5	1:3:6
Tulsa	22,000	..	2	1.63	5	.25	5	1:2½:5
Mountain Division:								
Utah—								
Ogden	54,418	1½	1½	2.10*	5	.55	6	1:3:6
Salt Lake City	8,028[20]	1[21]	2	1.93*	10	.60	6[18]	1:3:6
Pacific Coast Division:								
California								
Los Angeles..	800,000	..		1.50*		...	3[22]	1:3:6
Modesto	......	2½	1½	1.35	0	.....	..	....
Oakland	97,972	2	1½	1.80*	0	.25[15]	6	1:3:6
Pasadena	26,889	1	2	1.40		.	4	1:3:6
San Francisco	200,074	1½		2.186	0	.	6	1:2½ .
So. Pasadena.	42,500	1	[illegible]	1.413	0		5	1:2:4
So. Pasadena.	7,700	0	[illegible]	1.233	0	...	4	1:2:4
Oregon -								
Portland	40,447	1	2	1.54*	10	.35	5	1:3:6
Washington—								
Aberdeen	11,531	1	2	1.68*	[illegible]	.40	6	
Everett	40,000	1	2	1.45*		.45	5	1:3:6
Seattle	217,685	1	2			.30	.	1:3:6
Tacoma	33,981	1	1½	.		..	5	1:3:6
Canadian Division:								
Quebec—								
Westmount ..	4,514	1	2	3.18	5	...	5	1:3:6
Ontario								
London	43,260	2	1	2.36	10	..	5	1:8
Ottawa	120,000	¾	2	2.20	10		6	1:3:6
Toronto	316,694	1½	2	1.23*[17]	10	.65	6[illegible]	1:3:7
Saskatchewan								
Regina	26,779	1	2	2.85	15	.50	5	1:6
Alberta—								
Edmonton ...	4,654	1	2	2.45*	5	.75	6	1:3:7
British Columbia								
So. Vancouver	.	.	.....	.	.	.	.	.
Vancouver ...	1,350	1	2	2.47*	5	.98	5	
Victoria	112,301	.	.	1.97*[19]	5		6[18]	1:3:6

*Does not include grading. †Done by day labor.

[1] 13,222 sq. yds. cost \$1.73 per sq. yd.; 4,005 sq. yds. cost \$1.58 per sq. yd. [2] On bridges. [3] Without binder \$2.28. [4] Includes curb, drains, grading. [5] Repaving. [6] On 6-in. base; \$1.642 on 5-in. base; \$1.588 on 4-in. base. [7] Resurfacing only; no base included. [8] 1½-in. and 1-in. binder; 1½-in. and 2-in. surface. [9] Includes grading and curb and gutter. [10] Resurfacing only. [11] 1½-in. or 2-in. [12] 3-in. asphalt surface. [13] Some with no binder. [14] Paint coat binder. [15] Per sq. yd. [16] 1 sack cement in each 14 sq. ft. base in place. [17] Without base. [18] Some on 5-in. base. [19] \$1.97 for heavy; \$1.65 for light. [20] Miles. [21] 1-in. or 1½-in. [22] 3-in. to 6-in.

TABLE VI.—AMOUNT, AVERAGE PRICE AND DETAILS OF CONCRETE PAVEMENT CONSTRUCTED IN 1914 IN VARIOUS CITIES.

	Square yards.	Type.	Total thickness, ins.	Av. cost per sq. yd., incl. grading.	Guarantee, yrs.	Bottom Course. Thickness, ins.	Bottom Course. Proportions.
New England Division:							
Maine—							
Portland	7,162	1-course	6	\$2.15	5	.	...
Massachusetts							
Boston	61,174	....	.	.75		..	...
Fall River....	3,558[1]	1-course	6	2.12	5	..	.....
Lynn	67,595	1-course	6	1.15½	.	..	.....
Springfield ...	36,871[1]	Bit-top[2]	6	1.61	5	.	.....
Springfield ...	2,009†	Bit-top[2]	6	1.18	..	.	1:2:4
Worcester ...	3,244	Bit-top	6	1.58	.	..	...
Connecticut—							
Greenwich ...	55,021	Bit-top		.		.	....
Hartford	11,400†	Bit-top	6½	1.10*	...	6	1:2:4
Meriden	17,386	1-course	6	1.28	5	6	1:2:4
Middletown ..	6,485	1-course	6	1.24	.	...	....
Wallingford ..	3,608	2-course	6½	1.35	5	4½	1:2½:4½
Rhode Island—							
Pawtucket ...	6,472	.. .[3]	6	.		4	1:3:6
Middle Atlantic Division:							
New York—							
Binghamton .	6,439	1-course	7[4]	1.52	3	.	1:1½:3
Gloversville ..	5,575	2-course	6	1.45			....
Johnstown ...	7,040	1-course	7	.90*	...	7	1:2½:5
Schenectady .	1,150	1-course	7	1.45	3	7	1:2:4
Tonawanda ..	23,000	1-course	6	1.44	3	6	1:1½:3
New Jersey—							
Roselle Park.	17,000	Bit-top	7[illegible]	1.28*	1	7	1:2:4
Pennsylvania—							
Bellwood	390	....	.	1.35	5	4	1:4
Carlisle	200†	1-course	.	899			.. .
DuBois	3,953	2-course	8	1.63	4	6	1:2½:5
Juniata	864	2-course	8[6]	1.51	5	...	1:2½:4
Philadelphia	28,105	1-course	6[4]	.98	0	...	1:2:3
Pittsburgh ...	2,950	1-course	6	1.39	1	6	1:2:3
East Ninth Central Division:							
Ohio—							
Fostoria	3,000	1-course	6	1.39*		.	
Geneva	4,600	Bit-top	7	1.55*	3		.. .
Sandusky ...	8,700	2-course[5]	8	1.30*	5		1:1½:3
Toledo	22,182	1-course	6[7]	1.39*	5		1:3½:6
Indiana—							
Evansville ...	7,270	1-course	6[8]	1.51½	5	.	1:2:4
Evansville ...	9,433	Bit-top	6[8]	1.40	5		1:2:4
Fort Wayne..	3,816	2-course[5]	7	....	5	6	1:3:6
Frankfort ..	14,488	2-course	6[8]	1.25	5		.... .
Gary	8,520	1-course	7	1.32*	3		.
Gary	3,500	2-course	7½	1.70*	3		....
Lafayette	5,509	1-course	6[8]	1.32	5	..	1:1½:3
Rushville	1,600	2-course	6	1.30	5	4½	1:4
South Bend...	6,153	1-course	7	1.158	1	.	. .
Illinois—							
Charleston ...	2,400	2-course		1.30			....
Chicago	101,888	1-course[9]	[illegible]	1.60*	3		1:2:3
Lyons	12,200	2-course	8[10]	1.53½	1		1:2:4
Moline	10,199	1-course	7	1.10*	5	.	...
Morrison	12,000	1-course	7	1.28	.		1:2:3
Peoria	2,394	1-course	6	.94*	2	.	1:3:6
Rockford	5,760	1-course	...	1.10	.	.	1:2:4
Wilmette	3,627	1-course	8[8]	1.15*	2		1:1½:3
Michigan—							
Ann Arbor....	11,832†	Bit-top	7	.984*		5	1:8
Detroit	170,160	2-course[5]	7	2.28	..	6	1:3:6
Flint	19,381	1-course	6	1.68	..	..	1:2:4
Grand Rapids.	1,738	2-course	6½	1.15*	3	5½	..
Highland Park	12,388	2-course[5]	8[10]	1.42*	5	6	1:3:5
Howell	1,833	2-course	8	.85	..	.	
Manistee	352	2-course	7	1.40	5	5½	1:2½:5
Manistee	1,438†	Bit-top	7	1.03	...	5	1:3:6
Munising	2,000	1-course	6	1.50	..	.	.
Petoskey	2,785	2-course	8	1.17*	5		.
Petoskey	9,831	Bit-top	8[12]	1.50*	5	6[13]	1:8
Port Huron...	10,000	2-course	7	1.25*	5		
Wisconsin							
Berlin	5,200	2-course	7½	1.38	[illegible]		1:3:5
Eau Claire...	9,810	1-course	7[14]	1.27	.		.
Fond du Lac.	41,859	2-course[5]	8[11]	1.49	5	6½[15]	1:2½:5
Green Bay...	1,837	1-course	6	92½	5		1:2:4
Marinette	10,146	2-course	7	1.30*	1	5	1:2½:5
Oshkosh	15,686	2-course[5]	7	1.71	5		1:2:5
Oshkosh ..	[illegible],000	2-course	9	1.74	.		1:4:8
Sheboygan ...	52,139	2-course	7½	1.39		5¾	1:3:5
Superior	43,103	2-course	7½	1.36*	5	6	1:2½:5
Watertown ..	6,726	2-course	7½[16]	1.43	5		
West North Central Division:							
Minnesota—							
Duluth	5,400	1-course	[illegible]	1.85*			
Duluth	750	Bit-top	7	1.90*		5	1:3:6
Faribault	965	2-course	7½	1.45*	2	6	1:5½
Mankato ...	19,527	. .	6	1.05		6	1:4½
Minneapolis .	64,886	1-course	7	1.30			1:1½:3
St. Cloud.....	5,074	1-course	7	1.18*			1:1½:3
St. Cloud....	5,230	2-course	7	1.25*	2		
St. Paul..	572†	2-course	10½	1.60		5	1:3:5
Virginia	525[18]	2-course[5]	[illegible]	[illegible]		13	1:2:4
Iowa							
Atlantic .	51,927	1-course	6	1.18*	[illegible]		1:2:4
Cedar Rapids.	13,194	2-course	7	1.32*		5	1:3:5
Des Moines...	65,364	1-course	8[illegible]	1.50*	1		[illegible]
Eagle Grove..	4,000	1-course	7[9]	1.18	2		[illegible]
Marshalltown.	5,700	2-course	7	1.31½		[illegible]	1:2½:5
Missouri							
CapeGirardeau	50,154	1-course	6	[illegible]			1:1½:3
Cape Girardeau	16,893	Bit-top		1.02*[2]			1:2:4[21]
Columbia	5,201	1-course	6	.90*			1:2½:4½
Columbia ..	3,706	Bit-top	6	1.30*	[illegible]	6	1:2:4
Kansas City	[illegible]	1-course	6	[illegible]			
Kirksville	1,120	2-course	7	1.56		5½	[illegible]
Sikeston	3,500	1-course	6½	1.48	2		1:2:3
South Dakota							
Watertown	[illegible]	1-course	[illegible]	[illegible]			
Watertown ..	596[5]	1-course	[illegible]	[illegible]			
Nebraska							
Lincoln ...	1,951	2-course	6	1.40		4	1:3:6
Nebraska City	9,953	2-course	6	1.17½		4	1:2:4

TABLE VI.—AMOUNT, AVERAGE PRICE AND DETAILS OF CONCRETE PAVEMENT CONSTRUCTION IN 1914—CONTINUED.

	Square yards.	Type.	Total thickness, ins.	Av. cost per sq. yd., incl. grad'g.	Guarantee, yrs.	Bottom Course. Thickness, ins.	Bottom Course. Proportions.
South Omaha.	8,312	1-course	7	1.30*	...	..	....
South Omaha.	20,178	Bit-top	...	1.86*	...		1:3:6
Kansas—							
Abilene	15,400	Bit-top[27]	6½	1.44*	5	1½	1:3:5
Iola	1,200	2-course	6	1.13*	.	4	....
Newton	5,000	1-course	6	1.00*	1	.	1:2:4
Pittsburg	5,839	1-course	6	1.05*	.		1:2:4
Salina	1,025	1-course	6	1.25*	1		....
South Atlantic Division:							
District of Columbia—							
Washington ..	14,675	Bit-top	. .	.94*	5	6	1:3:7
Virginia—							
Pocahontas ..	1,200	1-course	6	.75	..	.	1:2½:5
South Carolina—							
Columbia	2,969	2-course	6	1.35	...	4½	1:2½:5
East South Central Division:							
Tennessee—							
Memphis	23,843	1-course	6	1.15	.		...
Memphis	14,599	Bit-top	6¼	1.29	1		. .
Mississippi—							
Clarksdale ...	2,400	Bit-top	6½	1.82½*	3	5	1:3:6
West South Central Division:							
Louisiana—							
New Orleans..	4,160	Bit-top		1.48	3	6	.....
Texas—							
Denison	26,731	Bit-top[25]	7	1.64	5	5	1:3:5
Houston	431	1-course	...	....	...	.	....
Houston	8,968	Hassam	6	...	5	.	....
Mountain Division:							
Montana—							
Great Falls...	4,548	1-course	6	1.31*	2		1:2:4
Utah—							
Ogden	15,412	2-course	7	1.41*	0		1:2.8:4.7
Salt Lake	......	1-course		1.30*	0		....
Pacific Coast Division:							
California—							
Los Angeles...	40,000	....		1.20*			1:2:3½
Palo Alto.....	47,600	1-course	5	1.22	...	...	1:2:4
Pomona	4,127	Bit-top	5⅜	.927	...	5	1:2:4
Santa Ana....	19,800	Bit-top	5½	.99	...	4	1:3:6
Santa Barbara	7,051	Bit-top	5½	1.21½	...	4	1:3:5
Santa Barbara	12,802	Bit-top	6½	1.38	...	5	1:3:5
Santa Barbara	38,365	Bit-top	7½	1.48½	...	6	1:3:5
Santa Barbara	6,200	Bit-top	9½	1.71	....	8	1:3:5
Oregon—							
Corvallis	5,561	1-course	6	.92*	...	6	1:2:4
McMinnville .	73,503	Bit-top	6	1.52*	...	4	1:2½:5
Portland	68,919	1-course	6	1.24*	10	...	1:2:4
Salem	2,562	1-course	6	1.10*	...	...	1:2:4
Salem	12,487	Bit-top	5½	1.26	. .	4	....
Washington—							
Aberdeen	3,535	Bit-top	6	1.10*	...	4	.....[28]
Aberdeen	655	Bit-top	7	1.16*	...	5	.....[28]
Aberdeen	1,007	Bit-top	8	1.25*	...	6	.....[28]
South Bend...	16,080	1-course	6	1.24*	..	...	1:2:4
Tacoma	6,116	2-course	6	....	...	4	1:3:6
Canadian Division:							
Quebec—							
Westmount ..	5,235	2-course	6	2.75	.	..	1:2½:5
Ontario—							
London	4,755	1-course	...	....	..	...	....
Oshawa	12,000	1-course	7[4]	.87	2	...	1:2:4
Toronto	29,751	1-course	6	....[29]	10	...	1:2:5
Toronto	3,240	Bit-top	6	1.65*	3	...	.. ...
Windsor	72,577	2-course	6½	1.30*	...	...	.. ..
British Columbia—							
New Westminster	......	Hassam	6	2.25*	5	...	......
Vancouver ...	10,367	2-course	7	2.01*	...	...	.... .
New Brunswick—							
St. John.......	2,172	1-course	8	1.70	..	...	....

*Does not include grading. †Done by day labor.

[1]Hassam. [2]¾-in. [3]Warrenite. [4]7-in. center; 5-in. sides. [5]Reinforced. [6]At crown; 6-in. at gutter. [7]6-in. or 7-in. [8]6-in. and 8-in. [9]And bit-top. [10]8-in. at center; 6-in. at sides. [11]6-in. at crown; 4-in. at curb; 2-in. wearing surface, 1:1:2. [12]8-in., 6-in. and 5½-in. [13]6-in. and 4-in. [14]7-in. and 5½-in. [15]5-in. to 8-in. [16]3½-in. to 6½-in. [18]$1.55 sacks per sq. yd. [20]Also some at 90 cts. [21]Some 1:3:5. [22]Per 6-in.; $1.47 per 8-in. [23]1 bag cement per 4¼ cu. ft. in place. [24]Alley approaches. [25]2-in. top. [26]Joplin chats. [28]1 sack cement in each 14 sq. ft. base. [29]$7.93 per cu. yd.

TABLE VII.—AMOUNT, AVERAGE PRICE AND DETAILS OF WOOD BLOCK PAVEMENT LAID IN 1914 IN VARIOUS CITIES.

	Square yards.	Kind of filler.	Average price per sq. yd., including base and grading.	Guarantee, yrs.	Total thickness pavement, ins.	Concrete Base. Thickness, ins.	Concrete Base. Proportions.
New England Division:							
Massachusetts—							
Boston	2,522	Grout	$4.00	5	11	6	1:3:7
Cambridge	29,037	Sand	.....	..	..	..	....
New Bedford...	1,520	....	...	.	.	.	....
Southbridge ...	7,300	Sand[1]	3.38	5	9½	6	1:3:6
Springfield	10,884	Sand	3.04	..	10	5	1:3:6
Connecticut—							
Ansonia	9,500	Sand	3.32	5	10½	6	1:3:6
Bridgeport	12,057	Sand	3.14	5	.	6	1:3:6
Meriden	44,331	Sand	3.20	5	10½	6	1:2½:5
New Haven....	81,944	Sand	2.99½	5	10½	6	1:3:6
Rhode Island—							
Providence	7,479	Sand	3.25	5	10½	6	1:3:6
Middle Atlantic Division:							
New York—							
Binghamton ...	1,587[2]	Pitch	2.38	5	3	.	....
Johnstown	1,118	Bitumen	3.85	5	..	6	1:2½:5
Rochester	30,390	....	2.90	5	..	6	1:3:6
New Jersey—							
Jersey City.....	5,622	Sand	2.99	..	..	5	....
Newark	73,151	Sand	3.34	..	.	..	....
Pennsylvania—							
Philadelphia ..	31,224	Sand	3.28	5	11	6	1:3:6
Pittsburg	6,236	Grout	3.01	5	10	6	1:3:6
East North Central Division:							
Ohio—							
Akron	18,840[3]	Tar	2.64*	2	..	6	1:3:6
Cincinnati	44,015	Sand	2.83	2	10½	6	1:3:6
Toledo	23,729[4]	Sand	3.15*	5	10	6	1:3½:6
Indiana—							
Muncie	641	Asphalt	2.69	5	10	6	1:3:5
Illinois—							
Chicago	139,914	Pitch	3.12*	5	10½	6	1:3:6
Decatur	12,000[5]	Pitch	2.45*	5	11	6	1:3:5
Granite City...	11,500[5]	Pitch	2.65*	..	10½	6	1:3:5
Michigan—							
Detroit	262,969[6]	Tar	2.48	0	11	6	1:3:6
Detroit	3,104	Tar	3.55	0	10½	6	1:3:6
Flint	9,028	Sand	2.46*	..	10½	6	1:3:6
Wisconsin—							
Lake Geneva...	21,288	Pitch	2.14	5	9	5	1:6
West North Central Division:							
Minneapolis ...	204,655†	Pitch	2.40	..	9½[7]	5	1:3:6
New Ulm......	15,204[8]	Pitch	2.31	5	9½	5	1:3:5
Owatonna	10,396[9]	Pitch	2.29	5	9	5	1:8
Rochester	16,541[10]	Pitch	2.17	5	..	5	1:3:5
St. Paul........	269,969	Pitch	2.60†	..	9½	5[11]	1:3:5
Virginia	16,073	....	2.48*	5	10½	6	1:2:4
Iowa—							
Cedar Rapids..	5,921	....	2.95*	..	10¼	6	1:3:5
Missouri—							
Kansas City...	10,765	Bitumen	3.03*	5	12	8	1:3:6
Kansas City...	16,783[12]	Bitumen	2.71*	5	12	8	1:3:6
South Atlantic Division:							
Florida—							
Pensacola	1,550†	None	2.13	..	..	4	1:3:6
East South Central Division:							
Kentucky—							
Louisville	9,133	Asphalt	3.17*	5	11½	6	1:3:7
Tennessee—							
Nashville	23,951	Pitch	2.64	5	10	..	....
West South Central Division:							
Louisiana—							
New Orleans...	13,257	....	3.11	3	11	6	1:3:6
Texas—							
Houston	73,275[5]	Asphalt	.....	5	9	5	1:2½:5[14]
Mountain Division:							
Montana—							
Butte	500	....	4.00	5	10	6	1:3:5
Great Falls.....	13,464	Pitch	2.80*	5	9¼[15]	4	1:3:5
Pacific Coast Division:							
Oregon—							
Portland	12,108	Grout	2.60*	20	11	6	1:3:6
Washington—							
Seattle	2,778	Asphalt	.....	..	..	..	1:3:6
Canadian Division:							
Ontario—							
Berlin	10,372	Sand	3.10	10	8	5	1:5
Ottawa	22,000	....	3.85	10	10½	6	1:3:6
Toronto	5,795	Pitch	3.55*	10	10¾	6	1:3:7
Welland	6,098[5]	Sand	3.05	5	..	6	1:6
British Columbia—							
New Westminster	......[16]	Bitumen	3.75*	5	..	6	1:7
So. Vancouver.	65,743	Pitch	3.55	15	10½	6	1:3:6
Vancouver	27,268	Pitch[17]	3.14*	10	10½	6	....

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*Does not include grading. †Done by day labor.

[1]Sand and clay. [2]Laid on bridge floor. [3]3-in. block. [4]3½-in. block. [5]Yellow pine. [6]Plain cedar. [7]9½-in. and 10-in. [8]Tamarack. [9]Tamarack and Norway, 3-in. block, 10-lb. treatment. [10]3-in. block. [11]5-in. and 5½-in. [12]Repaving. [13]9-in. to 10½-in.; 5-in. to 6-in. concrete base. [14]Old specifications; new specifications call for 1:3:6. [15]9¼-in. and 7¾-in.; 4-in. and 5-in. concrete base. [16]Fir block. [17]4 pitch and 1 tar.

TABLE VIII.—AMOUNT, AVERAGE PRICE AND DETAILS OF BITULITHIC PAVEMENT CONSTRUCTED IN 1914 IN VARIOUS CITIES.

	Square yards.	Average price per sq. yd., including base and grading	Guarantee, years.	Price per cu. yd. if paid separately	Total thickness pavement, ins.	Concrete base.	
						Thickness, ins.	Proportion.
New England Division:							
Massachusetts—							
Boston	54,842	$2.75	5	$0.50	8	6	1:3:7
Cambridge	22,435	2.75	..	.....	7	5	1:3:5
New Bedford	43,692	.....	5	.....	6	..	....
Springfield	14,705	2.40	5	.....	..	..	....
Rhode Island—							
Providence	77,495	2.26[1]	5	.....	7	5	1:3:6
Middle Atlantic Division:							
New York—							
Binghamton	3,224	2.36	5	.....	8	6	1:2:4
Johnstown	11,799	2.45*	5	.60	8	6	1:2½:5
New York, Queensborough	92,730	1.65	5	.50	7	..	....
Utica	30,496	2.26	5	.....	9	6	1:3:7
Utica	34,282[2]	1.55	5	.....	8	..	....
New Jersey—							
Newark	136,953	2.25	..	.....	..	..	....
Pennsylvania—							
Scranton	6,721	2.39	5	.....	9	6	1:3:6
West North Central Division:							
Iowa—							
Des Moines	29,843	2.097	5	.....	7	5	1:3:6
Pella	36,193	.....	5	.....	7	..	....
Kansas—							
Rosedale	13,335	2.05	[illegible]	.25	6	4	1:3:6
South Atlantic Division:							
North Carolina—							
Asheville	45,400	2.10	5	.35	7	5	1:2½:5
East South Central Division:							
Kentucky—							
Owensboro	21,000[3]	2.14	5	.....	..	6	1:3:5
Tennessee—							
Jackson	3,428	2.17	5	.50	8	6	1:3:5
Jackson	4,557[4]	1.75	5	.....	8	..	....
Nashville	15,531	1.80	5	.50	8½	.	....
Alabama—							
New Decatur	6,260	1.97*	5	.....	6	4	1:3:5
West South Central Division:							
Louisiana—							
New Orleans	14,370	2.40	5	.....	8	6	1:3:6
Texas—							
Houston	91,050	.....	5	.....	7[5]	5[6]	1:2½:5
Mountain Division:							
Montana—							
Bozeman	30,000[7]	1.97*	5	.70	6	..	....
Butte	21,761	2.85	5	.....	7	5	1:3:5
Great Falls	80,480	1.89*	5	.71	6	4	1:3:5
Utah—							
Salt Lake City	3,185	2.10*	10	.60	6	4[8]	....
Pacific Coast Division:							
California—							
Los Angeles	......	1.80	..	.....	1½[9]	3[10]	1:3:6
Pasadena	20,618	1.57½	..	.....	..	4	1:3:6
Oregon—							
Eugene	11,398	1.77	5	.60	7	.	
Eugene	13,377[11]	1.62	.	.			
Portland	33,041[12]	1.85*	10	.35	6		.
Portland	128,083[13]	1.43*	10	.35	5		.
Portland	17,446[14]	1.39*	10	.35	3½		..
Washington—							
Walla Walla	11,440[15]	1.48*	[illegible]	.70	4		....
Canadian Division:							
Quebec—							
St. Lambert	6,001	2.80[1]	5	.	7	[illegible]	1:2½:5
Ontario—							
Berlin	12,086	2.53	10	....	7	[illegible]	1:5
Sudbury	29,284	2.65	10	.....	8	6	1:3:6
Toronto	47,629	1.55*	10	.65	7	[illegible]	1:3:7
Manitoba—							
St. Boniface	10,207	2.70	5	..	8	[illegible]	1:3:6
Alberta—							
Edmonton	5,737	2.70*	5	.75	8	6	1:3:7
British Columbia:							
New Westminster	......	2.25*	5	.75	9	.	....
South Vancouver	10,594	2.45	5	..	7	5	1:2:5

*Does not include grading.

[1] $2.20 to $2.33. [2] Resurface. [3] Repavement. [4] On gravel macadam. [5] 7-in. to 8-in. [6] 5-in. and 6-in. [7] On rock base. [8] 4-in. bituminous base. [9] 4½-in. to 8-in. [10] 3-in. to 6-in. [11] Gravel bitulithic. [12] On crushed rock base. [13] Gravel bitulithic, Class A. [14] Bitulithic redress. [15] 2½-in. bituminous base.

TABLE IX.—AMOUNT, AVERAGE PRICE AND DETAILS OF ASPHALT BLOCK PAVEMENT LAID IN 1914 IN VARIOUS CITIES.

	Square yards.	Average price per sq. yd., including base and grading	Guarantee, years.	Total thickness of pavement, ins.	Thickness, ins.	Proportions.
Holyoke, Mass.	5,567	$2.38[1]	.	..	4	1:2½:5
Jamestown, N. Y.	9,423	2.35*	..	..	5	1:2½:5
New York, Queens, N. Y.	8,923	2.70	5	9	.	....
Niagara Falls, N. Y.	34,165	2.62	5	9½	6	1:3:6
Newark, N. J.	10,817	2.53		..	.	....
West New York, N. J.	26,650	2.25	5	..	5	1:3:5
London, O.	12,179	2.15	5	7½	5	1:2:3
Tiffin, O.	5,100	1.90	3	6½	.	....
Toledo, O.	7,794	2.00*	5	7½	5	1:3½:6
Washington, D. C.	5,668[2]	1.79*	.	11	.	....
Washington, D. C.	2,424	1.79*	5	8	.	1:3:7
Windsor, Ont.	36,086	2.75*	5	10	6	1:2:4
Regina, Sask.	28,525	3.00	15	..	-	1:6

*Does not include grading.

[1] $2.38 for 2½-in. block; $2.20 for 2-in. block. [2] 5-in. block on 6-in. gravel.

TABLE X.—AMOUNT AND AVERAGE PRICE OF BITUMINOUS MACADAM LAID IN 1914 IN VARIOUS CITIES.

	Square yards.	Av. price per sq. yd. including grading.	Total thickness—Ins.
New England Division:			
Maine—			
Portland	7,033	$1.08	.
Rumford	1,200	1.18	
Saco	1,600	1.25	.
New Hampshire—			
Laconia	2,200	.25	..
Vermont—			
Barre	3,600	.63	6
Massachusetts—			
Belmont	15,000†	1.00	6
Boston	376,593	.85	6
Cambridge	30,783	.75	7
Clinton	10,792	.50	.
Fall River	30,778	1.19	..
Haverhill	36,884	1.10	6
Lowell	28,757	.95	4
Newton	71,000	.56	3
Revere	4,000	1.00	5
Southbridge	8,400	1.12	16[1]
Springfield	62,408†	1.063	6[2]
Springfield	81,339†	.67	6[3]
Taunton	...	1.00†	..
Waltham	9,864	.66	.
Westfield	1,761		..
Winchester	12,643	5.43	..
Worcester	30,776	.87	6
Connecticut—			
New Haven	105,383	1.05[4]	6
Wallingford	12,413	1.20	7½
Rhode Island—			
Providence	39,436	.995	7⅜
Middle Atlantic Division:			
New York—			
Carthage	3,150	1.10	12
Fulton	19,810	1.25	7
Gouvernor	4,000	..	..
Jamestown	12,338†	1.35	..
Johnstown	3,500	1.52	8
Middletown	15,000	.	..
New York, Queens Borough	110,585†	..	4[7]
Oswego	16,193	1.50	5
Plattsburgh	16,460†	.86	8
Poughkeepsie	1,526	1.30	7
Syracuse	13,652	1.50	9
New Jersey—			
Passaic	15,612	.92	7
Pennsylvania—			
Clearfield	1,200	.85	3[8]
East North Central Division:			
Ohio—			
Cincinnati	39,657	1.51	9
Toledo	6,155	1.19*	8
Indiana—			
Decatur	3,420	.80*	..
Frankfort	5,531	1.44	7[9]
Gary	16,230	1.33*	10
Greencastle	25,000	.75*	10
South Bend	1,791	.98*	8
Illinois—			
Chicago	580,594	1.23*	10½
Hinsdale	8,000	1.42	10[10]
Marion	12,000	1.30	7½[11]
Murphysboro	41,000	1.25	6½[12]
Wilmette	8,575	1.55*	8[13]
Wisconsin—			
Chippewa Falls	8,000	1.51	9½
Eau Claire	1,170	1.10	6½
Edgerton	7,600	1.15½	9
Janesville	4,245	1.05	9
La Crosse	8,455	1.65	7½[16]
Racine	7,614	1.69	10
West North Central Division:			
Missouri—			
Jefferson City	96,000	.90*	8
Kansas City	89,416	1.31	10
Marshall	2,600	1.36	6½[17]
Nevada	30,000	1.28*	7[18]
Kansas—			
Osawotomie	15,735	.90*	9
Ottawa	21,062	.92*	9
South Atlantic Division:			
Virginia—			
Newport News	10,000†	.60	..
North Carolina	11,500†	.96	6
Georgia—			
Atlanta	85,311	..	..
East South Central Division:			
Kentucky—			
Dayton	4,500	1.19*	9
Tennessee—			
Nashville	12,487	.98	9
West South Central States:			
Texas—			
Mineral Wells	10,000	1.04	6[19]
Pacific Coast Division:			
California—			
Hollister	32,805	.88	6
Los Angeles	360,000[20]	.90	6
Oakland	78,351	.68*	8[21]
Oakland	222,035	.89*	8[22]
Oxnard	8,335[23]	.45*	
Pasadena	164,974	.60	4[24]
South Pasadena	3,000	.27	2
Oregon—			
Hood River	9,000	1.00	6
Canadian Division:			
New Brunswick—			
St. John	15,586	1.05	6
Quebec—			
St. Lambert	7,100[25]	1.00	3
Ontario—			
Ottawa	25,000†	1.80	

*Does not include grading. †Done by day labor.

[1] Includes 10-in. limestone foundation. [2] 4-in. base; 2-in. top. [3] 4-in. base of second-hand material and 2-in. top. [4] With new stone; $0.635 with 4-in. of stone from old macadam and 2-in. of new stone. [5] $0.9957 to $1.383 and includes cost of cobble gutters. [6] On 5-in. concrete base. [7] 4-in. to 5-in. [8] 3-in. on old brick pavement. [9] Includes 8-in. 1:2½:5 concrete base. [10] 10-in. and 8-in. [11] Includes 4-in. 1:3:6 concrete base. [12] 2½-in. wearing surface on 4-in. 1:3:5 concrete base. [13] Includes 6-in. 1:3:6 concrete base. [14] Includes 6-in. 1:3:5 concrete base. [15] $1.06-$1.15. [16] Includes 5-in. 1:2½:5 concrete base. [17] Includes 4-in. 1:2:5 concrete base. [18] Includes 5-in. 1:6 concrete base. [19] Includes 4-in. concrete base. [20] Macadam and oil. [21] 6-in. rock at gutter, 8-in. at center before rolling; 1½ gal. oil per sq. yd. [22] 4-in. at gutter, 5-in. at center for base, 3-in. rock top course, 1½ gal. oil per sq. yd. [23] Scarified and resurfaced. [24] 4-in. to 7-in. [25] On old macadam.

TABLE XI. PREVAILING LOCAL PRICES IN 1911 FOR MATERIALS USED IN PAVEMENT CONSTRUCTION

	Portland cement, per bbl.	Broken stone, per cu. yd.	Sand, per cu. yd.	Paving brick, per sq. yd.	Asphalt, per ton	Creosoted wood block, per sq. yd.	Granite block, per sq. yd.	Gravel, per cu. yd.
New England Division:								
Maine								
Portland	$1.75	$1.80	$1.00	$1.05			$1.14	$1.05
New Hampshire								
Laconia	1.65	1.30	0.25[1]					
Vermont								
Barre							1.30	
Massachusetts								
Andover	2.00							
Belmont	....	1.00[2]	....					0.50
Boston	1.75	1.50						
Cambridge	1.25	1.70	1.00	1.25		2.25		1.25
Chelmsford								0.10[3]
Clinton		1.00*						
Fall River	1.45	1.15*	1.25				70.00†	0.10[4]
Haverhill	1.68	1.50	0.35				1.64	0.85
Lawrence	1.69						1.64	
Lowell	1.44[5]	1.20	1.00				1.20	
Lynn	1.74	1.00*	0.70				1.47	1.00
Malden	1.80[6]	1.75	1.00					
New Bedford	1.27	[illegible]	.90				1.65*	.90
Newton	....	1.65	....					
Provincetown	1.80		....					
Revere	2.00††	1.80	1.50				1.60	1.50
Southbridge	....	1.35	1.25			2.50		
Springfield	1.50	1.15*[7]	1.25	32.00†[8]	17.00	1.90	1.54*	
Taunton	1.60							
Waltham	1.60	1.50	1.00					
Webster		0.15						
Westfield	1.75							
Worcester	1.76	1.10	1.50			2.25	1.62	1.25
Connecticut—								
Ansonia	1.25	1.55	1.10					1.00
Bridgeport	1.49	1.35	1.00			1.82	1.70	1.75
Derby	....	1.25*	1.10					1.00
Hartford	1.72	1.25	0.86					
Killingly	....	....	1.00					
Middletown	....	1.15	1.00			....		
New Haven	1.25	1.80	1.00[9]		20.00	1.80		
Wallingford	1.50	2.30	0.75					
Waterbury	....	1.20*	1.00					
Rhode Island								
Providence	1.40	1.35	0.70††				1.80[10]	1.35††
Woonsocket	1.75	1.40	....					
Middle Atlantic Division:								
New York								
Ballston Spa	3.60	1.10	0.50					
Binghamton	1.20			1.50	24.00	....		1.50[11]
Buffalo	1.24	0.90[12]	0.85				2.00[13]	0.85
Elmira	1.40[14]		1.35	0.98				1.00
Endicott	....	....	1.00					....
Fairport	1.30	1.75	1.50	1.00	....	....		1.50
Fulton	1.25	0.60	0.80	1.25	0.081‡	....		1.00
Gloversville	1.60	1.00[15]	1.00					
Jamestown	1.32	....	1.60	0.80	20.00	....		1.20
Johnstown	1.60	1.75	0.75		0.135‡	....		0.75
New York Borough of Brooklyn	1.25	1.75	0.80		20.00	1.62	2.25	1.50
New York Borough of Queens	1.50	2.00	1.00	1.50	15.00	1.70	1.80	2.00
Niagara Falls	1.25	1.75	1.50	0.90	20.00	....		1.50
Norwich	1.35	1.50	2.00					
Olean	1.20	....	1.75	0.86				1.00
Oneonta	1.40[5]	1.55	1.00					
Oswego	1.90	2.00	1.30					
Poughkeepsie	1.40	1.50	1.30					1.30
Plattsburgh	1.80	1.25	0.50	1.18		1.74		0.50
Rochester	2.00	1.50	1.25	1.05	20.00	1.90		1.25
Salamanca	1.35	....	1.40	0.78				1.25
Schenectady	1.35	1.50	0.70	1.06	20.00		1.73	1.25
Syracuse	1.17	1.50	1.35	1.04	16.75			
Tonawanda	1.10	0.85	0.95					
Utica	1.00[16]	1.23	1.00					
Watertown	1.55	1.40	1.00	1.10		1.75		1.00
New Jersey								
Bayonne	1.35	1.80	1.15		30.00		3.15	1.50
Camden	1.40	1.40	0.25	20.00†	15.50		65.00†	....
Passaic	1.15	2.10	1.00	....				....
Plainfield	1.50	1.90	....					
Ridgewood	1.20	2.50	1.50					1.50
Salem	....	....	1.50					1.50
Trenton	1.40	2.00	1.85	1.15[17]	26.50[18]		2.24[17]	....
West New York	1.48	1.50	1.75					
Pennsylvania								
Athens	1.80	1.50	1.50					
Bloomsburg	1.35	....	0.50					0.50
Carlisle	1.32[5]	0.75[19]	1.35	0.86				
Catasauqua	1.00	1.10	1.25					
Clairton	....	....	1.10	0.63				1.00
Clearfield	1.25	1.00	1.00	0.71				
Connellsville	1.60	....	1.28	0.76				0.83
Corry	....	....	1.25					1.00
Dorranceton	1.10	1.10	1.00		22.50			
Du Bois	1.42	0.95	0.95	0.695				
Erie	2.16	1.50	0.50	0.75	16.00			0.80
Farrell	....	....	2.00	16.00†				
Franklin	1.35		1.50	19.00†				1.25[20]
Greenville	1.40	....		1.37[21]				
Hanover	1.60	1.10*	1.30*					
Hazleton	1.44	0.80	1.00*					
Juniata	1.24[5]	0.90*[17]	1.00*					0.90*[17]
Kingston	1.65	1.25	1.10	1.09				
Larksville	1.48	....						
Meadville	1.25	....	1.60	0.76				1.60
Monongahela	1.40	1.10	1.25	0.73				
New Brighton	1.50	1.00	....					
North East	....	....	1.25					
Philadelphia	1.82	1.71*	1.25	25.00†	....			
Scranton	1.30	1.50	1.50	0.95	16.00		1.96	
Somerset	....	0.80	1.45	0.80				
Wilkes-Barre	1.15[5]	1.25	1.25	1.10	25.00		3.25[22]	
East North Central Division:								
Ohio—								
Akron	1.35	1.00	1.00	0.75		1.45	2.90	1.25
Alliance	....	1.00[23]	1.25	0.70		....	....	....
Amherst		0.80[23]	1.00	....				
Ashtabula	....	....		0.72	22.50			....
Barberton	1.65	0.90	1.25	0.70		1.40		1.00
Bellefontaine	1.60	....	1.00	0.70				0.75
Bryan	1.40	1.24	0.90	0.78				....
Cambridge	1.19	1.40	1.35	0.74††				1.35
Canton	1.30	1.10	1.00	0.70				1.10
Chillicothe	1.40[24]		0.60	0.70		....		0.08⅓[25]
Cincinnati	1.41	1.86	1.35	0.72	19.00	1.50	1.32	0.89
Conneaut	1.40[5]	....	1.00	0.64		....		1.00
East Liverpool	1.27	....	1.00	0.62				0.65
Findlay		0.75[1]	1.10					....
Fostoria	1.30	1.10	1.10					....
Geneva	1.40	1.50	1.50	0.75				1.50
Hamilton	1.40	....	1.00	18.00†				0.75
Ironton	1.24	0.80	0.60	0.75				0.75
London	1.60	....		....				
Loraine	....	0.80	1.10	....	20.00			....
Marietta	....	....	1.00	14.50†				....
Miamisburg	1.50	....	0.60	1.75				0.60
Mt. Vernon	1.35	....	1.10	0.80				0.85
Newark	....	....	0.75[26]	0.74				0.50[26]
Oberlin	1.40	1.45	1.10	0.72				....
Orrville	1.60[27]	0.80	1.00	0.75				0.80
Painesville	1.24	0.69	0.50	0.74				0.50
Sandusky	1.35	1.20	1.20	0.80	30.00			....
Tiffin	....	1.40	1.40	1.02	....			
Toledo	1.25	....			18.00			....
Indiana—								
Bremen	1.60	....	1.25	....				1.50
Crawfordsville	1.45	....	0.25[1]	0.68				0.20[1]
Crown Point	1.75	1.35	1.35	....	20.00			1.50
Decatur	....	1.25	1.10	21.00†				1.10
Evansville	1.35	1.25	1.00	1.98[28]				1.00
Fort Wayne	1.20	0.87	0.78	0.86	22.10			....
Frankfort	1.18	1.12	1.00	0.76				1.00
Gary	1.20[5]	1.10	0.95	0.95	....			0.95
Greencastle	1.25[5]	1.00	1.00	1.80	32.50			1.00
Lafayette	1.20	....		....				0.56[29]
Logansport	1.30	0.90	1.25	0.80	20.00			1.25
Muncie	1.38	1.10	1.00	0.85		1.45		1.00
Noblesville	1.40	....	0.75	1.33				0.75
Portland	....	....	0.75	1.73[30]				0.75
Princeton	1.60	1.25	1.35					1.35
Rushville	1.20	1.05	0.85					0.95
Salem	2.32	1.55	1.30	0.68				1.55
South Bend	1.25	....	1.00	0.90[31]	23.00			1.00
Illinois—								
Alton	1.30	1.25	1.25	0.67				
Charleston	....	....	1.25	....	....			....
Chicago	1.25	1.65	1.65	0.86	20.00	1.95	2.15	1.65
Danville	1.23[32]	0.82[33]	0.82	0.75		....		....
Decatur	1.45	1.25	1.25	....	....	1.50		1.10
Dixon	1.15	1.40	1.25[34]	0.84[35]	19.00	....		1.25[34]
East St. Louis	1.25	0.95	0.85	0.72			....	0.95
Granite City	1.25	1.35	0.85	0.78		1.57		1.40
Hillsboro	1.25	1.50	1.40	0.75	....	....		....
Kewanee	1.50	1.65	1.25	0.80	6.00			....
Lake Forest	....	1.35[36]	1.00[36]	....	22.50		....	1.00[36]
Lawrenceville	1.22	1.00	0.90					0.90
Marion	....	1.50	1.60	....				....
Mattoon	1.23	1.30	0.95	0.72				0.95
Moline	1.20	.90	.45	.81	20.00			.75
Morrison			....					1.62
Murphysboro	1.20	1.20	1.10	.70				....
Pana	1.25	....	.90	.78				.95
Paris	1.20	1.10	1.00		....			1.00
Peoria	1.35	2.00	1.50	.76	28.00	1.60		1.75
Rockford	1.10	1.25	1.00	.85	17.00			
Waukegan	1.30	1.20	1.10	.88	24.00			1.10
Michigan—								
Ann Arbor	1.14[5]	....	63[36]					.85††
Battle Creek	1.10	....		.80[36]		....		....
Benton Harbor	1.30[37]	1.25	.65	.96	....			1.10
Detroit	1.07	1.05	1.15	.95	28.66	1.49[38]	2.05	1.25[39]
Flint	1.30	....			....	....		....
Grand Rapids	1.35[5]	1.60[1]	.40[1]	1.25				.90[1]
Highland Park	1.19	1.08	.72	....				....
Holland	....	1.30	....	....				1.75[40]
Howell	1.30	....	1.00	....				....
Kalamazoo	1.17	....		.88				.66
Manistee	1.50	1.25	.40					1.25
Monroe			....	....		1.45	....	
Munising	1.80	1.50	.75	....				
Niles	1.50	....	0.75	0.22†				
Petoskey	1.33	1.00	1.00	....	28.00			....
Port Huron	1.25	....						0.50
Saginaw	1.23	....						....
Wisconsin—								
Berlin	1.55	1.25	0.90	....				0.90
Chippewa Falls	1.50	2.20	0.10[1]		17.40	....	....	
Eau Claire	1.35	1.80	0.25	1.03	....	1.10	....	0.25
Edgerton	....	....		....	....	....		0.85
Fond du Lac	1.35	0.96[41]	1.05[41]	1.10	....	....		....
Janesville	1.20	0.90	0.60	....	26.00	1.34	....	....
La Crosse	....	1.35	0.50	0.24†	22.00	....	....	....
Lake Geneva	1.40	....	1.35	....	....	1.25	....	1.30
Marinette	1.35[5]	1.10	0.75††	....		....		....
Oshkosh	1.40	1.40	1.25	....				....
Sheboygan	1.42	1.25	1.00	1.10				1.00
Superior	1.50	1.65	0.75	1.10	18.00			1.10
West North Central Division:								
Minnesota—								
Cloquet	....	1.00	0.40		....		....	....
Duluth	1.53	1.00	0.80[43]	1.10	17.00		....	1.00
Faribault	1.40	1.50	1.00		....		....	0.80
Lake City	....	3.00	0.50	....			....	0.60

TABLE XI.—PREVAILING LOCAL PRICES IN 1914 FOR MATERIALS USED IN PAVEMENT CONSTRUCTION—CONTINUED.

	Portland cement, per bbl.	Broken stone, per cu. yd.	Sand, per cu. yd.	Paving brick, per sq. yd.	Asphalt, per ton.	Creosoted wood block, per sq. yd.	Granite block, per sq. yd.	Gravel, per cu. yd.
Mankato	1.30	0.95	0.60					0.65
Minneapolis	1.25	1.45[44]	0.40[45]	1.06	19.00	1.45[46]	1.60	1.35[47]
New Ulm	1.90	1.40	0.75			1.35		0.75
Owatonna	1.97	....	0.70					0.65
Rochester	1.40	1.75	1.00	....	....			1.00
St. Cloud	2.00	1.65	1.00					
St. Paul	1.28	2.00	1.20	1.06	19.50	1.26	1.76	1.77
Virginia	1.65	2.35	1.50			1.55		2.00
Winona			0.98	0.97				
Iowa—								
Anamosa	1.60	0.80	1.50					1.50
Boone	1.40	1.85	1.15	0.80				1.25
Cedar Rapids	1.40	1.75	1.00	0.95		1.50		2.00
Des Moines	1.40	1.50	1.25	0.90	30.00	1.65		1.25
Eagle Grove		1.56	0.85					
Iowa Falls	....	1.20	1.10					
Marshalltown	1.35	....	1.00					1.10
Oskaloosa	1.41	....	1.35	0.80				
Rock Rapids	1.50	....	0.75					0.75
Pella	1.10[48]	....	1.75					
Waterloo	1.35	1.50	1.00	0.90	30.00	1.40		1.25
Missouri—								
Brookfield	1.60	3.20	1.55	0.87½				
Cape Girardeau	1.35	1.25	1.00		21.50[49]			
Columbia	1.60	1.60	1.50	1.00	20.00			1.10
Jefferson City	1.50	1.35	1.00		20.00			1.25
Kansas City	1.25[2]	1.40	1.20	0.80[17]	18.00	1.40		
Kirksville	1.68	2.10	1.40					
Kirkwood	1.40	0.60	0.50					0.60
Marshall	1.50	2.00	1.00	1.00				
Nevada	1.40	1.40			21.00		1.00	
Sedalia	1.20		1.35	0.85[50]	25.00			
Sikeston	1.29	1.25	1.10	0.90				
University City	1.40	....						
South Dakota—								
Watertown	2.00		0.90					
Nebraska—								
Auburn	1.20	1.75	1.35	0.72	18.00			
Chadron	....	2.40	3.00					1.25
Holdrege	2.00	0.15[51]	0.10[51]					
Lincoln	1.30	2.25	0.70	.95	20.00			
Seward	1.60	....	0.90					0.90
South Omaha	1.50	2.10	1.25					
Kansas—								
Abilene	1.50	1.60	1.35		25.00			
Chanute	1.25	1.35	1.60	.62	18.00			
Emporia	1.20[5]	1.46	1.35	19.80[4]	22.60			1.10
Fort Scott	1.25	1.25	1.80	.82	19.50			
Girard	1.15[17]	2.10[17]	1.35*[17]					
Iola	1.40	1.35	1.62	14.00†	19.75			
Junction City	1.34	1.45	.65		17.00			
McPherson	1.32	1.65	1.00		24.00			
Neodesha	1.15	1.25[?]	1.50	.67	18.00			
Newton	1.26	1.65	1.00	.72				
Ottawa	1.30	2.00	1.35	.70	20.00			
Parsons	1.40	1.30	1.65	.75	19.00			
Pittsburg	1.20	1.00[36]	1.50[?]	.72‡	....			
Rosedale	1.35	1.10[52]	1.50	.73	24.60			
Salina	1.40	1.65	1.25	.75	23.00			
South Atlantic Division:								
District of Columbia—								
Washington	1.04	1.50	0.54	.99				0.69
Virginia—								
Clifton Forge	....	1.60	1.00					
Newport News		2.25‡			.81‡			
Pocahontas	2.00	.90	1.10					
West Virginia—								
Moundsville	1.30	....	0.75	0.56				0.75
North Carolina—								
Asheville	1.70	1.75	1.00					
Charlotte	1.60	2.00	1.00					1.25
Durham	....	1.25*	1.00					....
Greensboro	2.06	.60	1.00					
Rocky Mount	1.70	2.00	1.00					
South Carolina—								
Columbia	1.70	1.70*	1.00					
Union	2.00	1.00	0.75					
Georgia—								
Rome	1.15	1.50	1.10					1.50
Florida—								
Daytona	2.00							
Lake City	....	1.60[41]						....
Orlando	2.03	2.00	1.00					
Pensacola	1.15[?]	1.70	1.50					1.70
East South Central Division:								
Kentucky—								
Dayton	1.35	1.60	1.00	0.80				
Lexington	1.45[5]	1.10	1.70	1.50				
Louisville	1.60	1.34	1.00		18.20			1.25
Murray			0.50					
Nicholasville	0.90	0.20						....
Owensboro	1.75	1.15	1.00					1.00
Tennessee—								
Bristol	1.80	0.60	0.80					....
Jackson	2.40	2.28	0.50					
Lebanon	2.00	1.10	1.35					2.00
Memphis	1.45*	1.50	1.00	20.00†	...	1.40		1.50
Nashville	1.00	1.50	1.35	1.00		1.30	1.20	1.50
Alabama—								
New Decatur	1.50	1.25	1.50					1.50
Mississippi—								
Clarksdale	2.10	2.00	1.80					
Vicksburg	1.80		0.90	2.07	22.00	2.54	2.80	1.00
West South Central Division:								
Arkansas—								
Jonesboro	1.80*	1.65	1.30	1.00	25.00			1.10
Louisiana—								
New Orleans	1.40		1.10			1.70	1.12	
Oklahoma—								
Ponca City	1.80	2.20	1.00	....	....	....	....	....
Shawnee	1.65	1.65	1.00	....	....	....	....	....
Texas—								
Denison	1.40[?]	1.75	[illegible]	.75	18.00			1.50
Greenville	1.70	1.85	1.40	....	....	....	....	1.25
Laredo			.75					.75
Lufkin	2.00	2.80	1.15	....	....	....	....	2.15
Mineral Wells		2.00						
Mountain Division:								
Montana—								
Bozeman	[illegible]	2.00	2.25		20.00			
Butte	2.20	1.50[?]	1.50[?]					
Dillon		1.25						
Great Falls	2.05	....	1.25	....	....	....	....	....
Miles City	2.60		1.25		28.00	1.65		.75
Utah—								
Ogden	2.25		1.00		16.00			1.00
Salt Lake City	2.25	1.50	1.00	....	19.00	....	....	1.00
Idaho—								
St. Maries	2.00	2.50	2.00					
Sandpoint	1.50	1.50	.50			2.50[?]		1.50
Colorado—								
Grand Junction	2.52	2.00	.80	....	....	....	....	.80
Wyoming—								
Cheyenne	....	....	.75	....	....	....	....	.60
Pacific Coast Division:								
California—								
Modesto	2.85	1.45	1.90	....	....	....	....	1.40
Monrovia	2.40	....	....	....	....	....	....	.70
Nevada City	3.60	.95						
Oakland	2.00[5]	1.25[?]	1.00		8.00[58]			1.00
Oxnard	2.40	1.90	1.50					
Palo Alto	2.00	1.75	1.75	....	....	....	....	....
Pasadena	2.25	1.00*	.50*	....	....	....	....	.75
Pomona	2.30	1.25	1.00					
San Francisco	2.30[17]	1.60	....	....	9.00	....	....	....
Santa Ana	2.00							
Santa Barbara	[illegible]	[illegible]	1.25		14.00			1.65
South Pasadena	2.25	1.50	1.00	....	9.00[53]	....	....	1.00
Oregon—								
Corvallis	2.46[?]	.70[60]	.75		10.00			.75
Eugene	2.43[5]	1.25	1.25[61]	....	....	....	....	1.25
Hood River	2.50	2.25	1.50	....	....	....	....	....
McMinnville	1.75	1.25	1.75	....	10.00[62]	....	....	1.25
Portland	1.90	1.00	.75	.95	10.50	.80	1.60[63]	.70
Washington—								
Aberdeen	1.70	....	1.00[64]	....	....	....	....	1.00[64]
Everett	2.00	....	1.10	....	12.00	....	....	1.10[64]
South Bend	1.58	1.45	1.25[65]	....	....	....	....	1.25[65]
Tacoma	2.00		.90	24.00[?]				.90
Walla Walla	2.15	1.60	1.75		17.00			1.60
Canadian Division:								
Nova Scotia—								
Halifax		1.10	1.10				2.35	1.15
Sydney	1.85	1.40	1.07[?]					.87*
Prince Edward Island—								
Charlottestown	2.40	2.25	1.00	....	....	....	....	2.00
New Brunswick—								
St. John	2.00	1.90	1.60		19.80			1.10
Quebec—								
St. Lambert	1.41	2.00	1.70					
Westmount	1.55							
Ontario—								
Berlin	1.65		.68					.80
Belleville	1.84	1.25	1.25					1.25
Kingston	1.52½	1.25	1.20					
London	1.50		1.25	29.40†				1.00[?]
Oshawa	1.60	1.50	1.00	1.60				1.00
Ottawa	[illegible]	1.50	1.00		22.50			
Sudbury	1.80	3.00	.90					.90
Toronto	1.40[?]	1.31	.90	1.18	[illegible]	2.10[?]	1.78	1.10
Welland	1.65	....	1.65	1.30	[illegible]	1.35	....	1.65[?]
Windsor	1.35		1.35					1.35
Manitoba—								
St. Boniface	2.60	2.50	1.80					1.80
Saskatchewan—								
Regina	2.40	4.00	1.00		30.00			2.00
Alberta—								
Edmonton	2.85	3.50	2.10		[illegible]			2.50
Lethbridge	3.00		1.25					1.25
British Columbia—								
New Westminster	2.35	1.66[?]	1.00					1.10
Vancouver	2.35	1.12[?]	1.10[?]	25.00[?]	16.50	[illegible]	2.15	1.10[?]
Victoria	2.35	....	1.60[2]	....	....	....	....	1.75
South Vancouver	2.60	1.50	1.50					[illegible]

*Per ton. †Per M. ††On job. ‡Per gal.

[1]At pit. [2]Delivered. [3]Per 2-horse load. [4]Per double load at bank. [5]Net. [6]$1.50 to $1.80. [7]$0.85 to $1.15. [8]$29.50 to $32.00. [9]$1.00 concrete sand; $1.50 asphalt sand. [10]$1.75 to $1.80. [11]Screened. [12]$0.80 to $0.90. [13]Medina block. [15]At crusher. [17]F. O. B. [18]$18.00 Trinidad, $26.50 Bermudez. [19]Own crushing plant. [20]$0.80 to $1.25. [21]Including filler and cushion. [22]Home granite block. [23]Broken slag. [24]$1.35-$1.40. [25]At bar. [26]On street. [27]$1.40 to $1.60. [28]$1.50 to $1.98. [29]Washed and screened. [30]In place on street. [31]$0.86 to $0.90. [32]$1.18 to $1.23. [33]Broken gravel. [34]$1.00 to $1.25. [35]$0.80 to $0.84. [36]On cars. [37]$1.21 to $1.30. [38]$1.49 to $1.77. [39]64 cts. to $1.25. [40]$1.75 per load of 1½ yds. [41]F. O. B. city. [42]75 cts. to $1. [43]40 cts. to 80 cts. [44]$1.45 to $2.40. [45]40 cts. to $1. [46]$1.29 to $1.45. [47]$1.35 to $2.25. [48]Car lots. [49]Road asphalt. [50]65 cts. to 85 cts. [51]Per 100 lbs. [52]90 cts. to $1.10. [53]$23 to $30. [54]Broken slag. [55]$1-$1.50. [56]Quoted. [57]85 cts. to $1.25. [58]$8 in tank cars, $11 in barrels. [59]In barrels. [60]Crushed gravel. [61]$1.25-$1.50. [62]$5 to $10. [63]Belgian block. [64]At bunkers. [65]$1.25 to $1.50. [66]$1.60 for slag cement. [67]60 cts. to $1. [68]Per 100 lbs. [69]$16.50 in drums; $13.50 cars. [70]$2.26 for lug blocks. [71]$25 to $30. [72]$1.40 to $1.66. [73]Scow. [74]$1.10 to $2.

TABLE XII.—LENGTH OF WORKING DAY AND PREVAILING LOCAL WAGES OF LABOR IN 1914 FOR PAVING WORK.

	Working day hrs.	Common labor.	Paver.	Team with driver.
New England Division:				
Maine:				
Portland	9	$2.00	$3.50	$5.00
New Hampshire:				
Laconia	9	2.00	3.50	4.50
Vermont:				
Barre	8	1.80	...	4.50
Massachusetts:				
Andover	8	2.00	...	5.00
Belmont	8	2.25	...	5.00
Boston	8	2.00	5.00	6.00
Cambridge	8	2.50	3.50	6.00[1]
Chelmsford	8	1.75	...	4.50
Clinton	8	2.00	...	5.00
Fall River	8	2.40	4.00	3.75[2]
Haverhill	8	2.33	3.00	5.00
Lawrence	8	2.25	4.50	5.00
Lowell	8	2.00	4.00	5.00
Lynn	9	2.50	...	5.25
Malden	8	2.25	5.00	5.50
Manchester	8	2.80	...	6.00
New Bedford	8	1.75	3.50	4.50
Newton	8	2.00[3]	...	...
Provincetown	8	2.00	...	2.00
Revere	8	2.50	...	6.00
Southbridge	9	2.00	...	4.50
Springfield	8	2.25	2.50	5.25
Taunton	8	2.00	2.25	...
Waltham	8	2.25	2.75	6.00
Webster	8	1.75	...	5.00
Westfield	8	2.00	...	5.00
Winchester	8	2.50	...	6.00
Worcester	8	2.00	4.00	5.50
Connecticut:				
Ansonia	8	1.60[4]	4.00	5.00
Bridgeport	8	1.75	4.50	6.00
Derby	9	1.60	...	5.00
Hartford	8	2.00	...	5.00
Killingly	10	1.75[5]	...	4.50
Meriden	10	2.00	3.00	6.00
Middletown	9	1.65	...	...
New Haven	10	2.00	3.50	4.00[6]
Wallingford	9	2.00	...	5.50
Waterbury	10	2.00	5.00[7]	6.00
Rhode Island:				
Providence	9	0.19½*	0.33⅓*	0.50*
Middle Atlantic Division:				
New York:				
Ballston Spa	8	1.75	...	...
Binghamton	8	2.00	2.50	4.00
Buffalo	8	1.80	4.80	7.00
Carthage	10	1.75	...	5.00
Elmira	8	1.60	2.50	4.50
Endicott	8	1.75	3.00	4.00
Fairport	8	0.22½*	...	5.00
Fulton	8	1.75	0.60*	4.50
Gloversville	8	2.00	...	4.50
Jamestown	8	2.00	2.25	5.00
Johnstown	8	2.00	3.50	5.00
New York (Bklyn)	8	1.90	5.00	6.00
New York (Queens)	8	2.00	6.00	2.00
Niagara Falls	8	0.25*	0.30*	6.50
Norwich	8	2.00	3.00	5.00
Olean	9	1.80	3.50	5.40
Oneonta	8	1.80	...	4.00
Oswego	8	2.00	...	4.50
Poughkeepsie	8	2.00	...	5.00
Plattsburgh	8	1.50	4.00	4.00
Rochester	8	2.00	4.00	5.50
Salamanca	8	1.75	3.00	4.80
Schenectady	8	2.25	5.00	5.00
Syracuse	8	1.75[8]	4.00	4.50
Tonawanda	8	1.80	...	5.00
Utica	8	...	...	5.00
Watertown	8	2.00	4.00	4.50
New Jersey:				
Atlantic City	10	1.75	...	5.00
Bayonne	9	1.80	4.50	6.00
Camden	10	1.50	2.50	5.50
Elizabeth	8	1.75	4.50	6.00
Newark	8	1.75[9]	...	6.00
Passaic	9	1.75	3.00	5.50
Plainfield	8	1.75	...	5.00
Ridgewood	8	2.00	5.00	6.00
Roselle Park	9	...	...	...
Salem	9	1.50	...	3.50[10]
Trenton	9	2.00	4.00	6.00
West New York	9	2.00	4.50	6.00
Pennsylvania:				
Athens	9	2.00	...	4.50
Bloomsburg	9	1.75	2.50	3.50
Carlisle	10	0.16*	0.20*	0.10*[11]
Catasauqua	9	1.75	...	4.50
Clairton	10	1.65	3.00	5.00
Clearfield	8	1.75	2.25	5.00
Connellsville	9	1.75	2.25	5.00
Corry	10	1.50[12]	3.00	5.00
Dorranceton	9	1.60	...	4.50
Du Bois	9	2.00	2.50	5.00
Edwardsville	9	1.85	...	...
Erie	10	1.75	2.50	5.00
Farrell	9	2.00	3.25	5.00
Franklin	9	1.80	0.08[13]	5.00
Greenville	10	2.00	2.80	5.00
Harrisburg	8	1.50	...	...
Hanover	10	1.75	...	4.50
Hanover Township	9	1.75	...	4.50
Hazleton	10	0.22*	0.45*	0.61*
Juniata	10	1.75	...	5.00
Kingston	9[14]	1.60[15]	...	5.00
Larksville	9	1.85	...	...
Meadville	10	1.75	2.50	5.00
Monongahela	10	2.20	4.50	6.60
New Brighton	9	1.70	...	5.00
North East	10	1.75	...	5.00
Philadelphia	10[56]	1.75[0]	3.75	4.10[53]
Phoenixville	10	1.65	...	...
Scranton	10	1.80	3.00	5.00
Somerset	10	1.75	...	4.00
South Bethlehem	8	1.50	2.00	5.00
West Hazleton	10	2.00	5.00	6.00
Wilkes-Barre	9[16]	1.82	3.00	4.50
Wilkes-Barre Twp.	9	1.80	...	...
East North Central Division:				
Ohio:				
Akron	10	2.25	4.00	7.50
Alliance	9[17]	1.50	5.00	5.00
Amherst	10	2.00	4.00	5.00
Ashtabula	10	1.75	2.50	5.00
Barberton	10	1.75[18]	5.00	5.00
Bellefontaine	10	1.75	3.00	3.50
Bryan	10	2.00	...	4.00
Cambridge	9	2.00	3.00	5.00
Canton	9	0.22½*	0.50*	0.60*
Chillicothe	10	1.75[19]	4.00	4.50
Cincinnati	10	2.00	5.60	6.00
Conneaut	10	2.00	3.50	5.00
East Liverpool	9	2.00	3.50	6.00
Findlay	9	2.00	3.25	4.50
Fostoria	10	2.25	3.50	5.00
Geneva	10	2.00	2.50	4.50
Hamilton	10	2.50	3.50	4.50
Ironton	10[20]	1.75[21]	2.25	3.50[22]
London	10	1.75	4.00	4.00
Lorain	10	1.75	...	5.00
Marietta	9	2.25	...	5.50
Miamisburg	10	2.00	3.00	4.00
Mt. Vernon	10	1.75	2.50	4.00
Newark	9	2.00	3.00	4.50
Oberlin	10	2.00	2.50[23]	5.00
Orrville	9	2.00	5.00	5.00
Painesville	10	1.75	3.50	5.00
Sandusky	10	2.00	4.00	5.00
Tiffin	10	2.25	3.00	4.00[24]
Toledo	9	2.25	4.00	6.00
Indiana:				
Bremen	10	2.00	...	4.00
Crawfordsville	10	2.00	4.00	4.00
Crown Point	10	0.22½*	...	0.50*
Decatur	10	2.00	...	4.00
Evansville	10	1.75[25]	3.00	4.00
Fort Wayne	10	2.25	3.50	5.50
Frankfort	10	2.00[26]	3.00	4.50
Gary	10	2.00	4.00	6.00
Greencastle	10	2.00	...	4.00
Lafayette	10	2.00	3.00	4.00
Logansport	10	2.00	5.00	4.50
Muncie	10	2.00	3.50	4.00
Noblesville	10	2.00	...	4.00
Portland	10	2.00	3.00	4.00
Princeton	9	0.25*	...	4.00
Rushville	10	2.00	...	4.00
Salem	10	1.75	...	4.00
South Bend	10	2.25[27]	0.50*	0.50*
Illinois:				
Alton	9	2.00	2.25	4.50
Anna	10	2.00	...	4.00
Charleston	9	1.80	...	4.00
Chicago	8[28]	2.25[29]	3.50	6.50
Clinton	10	2.00	...	...
Danville	9	0.20*	0.30*	0.40*
Decatur	10	0.20*	0.30*	0.60*
Dixon	9	2.50	4.00	4.50
East St. Louis	10	2.00	4.00	5.00
Galesburg	8	...	...	...
Granite City	8	2.00	3.50	5.00
Herrin	8	2.80	...	...
Hillsboro	8	2.00	4.00	5.00
Kewanee	9	2.25	...	4.00
Lake Forest	8	2.50	...	6.00
Lawrenceville	10	2.00	...	4.00
Marion	9	0.30*	...	3.50
Mattoon	10	0.22½*	0.30*	0.45*
Moline	10	1.75	2.50	5.00
Morrison	10	2.00	...	4.50
Murphysboro	10	2.50	3.50	5.00
Oak Park	9	...	...	...
Pana	8	0.27½*	0.40*	5.00
Paris	10	2.00	2.25	4.00
Peoria	10	1.75	5.00	6.00
Rockford	10	0.22½*	...	0.50*
Waukegan	9	1.80	2.70	6.00
Wilmette	9	2.70	...	5.50
Michigan:				
Ann Arbor	9	2.25	...	4.50
Battle Creek	10	2.50	4.00	5.00
Benton Harbor	9	2.00	3.00	0.50*
Detroit	8	2.00	2.50	4.40
Flint	10	2.00	3.00	5.00
Grand Rapids	8	2.00	3.50	5.00
Greenville	10	2.00	...	3.50[30]
Highland Park	10	2.00	...	6.00
Holland	9	2.00	2.00[31]	4.00
Howell	10	2.25	2.50	4.50
Kalamazoo	8	3.00	...	4.50
Manistee	10	1.75	7.00	5.00
Monroe	10	2.00	...	...
Munising	10	2.00	4.00	5.00
Niles	10	1.75	4.00	4.00
Petoskey	10	2.00	4.00	4.50
Port Huron	10	2.25	...	5.00
Saginaw	8	2.00	...	4.00
Wisconsin:				
Berlin	10	0.20*	...	3.50
Chippewa Falls	10	2.50	3.00	4.00
Eau Claire	10	2.00	...	4.00
Edgerton	10	2.25	...	4.00
Fond du Lac	10	2.00	3.50	5.00
Janesville	10	2.25	...	5.00
La Crosse	10	1.75	2.50	5.00
Lake Geneva	9	2.25	...	...
Marinette	10	1.75	2.25	4.50
Oshkosh	10	2.00	...	4.00
Racine	10	2.00	...	6.00
Sheboygan	10	1.75	0.60*	5.00
Superior	10	2.25	3.00	5.00
West North Central Division:				
Minnesota:				
Cloquet	10	2.25	...	4.50
Duluth	8	2.00[32]	4.00	6.00
Faribault	10	2.25	...	5.00
Lake City	10	1.75	...	5.00
Mankota	10	2.25	4.00	4.50
Minneapolis	8	2.50	3.00	5.00
New Ulm	10	2.50	3.50	4.50
Owatonna	10	2.50	...	4.50
Rochester	10	2.25	...	5.00
St. Cloud	9	2.25	...	5.00
St. Paul	10	2.50	3.50	6.00
Virginia	10	2.25	...	5.50
Winona	9	2.00	3.50	4.50
Iowa:				
Anamosa	10	2.50	5.00	5.00
Atlantic	10	2.25	...	4.00
Boone	9	2.25	4.00	5.00
Cedar Rapids	8	2.00	3.50	0.60*
Des Moines	9	2.25	2.75	5.00
Eagle Grove	10	2.25	2.75	3.50
Iowa Falls	10	2.00	...	...
Marshalltown	10	2.00	5.00	4.00
Missouri Valley	..	2.00	...	...
Muscatine	9	2.00	...	...
Oskaloosa	10	2.00	3.50	0.50*
Rock Rapids	10	2.50	...	5.00
Pella	8	2.00	...	4.00
Waterloo	10	2.25	3.00	4.50
Missouri:				
Brookfield	9	2.00	...	4.50
Cape Girardeau	10	2.00	...	4.00
Columbia	10	1.75	2.00	3.50
Jefferson	10	2.00	3.50	4.00
Kansas City	8	1.75	2.20	4.50
Kirksville	9	1.80	...	4.00
Kirkwood	9	2.25	3.60	5.00
Marshall	10	2.00	...	4.00
Mexico	10	1.75	...	4.00
Nevada	9	1.75	2.50	4.00
Sedalia	10	1.75	2.50	4.00
Sikeston	10	1.50	4.00	3.50
University City	10	0.20[33]	0.35*	5.00
South Dakota:				
Watertown	10	2.25	...	4.50
Nebraska:				
Auburn	10	2.00	3.00	4.00
Havelock	10	2.50	4.00	...
Holdrege	10	2.00	...	4.00
Lincoln	10	2.25	3.00	4.50
Nebraska City	10	2.00	...	...
Seward	10	2.00[34]	5.00	4.50[35]
South Omaha	8[36]	2.00[34]	...	5.00
Kansas:				
Abilene	8	1.75	2.25	3.75
Chanute	8	1.80	2.50	3.50
Emporia	8	2.00	2.50	4.00
Ft. Scott	8	1.75	0.03[37]	4.00
Girard	8	2.00	...	...
Herington	8	1.75	...	3.75
Iola	8	2.00	3.00	3.50
Junction City	8	2.00	...	4.00
McPherson	8	1.75	2.50	3.00
Neodesha	8	1.75	3.00	3.20
Newton	8	2.00	3.50	4.00
Osawotomie	8	1.75	...	3.50
Ottawa	8	1.60	2.40	3.20
Parsons	8	1.75	3.20	3.50
Pittsburgh	8	2.00	2.50	3.75
Rosedale	8	2.00	4.00	5.00
Salina	8	1.65	2.75	3.75
South Atlantic Division:				
District of Columbia:				
Washington	8	1.50[38]	...	4.00
Virginia:				
Clifton Forge	10	1.50	...	4.00
Newport News	10	1.50	2.50	3.50
Pocohontas	10	1.60	3.00	4.00
West Virginia:				
Moundsville	9	1.75	3.00	5.00
North Carolina:				
Asheville	9	1.35	2.50	4.00
Charlotte	10	1.25	2.50[39]	4.00
Durham	10	1.50	...	...
Greensboro	10	1.25	2.50	3.50
Rocky Mount	10	1.50	...	...
South Carolina:				
Columbia	10	1.25	2.50	4.00
Union	10	1.00	...	3.00
Georgia:				
Rome	10	1.25	3.00	4.00
Florida:				
Daytona	8	1.50	...	5.00
Lake City	10	1.25	...	4.50
Orlando	10	1.50	2.50	4.50
Pensacola	9	1.50	3.50	4.50
East South Central Division:				
Kentucky:				
Dayton	10	1.75	...	5.50
Lexington	9	1.50	2.00	4.00
Louisville	9	1.75	3.00[41]	4.00
Murray	..	1.50[42]	...	3.00
Nicholasville	10	1.50	...	4.00
Owensboro	10	1.75	...	4.00
Tennessee:				
Bristol	10	1.35	...	3.00
Jackson	9	1.50	...	3.50
Lebanon	8	1.50	2.00	3.50
Memphis	10	1.50	5.00	5.00
Nashville	10	1.50[43]	5.00	3.50
Alabama:				
New Decatur	10	1.50	...	4.50
Mississippi:				
Clarksdale	10	1.25	...	5.00[44]
Vicksburg	10	1.35	2.00	4.00
West South Central Division:				
Arkansas:				
Jonesboro	10	1.50	3.00	4.00
Louisiana:				
New Orleans	10	1.75	3.50	7.00
Oklahoma:				
Ponca City	8	2.00	...	4.00
Shawnee	8	1.75	3.00	3.50
Texas:				
Denison	8	1.50	...	3.50

TABLE XII.—CONTINUED.

	Working day hrs.	Common labor.	Paver.	Team with driver.
Greenville	8	1.75	4.00	3.75
Haskell	9	1.50	...	4.00
Laredo	8	1.00	...	3.50
Lufkin	8	0.30*	...	0.70*
Mineral Wells	8	1.75	...	3.50
Mountain Division:				
Montana:				
Bozeman	8	3.00	4.00	6.00
Butte	8	4.00	8.00	7.00
Dillon	8	3.00	...	...
Great Falls	8	3.00	4.00	6.00
Miles City	8	3.00	...	6.00
Utah:				
Ogden	8	2.25	3.00	5.00
Salt Lake City	8	2.25	5.50	5.00
Idaho:				
St. Maries	9	2.50	4.00	6.00
Sandpoint	9	2.50	...	6.00
Colorado:				
Grand Junction	8	2.40	3.00	5.00
Wyoming:				
Cheyenne	9	2.25	...	5.00
Douglas	10	3.00	...	5.00
Pacific Coast Division:				
California:				
Hollister	8	2.00	...	4.00
Modesto	9	2.50	5.00	4.00
Los Angeles	..	2.50	2.50	5.00
Monrovia	8	2.25	...	5.00
Nevada City	8	2.50	...	...
Oakland	8[45]	2.00[46]	...	6.00
Oxnard	8	2.00	6.00	4.75
Palo Alto	8	2.25	3.50	4.50*
Pasadena	8	2.50	...	5.00
Pomona	9	2.25	...	4.50[47]
San Francisco	8	3.00	6.00	6.50
Santa Ana	8	2.25	3.50	4.50[47]
Santa Barbara	8	2.25	...	5.00
South Pasadena	8	2.00	4.00	5.50
Oregon:				
Corvallis	8	2.75	...	5.00
Eugene	8	2.25	6.00	4.50
Hood River	8	2.50	...	6.00
McMinnville	8	2.25	...	5.00
Portland	8	3.00	6.00	5.00
Salem	8	2.25	...	5.00
Washington:				
Aberdeen	8	2.50	...	7.00
Everett	8	2.50	...	6.00
Port Angeles	8	2.50	...	...
South Bend	8	2.50	10.00	6.00
Tacoma	8	2.25	6.00	7.00
Walla Walla	8	0.27½*	...	4.50
Canadian Division:				
Nova Scotia:				
Halifax	9	1.80	...	2.88[50]
Sydney	9	1.85	...	5.00[51]
Prince Edward Island:				
Charlottetown	10	1.35	...	3.50
New Brunswick:				
St. John	9	1.75[8]	4.55	5.00
Quebec:				
Lake Megantic	10	2.00	...	4.00
St. Lambert	10	0.17*	...	6.00
Westmount	10	2.00	5.00	3.50[50]
Ontario:				
Berlin	10	0.20*	...	0.50*
Belleville	10	1.75	...	...
Kingston	9	0.20[52]	...	5.00
London	9	0.25*	0.30*	5.00
Oshawa	10	0.17½*	0.30[53]	0.40*
Ottawa	9	2.25	...	5.25
Sudbury	10	2.00	...	5.00
Toronto	9	2.50[27]	2.70	6.00
Welland	10	2.25	5.00[54]	5.00
Windsor	9	2.25	3.00	.55*
Manitoba:				
St. Boniface	10	0.25*	0.37*	0.50*
Saskatchewan:				
Regina	10	2.50	6.00	5.00
Alberta:				
Edmonton	9	0.30*	...	0.70*
Lethbridge	10	0.25*	0.45*	6.00
British Columbia:				
New Westminster	8	3.00	4.00	7.00
South Vancouver	8	3.00	4.00	6.75
Vancouver	8	3.00	3.50[22]	7.00
Victoria	8	3.00	...	6.00

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*Per hour. [1] $6.00 double. [2] $3.75 to $5.50. [3] $2.00 to $2.25. [4] $1.60 to $1.75. [5] 1.75 for 9 hrs. [6] $4.00 single, $6.00 double. [7] $5.00 to $7.00. [8] $1.75 to 2.00. [9] 1.75 to $2.00. [10] $3.50 to $5.00. [11] $0.10 and $0.15 per hr. [12] $1.50 to $1.60. [13] per sq. yd. [14] 8-9 hrs. [15] $1.60 to $1.75. [16] 9-10 hrs. [17] 9-10 hrs. [18] $1.75 to $2.00. [19] $1.75 to $2.00 [20] will be 8 hrs. [21] $1.75 to $2.00. [22] $3.50 to $4.00. [23] $2.50 to $6.00. [24] 4.00 to $5.00 [25] $1.75 to $2.00. [26] $2.00 to $2.25. [27] $2.25 to $2.50. [28] 8-9 hrs. [29] $2.25 to $2.75. [30] $3.50 to $4.00. [31] $2.00 and up. [32] $2.00 to $2.25. [33] $0.20 to $0.25 per hr. [34] $2.00 to $2.50. [35] $4.50 to $5.00. [36] 8 to 10 hrs. [37] Contract—$0.03 per yd. [38] $1.50-$1.75. [39] $2.50 to $4.00. [40] $1.00 to $1.25. [41] $3.00 to $4.50. [42] $1.00 to $1.50. [43] $1.50 to $2.00. [44] $4.00 to $5.00. [45] 8 to 9 hrs. [46] $2.00 to $2.50. [47] $4.50 to $5.00. [48] $2.50 to $4.00. [49] $6.00 to $7.00. [50] Single team and driver. [51] 1-horse team and driver, $2.50. [52] 20 cts. to 25 cts. per hour. [53] 25 cts. to 30 cts. per hour, [54] $5.00 to $5.25. [55] $4.10 to $5.00. [56] 8 hours for city forces; 10 hours for contractors.

About 22 per cent of the total railway construction in Canada during 1914 was located in Alberta, according to a recent report. That province has one mile of railroad for every 125 persons. The mileage has doubled in three years, and at the beginning of 1915 had reached a total of 4,097 miles.

PERSONALS

Mr. F. McArthur, city engineer of Regina, Sask., states that the report of his resignation is not correct and that he will continue in his present position. Mr. L. A. Thornton, who was reported to succeed Mr. McArthur, will continue as city commissioner, especially in charge of capital expenditures.

Messrs. Robert S. Brewster, of New York, Arthur W. Lawrence of Bronxville and George W. Mertz of Port Chester have been appointed by the Governor of New York as members of the new Building Commission of Westchester County, New York. The selection of architects, and the construction of the buildings for the county will be in charge of this commission.

Mr. Frank A. Weaver, for five years district manager of the Cleveland office of the Ayer & Lord Tie Co., Chicago, has resigned to establish an office as construction engineer and contractor at 804 Swetland Bldg., Cleveland, Ohio. He will make a specialty of materials and installations of factory floors, particularly creosoted wood, Byerlite bituminous, Idealite carborundum, and Idealite ornamental floors.

Mr. V. J. Bedell, who has been city engineer and superintendent of water works at Marshall, Mo., since 1913, has resigned to open an office in Marshall for a general civil and sanitary engineering practice. Mr. Bedell was formerly assistant engineer for the Board of Improvements of Fort Smith, Ark., and prior to that was in railway work. From 1910 to 1913 he was field engineer in the sewer division, city engineer's office, at Kansas City, Mo.

Mr. H. M. Burwell is retiring from the civil engineering firm of Hermon & Burwell to enter upon an individual consulting engineering practice at Vancouver, B. C. Mr. Burwell has been in general practice in British Columbia for 17 years in land surveys and general engineering, and for 10 years on hydraulic engineering work. Since 1887 he has been a member first of the firm of Garden, Hermon & Burwell, and later Hermon & Burwell. From 1904 to 1906 he was engineer in charge of construction of the Coquillan Lake hydro-electric development, and from 1906 to 1913 was engineer in charge of Vancouver water works extensions and of the Pitt Meadows reclamation work.

Messrs. Isaac Harby, Ludlow L. Melius and Louis W. Abrons announce the organization of the firm of Harby, Abrons & Melius, Inc., for the purpose of general contracting and building construction, with offices at 30 E. 42d St., New York City. Mr. Harby, the president of the new firm, was formerly with Bing & Bing and E. Brooks & Co. Mr. Melius, the vice-president, is connected with the Spuyten Duyvil Construction Co., and Mr. Abrons, who is secretary and treasurer, is from the Perth Construction Co. All three members of the firm are civil engineers. Mr. Harby and Mr. Abrons being members and Mr. Melius an associate member of the American Society of Civil Engineers.

Mr. Edward B. Wayts has been appointed as superintendent for the Marshfield, Wis., Water, Electric Light & Power Co., and will have entire charge of the water system of the city, pumping station, power station and all transmission lines for power and lighting. Mr. Wayts has been employed in electrical work most of the time since he began in 1896 as helper in the shops of the Union Traction Co. of Indiana. In 1902 he went to sub-station operation, and in 1906 was night foreman in the shops of the Indianapolis & Eastern Traction Co. at Richmond, Ind. From 1908 to 1913 he was in South Dakota for the Chicago, Burlington & Quincy in the Black Hills, and as electrical superintendent of interurban lines, power and lighting. In 1913 he was appointed as superintendent of the water and light department at Downers Grove, Ill. During the year in which he held that office the water and light plant underwent reconstruction, among other things the substitution of crude oil power for steam, and Mr. Wayts gained considerable experience in municipal work which will be of value to him in his present position.

Mr. Alfred C. Nelson, consulting and contracting engineer, announces that he has opened offices at 418 Rockefeller Bldg., Cleveland, Ohio. He will make a specialty of blast furnaces, hot blast stoves, power and industrial plants, foundations, fire brick and steel construction, and the storing and handling of coal and ores. He is also prepared to undertake investigations, valuation, reports, etc. Mr. Nelson graduated in 1899 from the Case School of Applied Science, and at once entered the employ of the Harris Automatic Press Co., Niles, O., as draftsman. Later he became designer for the Packard Motor Car Co. In 1900 he was designer for the Ohio Steel Co. at Youngstown, and the following year held a similar position with the Browning Engineering Co. of Collinwood, Ohio. From 1901 to 1904 he was with the Wellman-Seaver-Morgan Co. of Cleveland, Ohio, and in 1904 was employed partly on special work for Mr. J. Koeple and partly as designer for the Olds Motor Co., Detroit, Mich. For two years he was designer for the American Steel & Wire Co. at Cleveland, and since 1906 he has been engineer in charge of construction of a number of complete blast furnace plants for Arthur G. McKee, engineer of Cleveland. Mr. Nelson is a member of the American Society of Mechanical Engineers and of the Cleveland Engineering Society.

CIVIL SERVICE NEWS

The Illinois State Civil Service Commission announces the following:

An examination of interest to the engineering profession is that for Utilities Investigator in the Illinois Public Utilities Commission, which is to be held on May 1, 1915. It pays from $100 to $150 per month, and is open to men over 21 years of age; there being two positions to be filled.

The examination will cover the training and experience of the applicant and will deal with the collection of data regarding railroad accidents, investigation of railway crossings over railroads and the performing of other engineering, inspecting or investigating work for the Commission. This examination is open only to residents of Illinois.

At the same time an examination will be held for Utilities Rate Expert in the Accounting Department of the Commission, which is open to men over 25 and pays from $125 to $175 a month.

Waterworks Improvements at Louisville, Ky., to Cost $900,000.

Improvements to cost $900,000 are contemplated for this present plant of the Louisville Water Co., of Louisville, Ky., in order to bring it up to its fullest efficiency. The following tabulation gives in detail the work proposed which will extend over several years:

30,000,000-gal. pumping engine and station large enough to install above pump in	$535,000
48-in. discharge main from River Pumping Station to Crescent Hill	153,000
36-in. main from Crescent Hill to Bardstown Road	100,000
Cleaning basins, Crescent Hill Reservoir.	6,000
Remodeling and improving electric power plant	10,000
Pipe system, services and meters	96,000
Total	$900,000

Nothing in the immediate future is to be done except the laying of the 48-in. main from the River Station to Crescent Hill, a distance of about 12,000 ft. Plans and specifications are now being prepared for it, and the work will be completed by the fall. Jas. B. Wilson is chief engineer and superintendent of the Louisville Water Co.

RAILWAYS

PROSPECTIVE WORK.

Arkansas:

Mountain Valley, Ark.—Mountain Valley Water Co. is reported to have made surveys and secured capital for construction of electric railway from Hot Springs to Mountain Valley.

Pine Bluff, Ark.—Engineers supposed to be representing J. G. White Engineering Corporation have been over route of proposed extension of Arkansas, Louisiana & Gulf Railroad from Monticello to Pine Bluff. It is reported that prospects are bright for early construction. J. M. Parker, Monroe, La., President.

Idaho:

Lewiston, Idaho.—Nez Perce & Eastern Ry. has been incorporated with capital stock of $1,000,000, of which $440,500 has been subscribed. Company proposes steam railroad from Lewiston to Nez Perce. Z. A. Johnson, Lewiston, President of Nezperce & Idaho Ry., is an incorporator.

Illinois:

Rockford, Ill.—Public Utilities Commission has authorized Rockford & Interurban Co. to issue $86,000 of bonds for improvements.

Springfield, Ill.—Illinois Central R. R. is understood to contemplate considerable amount of improvement work on its Springfield division. This is said to include additional terminal facilities along the line and new yards at Decatur and Clinton.

Indiana:

Gary, Ind.—New York Central Lines, it is reported, will start work this summer on the Chicago-Gary-Clearing yards. Yards will have capacity for 35,000 cars.

Louisiana:

Rayville, La.—Stock company is being organized to build and operate an interurban line from Rayville to point 22 miles south. It is hoped to have stock subscribed in 60 days for survey and purchase of right of way. T. J. Coenen, President Progressive League, Rayville, is interested.

Opelousas, La.—The Opelousas, Gulf & Northeastern R. R. has been purchased by Frank C. Nicodemus, Jr., of New York City, said to be representing the Texas & Pacific R. R.

Minnesota:

Little Falls, Minn.—Surveys are under way for line of Minneapolis & Central Minnesota Ry. from Little Falls to Pierz. B. H. Bradley is Chief Engineer.

New Mexico:

Des Moines, Mex.—Santa Fe System has purchased St. Louis, Rocky Mountain & Pacific Ry., 106-mile line extending from Des Moines to Ute Park, tapping coal fields of Colfax County.

North Carolina:

Goldsboro, N. C.—Citizens have voted bond issue for stock subscriptions for Goldsboro Street Ry. Co.

Ohio:

Cleveland, O.—Ordinance is before City Council for franchise for Cleveland, Akron & Canton Terminal Ry. Co. proposed subway under E. 55th St. from Lake Erie to point in Cuyahoga River Valley, connecting at grade with its proposed line in Akron and Canton. Project involves expenditure of about $10,000,000 and is reported to be backed by O. C. Barber, Barberton, O. Osborn Engineering Co., Cleveland, is consulting engineer.

Pennsylvania:

Erie, Pa.—Funds are being raised for survey of proposed route of Erie & Southwestern Interurban Ry., projecting a line from Erie to Linesville, Pa. H. C. Allen, Erie, is interested.

South Carolina:

Greenwood, S. C.—Savannah, Piedmont & Western Ry. has been incorporated, with minimum capital of $30,000 and maximum of $3,000,000, and proposes line from Greenwood to North Augusta, 60 miles. J. Peyton Clark, 43 Cedar St., New York City, General Manager. North Carolina Public Service Co. is reported to be interested.

Texas:

Quitman, Tex.—Quitman, Sulphur Springs & Great Northern Ry. proposes 28-mile line from Quitman to Sulphur Springs, passing through rolling and thickly settled country. Construction will involve 450,000 cu. yds. earth excavation, 500,000 cu. yds. embankment, 15,000 cu. yds. rock excavation and 3,620 lin. ft. trestle. No bridges will be required. Date of letting work has not been determined. T. A. Palmer, Quitman, Tex., is General Manager.

West Virginia:

Fairmont, W. Va.—Baltimore & Ohio R. R. probably will build branch from main line to new mining development of Consolidation Coal Co. in Farmington region, several miles west of Fairmont.

Wisconsin:

Bayfield, Wis.—Promotion work is under way for a new railway between Bayfield and Superior, along the south shore. It is estimated that line will cost $650,000. Grading between Bayfield and Orienta would be comparatively easy. T. N. Okerstrom, Port Wing, Wis., is interested.

Alberta:

Edmonton, Alberta.—Provincial Government will guarantee a branch of the Edmonton, Dunvegan & British Columbia Ry. from a point on the main line thereof to or through Grand Prairie City for a distance not to exceed 60 miles, at $20,000 per mile.

Ontario:

Toronto, Ont.—Ontario Legislature has granted Toronto & York Radial Ry. Co. (electric), a two years extension of time in which to start construction on certain lines outside of Toronto.

BIDS OPENED; CONTRACTS LET

California:

Brawley, Cal.—San Diego & Arizona Ry., E. J. Kallright, Chief Engineer, San Diego, is reported to have awarded contract for last section of line. Work covers about 34 miles and route follows through canyons, requiring short tunnels and heavy rock work.

Iowa:

Charles City, Ia.—P. E. Shugart, Nevada, Ia., has been awarded contract for grading 8-mile extension of Charles City Western Ry. from Charles City. Work involves about 100,000 cu. yds. excavation.

Maryland:

Williamsport, Md.—Claybourne, Johnson & Co., Baltimore, Md., have been awarded contract for grading and track laying for Williamsport, Nessle & Martinsburg Ry., proposing a steam line from Williamsport to Martinsburg. Pennsylvania Steel Co. has contract for superstructure of bridge over Potomac River. Grading is reported to have been started.

Ohio:

Columbus, O.—Bids were opened April 3 for the first 28-mile section of the Chesapeake & Ohio Northern Ry., the new 96-mile connecting link between the Chesapeake & Ohio R. R. and the Hocking Valley. The first section extends from Sciotoville to Waverly; the second section extends from Waverly to Circleville and the third from Circleville to Columbus.

Portsmouth, O.—O. S. Hord and A. Keathley, Cincinnati, O., have been awarded contracts for grading, concrete work and track laying for 21-mile extension of Ohio Valley Traction Co. from Sciotoville to Ironton.

Virginia:

Roanoke, Va.—Contracts for low-grade line of Norfolk & Western Ry. between Burkeville and point near Pamplin, Va., 36½ miles, have been let as follows: Patterson, Moran & Co., New York City; J. J. Sheehan, Roanoke, Va.; Rinehart & Dennis, Charlottesville, Va., and Robert Grace Contracting Co., Pittsburgh, Pa.

ROADS STREETS

BIDS ASKED.

California:

San Bernardino, Cal.—County Supervisors on March 30 ordered the advertisement for bids on five contracts, as follows: Colton Ave., Colton to the Riverside county line, 2.70 miles; Colton Ave., Colton to Bloomington, 4 miles; San Bernardino Ave., in the city of Rialto, 1.50 miles; Archibald Ave., Base Line to Colton Ave., 3.50 miles; 10th St., Upland, Euclid Ave. to Los Angeles county line, and 10th St., diagonal, Upland, to state highway, .60 mile. These roads are to be built of concrete.

Colorado:

Colorado Springs, Colo.—Until noon, April 10, by E. C. Sheldon, County Clerk, for 1,600 ft. of wagon road requiring 8,450 cu. yds. excavation and to cost $4,650.

Florida:

Jacksonville, Fla.—Until April 8, by E. A. Ricker, chairman County Commissioners, for 37 miles of highway (brick, asphalt macadam or other material) and for resurfacing with asphalt macadam or other material 29 miles.

Indiana:

Muncie, Ind.—Until 10 a. m., April 17, by Board of Public Works, for macadam on Fifth Street.

Lebanon, Ind.—Until 1 p. m., May 7, by County Auditor, for county line road.

Kokomo, Ind.—Until 10 a. m., April 22, by E. B. Swift, County Auditor, for paved road in Center Township.

Indianapolis, Ind.—Until 10 a. m., April 17, by W. T. Patten, County Auditor, for improvement of 17th Ave., Center Township.

Kansas:

McPherson, Kan.—Until April 10, by Milton Hawkinson, City Clerk, for 26 blocks of street paving and 8 blocks of alley paving. H. A. Rowland, City Engineer.

Kentucky.

Louisville, Ky.—Until 2 p. m., April 12, by Board of Public works, Roger G. McGrath, Secretary, for Letting No. 578, improvement of 10 alleys.

Louisiana:

New Orleans, La.—Until noon, April 24, by W. E. Atkinson, State Highway Engineer, for about 9 miles of earth road for Abbeville-Kaplan highway, Vermilion Parish.

Maryland:

Easton, Md.—Until noon, April 13, by J. B. Harrington, Clerk, County Commissioners, for 1.57 miles of state aid road. Frank W. Seth, County Roads Engineer.

Massachusetts:

Pittsfield, Mass.—Until April 9, by Board of Public Works, for furnishing 10 cars of asphaltic road oil.

Michigan:

Saginaw, Mich.—Until April 20, by Geo. Holcomb, Commissioner of Public Works, for paving portions of 13 streets.

Duluth, Minn.—Until 10 a. m., April 12, by R. Murchison, Commissioner Public Works, for sprinkling and cleaning streets during 1915.

Minnesota:

Duluth, Minn.—Until 10 a. m., April 16, by R. Murchison, Commissioner Public Works, for paving 12th St.; also for paving Minnesota Ave., from 12th to 38th Sts.

New Jersey:

Trenton, N. J.—Until April 20, by Board of County Freeholders, Theodore Tobish, County Engineer, for the construction of the extension of the River Road from Washington's Crossing to the Hunterdon County line; 30 ft. wide, 18 ft. of pavement, and about 5 miles in length; two miles of concrete to cost about $38,418 and three miles of bituminous concrete at about $80,049.

New York:

Albany, N. Y.—Until 1 p. m., April 20, by State Highway Commission, I. J. Morris, Sec-

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

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Frederick W. Taylor.

In the hall of engineering fame there are now two names of American engineers whose renown is due to their teachings of economics. The first of these great teachers was a civil engineer, A. M. Wellington. The second was a mechanical engineer, F. W. Taylor.

Wellington's "Economic Theory of Railway Location," and Taylor's "Shop Management" are two of the most important essays ever written. They are great not only because of the forceful exposition of economic principles, but because of the greatness of the authors. It is impossible to read either of those works without feeling the personal magnetism of a man himself electrified with a constructive idea.

It has been said of scientific books that only the latest need be read, for in them will be found the cream of all that has preceded. This may be true if by "cream" is meant merely bare facts. But the real cream is often in the spirit of the writer, a cream that can not be skimmed from his works by those who undertake to abstract the facts only. We should count it a great misfortune not to have read Wellington and Taylor in the original.

Yet in their original form none of the works of these two engineers did or could attract general public attention. Wellington was technical to such a degree, and Taylor was so narrow in his conception of the application of three "principles of shop management," that the general public could not be expected to find in their works the inspiration that engineers found there.

Many will be surprised to hear that Taylor, "the father of scientific management," used the expression "scientific management' in his essay on ship management but once. Throughout he spoke of the "art of management." Nor did he seem to perceive that the three principles that he combined in that "art" could be generalized, added to, and thus be made to form part of a science of management. Indeed he spoke of his shop management system as being an "invention," which, like all inventions, he said consisted of a new combination of old elements. He disclaimed title to the original discovery of any one of the three principles of management, but he did claim that he was the first to have *combined* them into a working system that should be applied to all shop management. This view was not broadened in his subsequent writings until other engineers had taken not only the three principles used by him but had added many in the effort to develop a science of management. Then, by a most curious stroke of chance, great general publicity was given to this new science.

Mr. Louis Brandeis, an attorney for certain shippers who were seeking to keep railway rates down, had read writings on "management engineering," "scientific management," etc., and he become imbued with the idea that the railways need not raise rates if they would apply the principles of "scientific management." Accordingly he called upon several exponents of "scientific management." Among those that he saw was the chief editor of *Engineering and Contracting*. He outlined what he wished to establish by evidence before the Interstate Commerce Commission, and asked the editor to appear as a witness. For reasons that need not be stated, the request was declined. Mr. Taylor likewise refused to testify. Other witnesses were secured, and Brandeis roused nation wide attention by his announcement that he would prove by them that American railways could save $1,000,000 a day, by applying the principles of "scientific management."

The spectacular announcement, coupled with the national importance of the hearing before the I. C. C., served to focus the eyes of the business world upon a science of whose existence few of them had heard, and, hearing, immediately denied. The controversy thus started speedily resulted in giving every newspaper reader at least some idea of what "scientific management" means. Then came magazine articles, and a mass of exaggerated or distorted claims for the new science. "Efficiency engineers" graduated by the hundreds from the school of grab-it-quick. A new idea was never seized upon more avidly than this, and, in spite of the blundering in the use of the new idea, it may be said that few ideas have ever resulted so speedily in a general increase in the efficiency of production.

One of the Chicago dailies said that nothing evolved from the brains of engineers had so appealed to the imagination and common sense of the public as "scientific management" had appealed.

When the full history of this new science comes to be written, it will be found that many engineers have played a prominent part in its evolution. Such men as Wellington will be recognized for their perception and elucidation of certain principles of engineering economics. Taylor will always be remembered for the great role that he has played. Technically his most important work was the scientific timing of the operations of men and machines. This seems to be the one "principle" that he came nearest to originating. Although he did not originate it, he was the first to apply it so thoroughly as to convince all enginers of its merit as a method of increasing operating efficiency. This alone entitles him to fame.

The Industrial Service Movement and Its Value to Engineers.

The apparently unending struggle between capital and labor is in part a natural outcome of the constant attempt being made to secure economic production without an equal effort on the part of both to understand the rights and privileges of each. There is no sound argument against economic production provided we understand the term "economic" to apply to the conservation of human energy as well as to actual reduction in costs. Much of the real, and also of the apparent, injustice of the present general attitude of both employers and employees is due to misunderstandings—both as to rights and as to intent. That we are not nearer an ultimate solution is strong argument that neither side is blameless, although it is not difficult to determine which is better able to make advances. The beneficial results which have attended the efforts of those employers who have made some sacrifices to secure a better understanding between employer and employed are encouraging, and we believe there are few employers who have initiated such action that have cause to regret it.

From the very nature of his work the engineer is particularly well suited to assist in securing a better understanding between the employer and his workmen, and at the same time increase his own prestige and influence. We are therefore in accord with the movement which is gaining headway to bring the workman and the engineering student more closely in touch with each other. It is evident that any such movement will also secure greater interest in both workman and engineer on the part of the employer. This movement, which is generally referred to as the "Industrial Service Movement," was started at Yale, in 1907, when the Young Men's Christian Association influenced some engineering students to get in close touch with workmen and boys in New Haven. The main idea of the work was to render service in teaching English and other subjects greatly needed by those taught, and at the same time to afford student engineers an opportunity to learn the manners, customs and ideas of the workmen. The latter purpose—the reaction on the engineering student—was the special object sought. As such work is often done amid the environments of the workmen, actual problems are faced, and there is no attempt to create artificial conditions; the student is able to sense the thoughts and feelings of the workmen, while the workmen in turn are better able to understand the qualities possessed by their instructor.

The reception which is being accorded the movement may be judged from the fact that about 3,500 students in 200 colleges have engaged regularly in industrial service during the past year, while it is estimated that 3,000 graduates are active in some form of industrial betterment. In general, leadership in the movement is vested in the Young Men's Christian Association, through its various departments, although the co-operation of recognized agencies for industrial and social betterment is sought.

We believe there are few activities open to the engineering student which offer such promise for the betterment of all concerned as does the industrial service movement. It is unquestionably true that no student can engage actively in such work without acquiring a better conception of the possibilities and responsibilities of industrial work. If such a man makes the best of his opportunities, and continues his interest in such work after graduation—and it is extremely probable that his interest will be held if once gained—he will be an important factor in the solution of many of the problems now facing capital and labor. It is certain that an engineer's success is assured if he shows real ability in such work. The engineering student is neglecting a very promising field if he does not make the most of every opportunity to engage in industrial service work—in fact few engineers are too old to profit by such work.

Some Features of the United States Steel Corporation's Report for 1914.

The report of the United States Steel Corporation for 1914 presents an interesting study of certain phases of the iron and steel trade. In general, the report reflects the condition of that trade for 1914, although the returns of several large independent companies are somewhat more favorable. Contrasted with 1913 the gross receipts of the corporation decreased $238,479,367, or about 30 per cent, while the net earnings declined $65,517,730, or about 48 per cent. As was to be expected this large decrease in business resulted in an increased ratio of expenses to business handled, the total of all operating and renewal charges for the year being about 85 per cent of the gross receipts. During 1914 there was expended for additional property, new plants and other permanent improvements $23,171,013; of this, the sum of $2,046,176 was spent for steamships for export trade, and $4,649,196 for a new plant at Duluth, Minn. Bonds of subsidiary companies were issued to the amount of $9,407,000, while the total amount of bonds paid off or redeemed by various sinking funds was $9,535,264, making the net decrease in the funded debt $128,264. The total amount charged for plant depreciation and mineral exhaustion from lands owned was $64,847,641.

There is outstanding $508,302,500 of common stock, $360,281,100 of preferred stock, and $589,043 of subsidiary company stocks. The corporation places its total assets at $1,792,233,493. After meeting various charges there was available for the payment of dividends, etc., the sum of $23,496,768. The actual payments of dividends during 1914 were $25,219,677 on the preferred stock—at the rate of 7 per cent—and $15,249,075 on the common stock—at 3 per cent—the previous common stock dividend being at the rate of 5 per cent. The common stock dividends include two of 1¼ per cent each and one of ½ per cent, no dividend being paid for the last quarter of 1914. From these figures it is seen that, to meet these dividends, the sum of $16,971,984 was paid from the surplus account. This surplus account, after setting aside $55,000,000 to meet capital accounts, remains at $135,204,472.

The amount of iron ore mined during 1914 was greatly under the production for 1913, the respective tonnages being 17,034,981 and 28,738,451. The blast furnace production for 1914 was 10,052,457 tons (of which 9,909,062 tons were pig iron), while for 1913 it was 14,080,730 tons (of which 13,879,706 tons were pig iron). The steel ingot production for 1914 was 11,826,476 tons (4,171,510 tons of Bessemer ingots and 7,674,966 tons of open-hearth ingots), while for 1913 it was 16,656,361 tons (6,131,809 tons of Bessemer ingots and 10,524,552 tons of open-hearth ingots). The production of rolled and other finished products for 1914 was 9,014,512 tons, while for 1913 it was 12,374,838 tons. The production of "Universal" Portland cement for 1914 was 9,116,000 bbls., and for 1913, 11,197,000 bbls. Other products produced extensively include limestone, coal and coke.

On account of the uncertain condition of the steel industry existing at the close of the year, because of unsatisfactory stock market conditions, and due to the fact that a large number of employees had been laid off, it was decided not to offer employees the usual annual privilege of subscribing for stock under the plan which had been observed during each of the preceding twelve years. At the close of the year there were 40,719 employees who had subscribed for stock during the preceding five years, and who at that time either held stock certificates in their own names or were paying for them on the installment plan. During the year there was disbursed by the trustees of the United States Steel and Carnegie Pension Fund the sum of $548,980.62, there being at that time 2,521 names on the pension rolls.

Even though the showing for 1914 was decidedly unsatisfactory the corporation adhered to its plan of expending during the year the sum of $23,171,013 for new plants and extensions, which indicates that the management was hopeful of the future. It is interesting to note that the increases in production reported since the first of the year seem to have justified this policy and point to a gradual return to normal conditions. The scale of wages was not reduced during the past year, although there was a considerable reduction in the number of men employed. The corporation reports 179,353 men employed in 1914 as against 228,906 men employed during the preceding busy year. Of the total working force about 73 per cent were employed in the manufacturing plants, about 15 per cent in iron ore and coal mining, and about 12 per cent in transportation and miscellaneous activities. The sum paid for wages in 1914 represents 29.1 per cent of the gross receipts.

The corporation in its report makes note of the termination of the "Hill" ore-land leases, but does not comment on its ultimate effect. The statement is made that the ore actually mined slightly exceeded the minimum called for in the contracts, which probably means that the price paid for this ore was high. The corporation still has extensive ore deposits in Minnesota and Michigan.

The Serviceableness of Reinforced Concrete Standpipes.

A sufficient number of reinforced concrete standpipes have been in service for a long enough period to justify a review of the performance of this class of structures. There is interest therefore in a discussion on this subject at a recent meeting of the New England Water Works Association. A number of reinforced concrete standpipes have been in use for several years in that section of the country and it was of these that the members spoke chiefly.

Leaks at the construction joints of the Westerly, Rhode Island, standpipe, which is 40 ft. in diameter and 70 ft. high, developed as soon as water was first turned in. Hot paraffin was unsuccessfully tried as a waterproof interior coating, and plastic slate was later unsuccessfully used to fill cracks. The latter substance imparted an objectionable taste to the water. Leaks continued to develop every time the standpipe was emptied and filled. In 1911 the entire inside was waterproofed by alternate layers of felt and coats of bituminous paint. The felt was applied in five layers, each saturated with a bituminous compound. No conspicuous leaks have since developed. Ice does not form in this tank, as it handles a ground water of uniformly high temperature (54° F.).

At Attleboro, Mass., the standpipe, 50 ft. in diameter and 100 ft. high, leaked from its first filling. Thirteen coats of Sylvester's wash (potash soap and alum) were applied, but this coating cracked, and watertightness was not secured. The exterior spalled off badly and the reinforcement was exposed at some points. The interior was finally waterproofed as at Westerly and the structure is now being encased in an 8-in. brick wall. The latter enterprise is something of a concession to popular opinion which was exercised somewhat at the appearance of the structure and was fearful as to its stability.

At Waltham, Mass., the standpipe, 100 ft. in diameter and 37 ft. in depth, suffered spalling over its lower half. This, of course, is detrimental to the appearance but has not impaired the stability of the structure. A brush coat of tar was unsuccessful applied to the interior as a waterproofing medium. At Manchester, Mass., the standpipe, 50 ft. in diameter and 72 ft. in height, developed seepage at numerous points, and one large crack formed as soon as the water was turned in. Lead plate coverings for the cracks were unsuccessfully applied, but recourse was finally had to an asphalt waterproofing. This tank also spalled off due to the freezing and thawing of the seepage water.

In this issue of ENGINEERING AND CONTRACTING we publish an article which gives data on and discusses reinforced concrete standpipes. The author presents diagrams showing the relation between diameter and height of 60 standpipes, capacities, and relation between diameter and cost per 1,000 gals. capacity. Our contributor has had extensive experience with structures of this type and he has been uniformly successful in the use of concrete for this purpose. It is interesting to note that this experience has been gained in Wisconsin and the surrounding regions where the action of frost cannot be called mild. The results of this experience has made our contributor enthusiastic over the dependability of the properly built reinforced concrete standpipe, and he wisely concludes that they may be used wherever local cost conditions are favorable.

As in all other uses of this material a very great deal depends upon the builder. We have enumerated a number of cases where seepage troubles have occurred. There are other standpipes in existence in which troubles from leakage have not been experienced. Thus, in the topical discussion to which we have referred, one speaker stated that he had used a 1:1:2 mix in standpipes up to 60 ft. in height and had thus avoided leakage. Experience in uses of concrete for other purposes, as well as for that here under discussion, indicate that tight tanks can be secured with a rich, well-puddled mix up to the height mentioned. Where leaks do occur it is probably cheaper in the long run to avoid experimenting with makeshift repair methods and to pass at once to some form of asphaltic lining which has been used with uniform satisfaction. For standpipes holding much over 60 ft. of water the lining with asphalt and felt of the portion in excess of this depth is worthy of consideration in the original design.

Abandoned Irrigation Canals and the Lesson They Teach.

A noteworthy history of irrigation in Nebraska is published in the biennial report just issued by State Engineer Donald D. Price. Though specifically the record of one western state the conditions described are largely true of irrigation in the western United States. Partial utilization only of many sources of water supply, great ditch overdraft on other sources, over irrigation necessitating drainage, excessive seepage losses and all the other inadequacies of construction and operation that are familiar to students of irrigation are set down in this story of irrigation in Nebraska and are true of nearly every state north and south and west that practices irrigation. In particular, however, it will interest irrigationists to note the extent of irrigation canal abandonment.

The irrigation canal system of Nebraska is estimated by the report to have cost $11,871,623. In 1914, there were in operation only 53 per cent of all the canals built and only 60 per cent of all the mileage of constructed canals. A summary from the tables follows:

Item.	Built.	Operated.	Per cent.
Number of canals.......	734	391	53
Mileage of canal........	2,414	1,441	60
Acreage under canal....	951,000	684,642	73

What are the causes responsible for this condition? First, in the great majority of cases the normal flow of the stream is not sufficient to supply the entire acreage under canal—the stream is over-ditched. Some canals cover lands for which water rights have not been granted and while the lands lie below the canal water cannot be used upon them. Some of the land under canal has by over-irrigation become water-logged and cannot be again cultivated until it has been drained. Subirrigation has removed some land from need of the canal supply. Some of the canals were built during the great drouth of the early nineties and in later wetter years there has been no occasion for their use. On the South Platte River where only 37 per cent of the total mileage of built canals was operated in 1914, the large percentage of abandoned canals is explained as follows:

> The canals were constructed at a period when there was sufficient flow in the river to supply them. Later diversions were made in Colorado and the part of the river in Nebraska is dry for the greater portion of the year.

That this abandonment of canals represents a financial loss is obvious. How great a loss it represents is pure speculation. The fact that such loss, whatever its amount, has been suffered is an indictment of irrigation engineering but it is important not to be led into exaggerating the seriousness of this indictment. Some of the named causes for canal abandonment follow from inadequate engineering at the beginning; for other causes named engineering is in nowise responsible. And it must never be forgotten that a certain amount of development waste is a part of the growth of any industry. The growth of our transportation systems shows this plainly; it exists in our water power development, and it exists in irrigation development. These facts do not excuse careless engineering in future irrigation development; rather they warn engineers of the need of more careful study in the future.

A Discussion of the Price of a Road.

The price of a road is defined in another column of this issue as the sum of the construction cost, the upkeep cost, the interest cost and the depreciation cost. On this presumption the price of three types of road most popular in Illinois are estimated. We hold no brief for the accuracy of these estimates but we do desire to commend to engineers and road officials generally the wisdom of economic studies of this character in selecting types of roads for the various localities in which they are engaged.

It has been urged frequently in these columns that the general adoption throughout any state of costly hard pavements was unwise. In prosperous states like Illinois there are many places where the best of permanent pavement is warranted but there are also more places where dirt, gravel and water bound macadam are demanded by all economic reasoning. The article referred to outlines the manner of such reasoning by specific examples. At the same time the author wisely warns the reader that blind adherence to such mathematical considerations is as illogical as it is to give them no attention.

Briefly, under present conditions, it is pointed out, the public is warranted in adapting types of construction that run higher in construction cost than mathematical consideration would seem to justify. The rapidly changing character of traffic conditions is one reason. In anticipation of a service which is becoming more severe each year expenditures for road construction should be directed with consideration of the future. Another reason for adopting high cost permanent construction lies in the fact that the least expensive constructions presuppose the existence of a methodically handled and economically administered system of maintenance. Until such a maintenance system exists wisdom in expenditures for road improvement would seem to suggest that the types least expensive in construction cost should be avoided unless their economy is assured by a fair preponderance of evidence.

The problem of the economic road is far from simple. The broad subject of road economics is much more intricate. Students of both cannot yet see the way clearly, and to the public generally it is practically a hidden way. The paper that we abstract and have here commented on is suggestive as one of a class of discussions directed to the instruction of the road user. The production of such discussions deserves to be encouraged. In the beginning the task was to influence the will of the people in favor of road improvement in general. This task has been fairly well accomplished, and the next step is instruction in the economics of roads.

A Profitable Field for Committee Work in Improving the Quality of Non-corrodible Metallic Alloys Used in Water Works Construction.

For more than 40 years water works engineers have been buying on the open market copper alloys resistant to corrosion in the presence of water or heavy moisture content of the air. Thus these alloys, commonly called brasses and bronzes, have been selected by the engineer without special knowledge of their properties or their peculiar fitness to perform the requisite service. Of late water engineers have begun to view such alloys with a more critical eye; this critical attitude being augmented by troubles with these materials on the Catskill Aqueduct construction. On that great enterprise an unprecedented amount of forgeable alloys was used, aggregating nearly 3,000,000 lbs., about two-thirds of which was in the form of castings and the balance in forgings. This extensive use, coupled with rigid inspection, has served to bring out some of the present limitations of available copper alloys in water works construction.

On the Catskill Aqueduct work the castings, ranging in weight from less than a pound to eleven tons each, gave no trouble. It was with such forms as bolts, ladder rungs, pipes, plates, flat bars, long rods and rivets that the failures were experienced. Many brass bolts failed without having been stressed and others failed on exposure to low temperatures in the absence of stress. These failures were numerous and important.

It is highly significant to note that these forgings were obtained from various manufacturers in New England, New York, New Jersey and Pennsylvania. No brand or make of brass or bronze gave full satisfaction. Thus the defects in these materials may fairly be regarded as general, and the individual manufacturer is quite blameless for the shortcomings of the alloys as now made. It may safely be asserted that all the manufacturers are endeavoring to supply satisfactory materials. We bespeak for them the co-operation of engineers in their endeavor to make fully dependable alloy forgings.

Publicity given the failures on the Catskill Aqueduct is tending to reopen the whole subject of the manufacture of these goods. In this issue we publish an article which enumerates the properties of the ideal alloy, and compares with the ideal the attributes of the copper-tin (bronzes), copper-zinc (brasses), copper-nickel, and nickel-steel alloys. Engineers who desire to inform themselves on this subject will find this article an excellent introduction to further study.

Following a study of the experiences of the Catskill Aqueduct engineers with the alloys used on that work the following queries were propounded: Can dependable alloy forgings be produced? What specifications should govern their manufacture? What inspection methods and tests should be adopted? What accelerated tests can be used? What working stresses should be allowed? What will be the resistance to fatigue of these alloys?

It seems that in the foregoing queries we see a field for profitable committee work. Would it not be a good plan for the American and New England Water Works Associations, the American Society for Testing Materials, and other interested organizations, to appoint a joint committee to take up the study of these matters in co-operation with the manufacturers? It seems to us that the need of such action is strongly indicated, for the queries show that exact knowledge of the subject is wanting. A set of standard specifications governing the manufacture and use of these alloys would be invaluable to the water works interests of the country and, naturally, will be highly beneficial to the manufacturers.

WATER WORKS

Data and Discussion on the Design, Construction and Cost of Reinforced Concrete Standpipes.

Contributed by W. G. Kirchoffer, Consulting Sanitary and Hydraulic Engineer, Madison, Wis.

Reinforced concrete has been used for the past 20 years for the construction of standpipes. The first one to be constructed, of which we have record, was at Calbe, Germany, in 1897. Since that time, they have been constructed in at least twelve different countries. Of 66 standpipes of which records have been published, there are 46 in the United States, 5 in Germany, 3 in each Belgium and France, 2 in each Mexico, Cuba and Italy and 1 in each, Holland, Russia and England. Of the 46 in the United States, 14 are in Massachusetts, 6 in Wisconsin, 4 in Virginia, 3 in Ohio, California, Rhode Island and New Hampshire, 2 in Maine and Connecticut, and 1 in each, New Jersey, Missouri, Georgia, New York, Minnesota and Vermont. The above list does not include railroad tanks or individual supply tanks. There are, of course, many more that have not been mentioned in available literature. That reinforced concrete is becoming popular as a material for these structures cannot be doubted.

DIAMETER AND HEIGHT

Figure 1 shows data on standpipes with respect to diameter and height. From this diagram, the conclusion can be drawn that the majority of standpipes are under 40 ft. in both height and diameter; that standpipes of larger diameter than 50 ft. are comparatively few and that standpipes of great height, over 70 ft., are of comparatively small diameter.

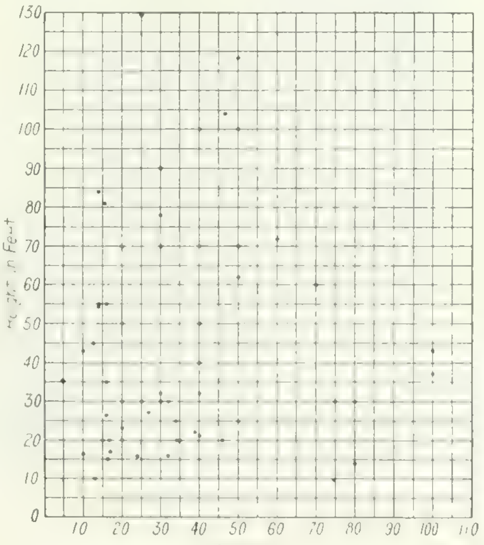

Fig. 1. Diagram Showing Relation Between Diameter and Height of 60 Reinforced Concrete Standpipes in Various Parts of America nad Europe.

From some computations I have made, it can be shown that standpipes of large diameter and height are not economical in first cost which may, in a way, account for the facts revealed by the diagram.

CAPACITY AND COST OF STANDPIPES.

Figure 2 shows the relation between diameter and capacity of standpipes and further verifies the statement made above that the greatest number of standpipes are of comparatively small capacity. The relationship of number to capacity is fairly uniform until a capacity of 200,000 gals. is reached, when the number begins to fall off in proportion to the size with a further reduction in numbers from 500,000 gals. upward.

Figure 3 shows the relation of cost per 1,000 gals. to diameter. No definite conclusions can be drawn from this diagram, as there were so few records of cost available. A curve of maximum cost per 1,000 gals., which may be of interest in estimating the cost of similar structures or in making comparisons with the cost of steel tanks and standpipes, has been placed on the diagram, but no great amount of reliance should be placed upon it in making exact estimates.

EXPERIENCE IN DESIGN AND CONSTRUCTION

The first standpipe to be constructed under my plans and specifications was at Monticello, Wisconsin. This standpipe is 14 ft. internal diameter by 50 ft. high with walls 12 ins. thick for full height. The concrete was mixed in the proportion of 1:2:4 and was reinforced with ¾ in., ⅝ in. and ½ in. round rods. The walls were poured in sections 5 ft. high with no special provisions for preventing leakage along the horizontal joints, except to clean the set concrete thoroughly and cover it with a grout coat before depositing the next course of concrete. The structure was waterproofed by plastering the inner surface with a ½ in. coat of one to one mortar and surfaced hard and smooth like a sidewalk. The surface was then covered with two coats of "Hydrex Preservative Paint." When the structure was complete, it was filled with water and allowed to stand for several days. A few small leaks developed, mostly along the line of the joints. Few of these leaks were of sufficient magnitude to wet the exterior surface of the standpipe to the base, but usually evaporated as fast as the water seeped through. The evaporation of the water left a white lime deposit on the surface of the wall as shown in Fig. 4.

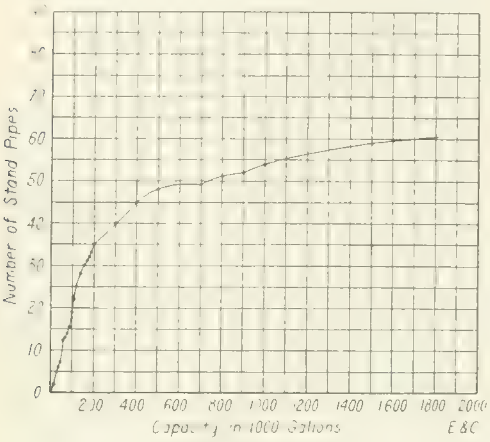

Fig. 2. Diagram Showing Relation Between Number and Capacity of Reinforced Concrete Standpipes.

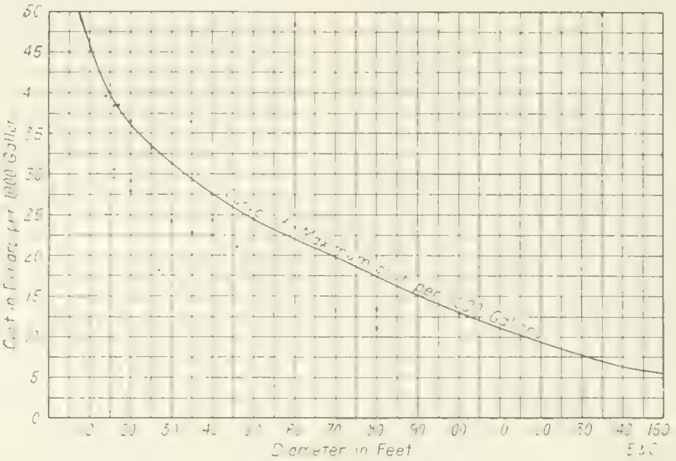

Fig. 3. Diagram Showing Relation Between Diameter and Cost Per 1,000 Gals. of 20 Reinforced Concrete Standpipes.

The standpipe was constructed by day labor at a labor and material cost of $1,977.46, as per detailed statement below. Bids were taken on the construction of the standpipe but were all rejected. There were four bids ranging from $2,796.50 to $3.349.

DETAILED COST OF STANDPIPE, MONTICELLO, WIS.

Labor	$ 524.92
Steel reinforcing	362.30
Cement	434.23
Lumber for forms	144.97
Hardware	42.86
Concrete mixer	195.00
Gravel and sand	190.94
Hoist	147.39
Pipe, elbows, etc	25.70
Paint	17.65
Manhole cover	4.95
Blacksmith bills	37.55
	$2,128.46
Less sale of mixer	151.00
Cost for labor and materials	$1,977.46

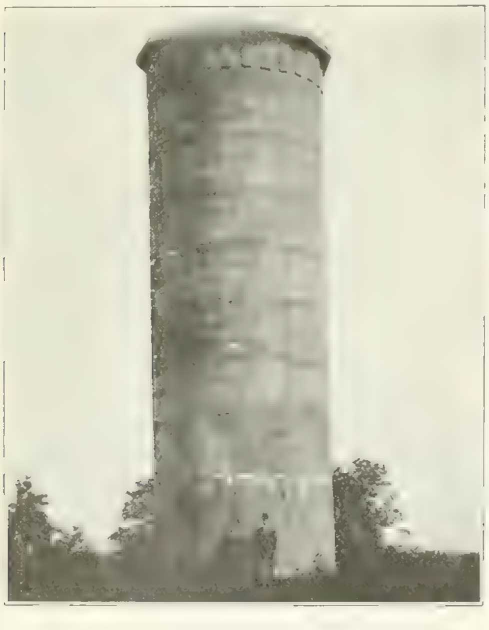

Fig. 4. View of Reinforced Concrete Standpipe at Monticello, Wis.

The Belleville standpipe, Fig. 5, was built in almost exact duplicate of the Monticello one with the exception that an effort was made to prevent the leakage along the joints and, for that purpose, strips of tin or galvanized iron 12 ins. wide were inserted in the top of each ring while the concrete was soft and allowed to project 6 ins. above so as to form a bond with the next ring. The scheme, however, did not prove successful, as the standpipe showed more joint leakage, judging from the deposit left on the wall, than the Monticello one did. This standpipe cost $2,400 under contract. At Wauzeka, a standpipe 16 ft. in diameter by 30 ft. high was constructed at a cost of $1,550 and another one at Mellen, 16 ft. diameter by 55 ft. high at a cost of $2,500 by day labor. The results so far as leakage are concerned were about the same. The amount of leakage in any of these was very small; an inappreciable amount so far as the cost or loss of water is concerned. As to damage to the standpipe, no evident signs were noticed after use for two or three years. The leakage was not sufficient for the frost to spall off the concrete and the leaks did not seem to get any larger but, on the other hand, appeared to get smaller. The only apparent damage done by these leaks is from an esthetic standpoint. From a distance, especially in cold weather, the standpipe looks as though it was shrouded in icicles but in reality it is only the residue from evaporation.

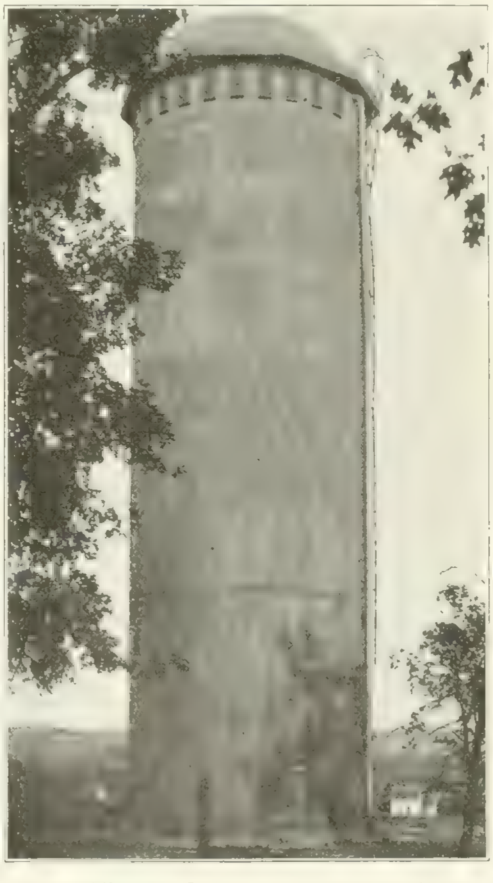

Fig. 5. View of Reinforced Concrete Standpipe at Belleville, Wis.

METHOD OF CONSTRUCTION.

The method used in constructing the sidewalls was to build both an outside and inside form, each 6 ft. high, as shown in Fig. 6. These were made in two sections so that they could be readily raised. In the earlier standpipes, the forms were made in four pieces and each time were lowered to the ground before being set for the next ring but, in the later ones, the forms were only loosened sufficiently to free the concrete and were then raised by four sets of blocks and tackles supported on cross timbers spiked to the upright of the inside scaffold. No outside scaffold was used. The outer form was held in place by a ¾-in. steel cable with turn buckles at the ends.

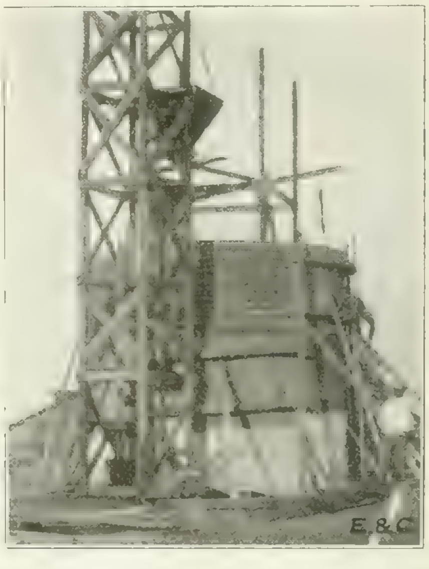

Fig. 6. View Illustrating Method of Raising, by Block and Tackle, Sections of Forms in Concrete Standpipe Construction.

DESIGN.

In the design of these standpipes, I have not considered the concrete as taking any direct stress in tension. This was all taken care of by the circular steel rods. However, the concrete was depended upon to transmit the tensional stresses to the rods. The walls were made uniformly 12 ins. thick, principally to aid in making the walls watertight and secondarily to simplify the form work and the carrying on of the work.

ROOFS AND DECORATIONS.

The roofs on all of these standpipes were dome shaped with radii same as standpipe. In this way, the ribs used on the inside forms could be used for the supporting arches and the lagging used to cover them. A flat cover could have been used as well so far as service is concerned but would not give as pleasing an appearance.

A cornice about 8 ins. thick by 12 ins. wide is made around the top with ten flat sides. Below this are raised panels 11 ins. wide by 2 ft. 8 ins. long and projecting 1 in. These are made by removing two adjacent boards of the outside form for a length of 2 ft. 8 ins. and covering the opening by boards on the outside of the regular forms thereby leaving an offset 1 in. deep. A simpler plan and one perhaps as effective would be to make a sunken panel by placing 1-in. boards of proper size on inside of forms.

PATENTED SLIDING BASE.

A United States patent has been issued, to an eastern concern, for a sliding base for the wall of the standpipe, with an asphalt joint on the inside to insure water tightness. It is the claim of the patentees that the cause of leakage is due to stresses set up in the wall caused by the bottom of the wall not being able to expand as the pressure increases and that if the walls are not fast to the bottom or otherwise secured, the leakage will be reduced to a minimum. None of the standpipes constructed under my specifications have been built in this way, but I did design one for the village of Albany, Wis. where I did incorporate something of this sort, but was immediately notified by wire (at my expense) that a royalty of $200 would be demanded, so we rejected all the bids and put up a steel tank and tower.

COST GOVERNS CHOICE BETWEEN CONCRETE STANDPIPES, STEEL STANDPIPES AND STEEL TANKS AND TOWERS.

That concrete is a proper alternate material with steel for similar structures cannot be denied by any one versed in the subject. Experience with steel standpipes has been disasterous in numerous cases. (See W. D. Pence's book on Standpipe Failures.) However, the substituting of a concrete standpipe for an elevated steel tank may not always be advisable or economical. Each problem should be studied out for the conditions to be met

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Some Considerations Affecting the Choice of Alloys in Water Works Design.

(Staff Abstract.)

Non-corrodible metallic alloys are used in place of iron or steel, in water works design, when equipment is inaccessible or where the danger exists of interruption to service resulting from corrosion. The engineer has usually accepted such alloys as were readily obtainable on the market, without thought of the special fitness of the alloy selected for any particular service. The use of such alloys is on the increase and their proper selection is correspondingly increasing in importance, said Horace Carpenter, of the Engineering Department of the Sanitary District of Chicago in discussing the available alloys and their properties in his paper before the Illinois Section of the American Water Works Association.

FORMS OF ALLOYS IN WATER WORKS CONSTRUCTION.

Alloys are used for water works construction in two forms: (1) Castings, and (2) bars or tubes. They are cast when it is possible for the material to pass directly from the foundry to the point of use. The bar or tube form is used where the alloy is forged, rolled, extruded or drawn after leaving the foundry, thus changing the structure of the material and its physical characteristics.

CHARACTERISTICS OF IDEAL ALLOY.

The ideal alloy has three characteristics here named in the order of their relative importance. 1. It must be able to withstand indefinitely the disintegrating action of the elements touched, this action taking the form of corrosion, erosion, or electrolysis. 2. It must be of such structure that it will successfully withstand disintegration, and must be free from internal stress which will produce progressive failure entirely independent of any exterior agency. This latter requirement implies a composition capable of successful fabrication under existing commercial conditions. 3. Since comparatively costly, it is desirable that the physical characteristics be as high as practicable to minimize expense.

FOUR ALLOYS CONSIDERED WITH RESPECT TO THE IDEAL.

The following alloys are considered with respect to the ideal: (1) The bronzes, or copper-tin alloys; (2) the brasses, or copper-zinc alloys; (3) the copper-nickel alloys; and (4) the nickel-steel alloys.

Bronzes.—The most commonly accepted bronze composition today is the so-called "Naval bronze," consisting of 88 per cent copper, 10 per cent tin, and 2 per cent zinc.

Castings of this alloy fullfil the ideal requirements in a very satisfactory manner. They are non-corrosive in the presence of nearly, if not all, the elements encountered, they are easily obtainable, of a homogeneous character, are stable and constant in physical characteristics, and the material is one that works well in the ordinary machinery operations.

Their physical characteristics are sufficiently high so that apparatus does not need to be unwieldy in design to obtain the requisite strength under ordinary conditions. A tensile strength of 30,000 lbs. per square inch, a yield point of 15,000 lbs., and an elongation of 15 per cent in 2 ins. can easily be obtained.

Rigid adherence to the composition as given above does not appear essential. The copper may be reduced to 85 per cent, with a corresponding increase in the zinc content or with a corresponding addition of lead without materially changing its ability to resist corrosion or its physical characteristics. In the presence of sulphur the addition of lead appears to aid the resistance to corrosion.

Where the material is to be used as a bearing metal, as in the seats of large gate valves, a considerable variation in the composition is desirable. The U. S. Reclamation Service have worked out for this purpose two alloys to be used in opposition to one another, as follows:

82.8% copper, 4.8% tin, 4.4% zinc, and 8% lead.
82.7% copper, 7.1% tin, 5.3% zinc, and 4.9% lead.

Experiments by Mr. Carpenter, while indicating the impracticability of attempting to confine the composition as closely as indicated, demonstrated that alloys of this nature containing about 5 per cent lead in one and 8 per cent in the other with corresponding differences in the tin content were very satisfactory for the purpose.

Alloys of the above nature may be used for castings only, as their high tin content makes it impossible to hammer, forge, roll or draw them successfully, so that where rods or tubes are required the content of tin must not exceed 2 per cent and most manufacturers hold to a maximum of 1½ per cent.

Brasses.—Where conditions of design require greater physical characteristics than shown by the bronzes or where forged, rolled or drawn forms are required, the engineer commonly resorts to the brasses, of which there are an endless variety, many of little value, but some highly satisfactory.

For castings of this character, manganese bronze has been very generally accepted and has given very satisfactory service. A characteristic casting of this material shows a composition of about 56 per cent copper, 40 per cent zinc, 1 per cent tin, 1.27 per cent iron, and 1.8 per cent manganese. The manganese content is small and it does not appear essential that the analysis of the completed casting show any such content, the manganese being introduced in the form of the ferrous-oxide to act as a flux and any residue being due to an overdose of the flux and such residue should not exceed 2 per cent. Such castings, properly made, can be relied upon to show a tensile strength of 65,000 lbs., a yield point of 35,000 lbs., and an elongation of 20 per cent in 2 ins. Certain manufacturers use vanadium in the place of manganese, and the resulting castings are of the same general character as manganese bronze. Castings of this material in small quantities are generally somewhat more expensive than those made of the bronzes referred to above, and it is the general experience that founders unused to the casting of manganese bronze experience considerable difficulty in obtaining satisfactory results. Where the quantity to be used is sufficient to appeal to founders experienced in handling the material, most excellent castings can be obtained at a price generally from 10 to 12 per cent less than corresponding castings of tin bronze.

Forgings, rods, and bars of these alloys show very satisfactory, non-corrosive properties and physical characteristics considerably greater than the cast material, the exact amount depending on the size and manner of fabrication, and would appear at first glance to be ideal substitutes for similar steel products. Unfortunately, however, the demand for such rods and bars is of such recent origin that the art of fabrication does not seem to have advanced to a point where the product can be guaranteed against failure by disintegation or by breaking or cracking without apparent cause. These failures in many instances have not manifested themselves until some months after the material has been fabricated and has passed a most rigid inspection, and have been entirely independent of any load thrown on the material. While no satisfactory solution of the causes of and no remedy for such failures has as yet been found, it does appear that the same are caused rather by the methods employed in rolling or drawing than by the composition of the material itself. It would, therefore, appear wise to exercise considerable conservatism in the selection of such rods until their manufacture has become further perfected and the various problems of temperature and rolling methods have been solved, meanwhile to use in their stead some of the brasses which have been manufactured for a sufficient length of time so that the engineer can feel comparative security in their use. Among these there appear Muntz metal, an alloy of 60 per cent copper and 40 per cent zinc, which in the larger sizes of rods can be depended upon to show a tensile strength of at least 40,000 lbs., and Tobin bronze with a tensile strength of 55,000 lbs., which together with other closely allied alloys are readily available.

Comparatively recently, one of the largest manufacturers of rods has produced an alloy containing about 57½ per cent copper, 40 per cent tin, ½ per cent lead, ½ per cent iron, and 1½ per cent nickel, which possesses high non-corrosive properties, together with physical characteristics equal to or slightly superior to Muntz metal. This material is produced in bars and rods.

Copper-Nickel Alloys.—The most prominent copper-nickel alloy appears to be Monel metal, a natural alloy containing about 60 per cent nickel, 36½ per cent copper, and 3½ per cent iron. This material has been very successfully used both in the form of castings and rods for large and small work. Its physical characteristics are at least 65,000 lbs. ultimate, 32,000 lbs. yield, and 25 per cent elongation for castings, with the ultimate and yield points at least 10 per cent higher for rolled rods. Non-corrosive tests indicate that it is not acted upon by either the acids or alkalies as found in construction work. It has been somewhat extensively used for propellers for battleships, both by this country and by foreign countries. It is also used by many valve manufacturers as a seat metal for valves for use with high pressure and superheated steam. It is also used in the form of forgings for valve stems for high pressure steam and water valves.

This material has not been in use for a sufficient length of time to determine its non-corrosive qualities under all circumstances, but every indication points to its entire acceptability. It is a comparatively costly material, probably costing in its various forms about 50 per cent more than the corresponding brass or bronze material, but its greater physical characteristics in many cases make this increase more apparent than real. It appears to require considerable skill on the part of the founder to obtain sound castings of Monel metal, and the unsuccessful attempts of some such have prejudiced many against its use.

The value of nickel-steel alloys for members under tension, as valve stems, has not received sufficient recognition by the water works engineer.

While not possessing the non-corrosive properties of the brasses or bronzes, a proper steel alloyed with from 20 to 25 per cent of nickel does possess such properties far in excess of ordinary carbon steels and combines with this property physical characteristics such that it should demand the careful consideration of the engineer.

In 1905, the Department of Water Supply, Gas, and Electricity of New York City specified for valve stems a nickel steel to contain not more than 0.05 per cent phosphorous or sulphur, between 0.21 per cent and 0.41 per cent carbon, and between 21 per cent and 24 per cent nickel, and to have a tensile strength of at least 80,000 lbs., yield point of 40,000 lbs., and an elongation of 22 per cent.

One of these stems when examined after five years' service showed no indication of corrosion of that part immersed in water, and only slight pitting of that part exposed to air.

There appears to be very little data available showing the effect of various corrosive substances on alloys. The manufacturers of such materials have experimented on such material but there appears to have been, in the past at least, a dislike on their part to make public the results. There follow a few results of comparative tests, which while not complete or conclusive, will be of assistance in selecting non-corrosive alloys. The full paper contains more data on corrosion.

THE CORROSIVE EFFECT OF MOIST EARTH ON ALLOYS AND STEEL.

Six test pieces were imbedded in a box of rich earth, which was kept moist with water and occasional additions of one-half per cent solutions of chlorides of sodium and magnesium. The weighed specimens presented about the same area to the corrosive influences in the soil. After six months, the specimens were taken out, washed, dried and reweighed. The following loss in weight represented the amount of corrosion in each case:

Sample.	Per cent loss in weight.
Manganese bronze	.09
Tobin bronze	.11
Monel metal	.12
Manganese bronze	.12
Muntz metal	.33
Steel	1.04

All the specimens showed the effect of more or less oxidation on the surface, the Monel metal presenting the least change in appearance as a result of corrosive action.

Shop Equipment and Motor Trucking Costs, Meter Division of Milwaukee Water Works.

An article contributed to this journal of Nov. 26, 1913, by Otto F. Poetsch, Superintendent of Meters, described the procedure in the meter division of the Milwaukee Water Works. That article showed the organization of the division, and described the installation and testing of meters, their location and the procedure in repairing them. The present article, based on Mr. Poetsch's latest annual report, describes the shop arrangement and equipment, the use and cost of operating motor trucks, the ownership of meters, and the testing of large meters.

The work of the division consists essentially of installing new meters on new services and the proper maintenance of meters in service so as to insure accurate registration. A force of 29 men is employed, as follows: 1 superintendent of meters, 4 office clerks, 1 stock clerk, 1 shop foreman, 1 machinist, 13 meter repairers and 8 helpers. The average salary of this force is $842 per year.

During 1914 2,285 new meters were installed and 560 were taken out of service. At the end of the year 60,958 were in service. Of this number 8,976 were taken off for examination and repair, 7,131 were examined and repaired on the premises and 268 of the larger meters were tested on the premises. A total of 16,375 meters, 26½ per cent, were looked after, but only 3,016, or 5 per cent, required new repair parts. Cost of new parts and time spent in repairing were charged to the consumer. The expense of the balance, 13,359 meters, was born by the division. These did not need new parts, requiring only cleaning, adjusting, repacking or testing. Accumulations of sand in meters either interfered with the registration or checked the flow entirely and many meters required cleaning on this account.

EQUIPMENT AND ARRANGEMENT OF SHOPS.

The repair shop is in the City Hall basement. The equipment, valued at $9,510, consists of four auto trucks, 1 Prentice lathe, 1 shaper, 1 pipe cutter, 1 drill press, and 1 speed lathe, all motor driven. There are also four Mueller meter testers, and other necessary fixtures, tools, supplies and minor equipment. A stock of repair parts valued at $9,240, is carried. The entire shop is arranged to economize on space.

General Repair Shop.—In the general repair shop three Mueller testing machines, one next to the other in a straight line, permit one man to operate these three machines. Here all meters are tested, whether new or repaired. On each side of these testing machines a special block was installed for the use of testing Worthington plunger meters. In the center of the general shop a 16-ft. by 4-ft. workbench provides room for 12 meter repair men to repair meters. Meter bins and shelving were built in such a way as to eliminate confusion in finding meters in progress of repairs.

Machine Shop.—The machine shop adjoins the general repair shop. Here there is a No. 2 Williams' pipe cutting machine, capable of cutting and threading pipe from ½-in. to 4-in. inclusive. Also a 24-in. Milwaukee shaper, 4-in. Prentice lathe, 1½-in. by 16-in. wet tool grinder, and a 20-in. Milwaukee drill press, each machine being separately motor driven. This eliminates dangerous overhead shafting and belting, thus making for safe and economical operation.

Employees' Room.—This room was fitted up, in 1914, with lavatory and locker facilities. There is a sectional steel locker for clothes, a 12-ft. wash-stand, a 12-ft. table and benches on which to eat lunch, and a 3-burner gas plate for warming or cooking lunches. Water works literature is provided and kept on file in this room.

Stock Rooms.—All stock of meter repair parts, supplies, materials and tools, except those in use in the shop, are kept in the stock room. Separate bins, properly labeled, make it easy for the stock clerk, who is in charge of all stock, to keep a proper check on it. All goods bought are received by him and reported on special receiving blanks to the superintendent of meters, so that the bill for goods received can be checked. All materials leaving the stock room are checked out, daily, by the stock clerk on sheets provided for this purpose. These sheets go to the cost clerk, daily, who makes proper charges and checks the stock leaving the stock room off his stock record card. At the end of the year an inventory is taken, which must agree with the stock record cards. In this manner a very good account is kept of all goods purchased and used.

MOTOR TRUCKING COSTS.

The department now has four auto trucks in use, which replaced the horses and wagons formerly used. During 1915 two cars will be added. The results obtained from auto trucks have proven highly satisfactory and far superior to the horse-drawn vehicles. A total of 24,645 miles were run by the four trucks, at an average cost of 97 cts. each, per working day. Table I gives a complete record.

TABLE I.—COST AND PERFORMANCE RECORD OF AUTO TRUCKS IN SERVICE OF METER DIVISION OF MILWAUKEE WATER WORKS.

Car No.	Miles made	Gals. gas	Miles per gal	Cost of gas, oil and grease	Repairs and miscellaneous	Depreciation	Tires	Total cost, incl. depreciation.	Cost per day, incl. depreciation.	Total cost per mile, incl. depreciation.	Date put in service.	Total cost, less depreciation.	Cost per day, less depreciation.	Total cost per mile, less depreciation.
2	5,622	630	9	$ 93.72	$385.25	$207.99	$133.76	$ 820.72	$2.73	$0.146	6- 7-12	$ 612.73	$2.04	$0.109
4	6,033	614	9.5	89.32	33.89	223.18	28.54	374.93	1.24	.062	4-28-13	151.75	.50	.025
6	6,271	458	14	66.95	64.24	75.22	85.92	292.33	.97	.046	1-30-14	217.01	.72	.034
8	6,719	409	16.5	58.41	25.52	80.61	113.11	277.65	.92	.047	2-10-14	197.04	.65	.029
Total	24,645	2,111	*12	$308.40	$508.90	$587.00	$361.33	$1,765.63	*$1.47	*$1.073	....	$1,178.53	*$0.97	*$0.049

*Average.

	Estimated total mileage.	Depreciation per mile.
Car No. 2, Kissel ¾-ton truck	40,000	$0.037
Car No. 4, Kissel ¾-ton truck	40,000	0.037
Car No. 6, Ford	40,000	0.012
Car No. 8, Ford	40,000	0.012

Note.—Car No. 2 was overhauled February, 1914. Expense, $303.04. Car No. 4 was under guarantee to April 28, 1914.

One of the new cars to be bought this year will be used by one man for making minor repairs to meters on premises. At present three men are required for this work. With the use of a light auto truck it can be handled by one man. The other new car is intended for emergency calls from consumers, such as frozen or burst meters, stoppage or bad leaks, and so on. These calls require prompt attention, so as not to cause property loss or unnecessary inconvenience to the consumers.

OWNERSHIP OF METERS.

In Milwaukee all services are metered and the consumer pays for the meter and pays for its maintenance. The meter is supplied by the consumer through a licensed plumber. The plumber buys the cheapest meter he can get. This is unfortunate. A poor meter entails three evils: it increases cost of repairs and maintenance, diminishes revenue because of failure to register on small flows, and renders the water department unpopular.

To overcome this situation meter specifications were prepared covering requirements, tests, capacities, durability, manufacturer's guarantee, etc. This has a tendency to improve meter quality, but does not entirely insure securing the best meter for the money expended.

Milwaukee is one of the few cities in which meters are not supplied by the water department. It has generally been found advisable for water departments and companies to own and supply meters. It is vital to the success of the meter system that the department select the meters, and control manner of setting and time for testing and repairs. This is best accomplished where the department owns the meters as this avoids the red tape, delays and expenses involved in sending notices to the owner or occupant and also avoids a second trip to the premises. The purchase of meters in large lots is, of course, economical. One-half the teaming expense on the 8,976 meters taken off in 1914 for repairs could have been saved had the department owned the meters. At present the meter is taken off, a pipe is inserted in its place while it is taken to the shop for overhauling after which the same meter is taken back and replaced in service. This requires two trips to the premises. If the department owned the meters a new one or one in good repair could be installed at once instead of the short pipe now inserted. This would obviate the necessity of averaging water bills for the time the meter is off.

TESTING LARGE METERS.

Records show that 100 of the largest consumers pay one-half of the entire meter revenue. In order to obtain full registration on the meters supplying these consumers, special attention is given these large meters. There are in service 489 meters of 3-in. size and larger. These meters are the important revenue producers and require close watching, as a loss of a few per cent by under-registration would amount to thousands of dollars.

A special card record is kept on these meters to show their condition at all times, so that we can see the condition of them. All meters of 3-in. and over are so equipped that they can be retested without much time or expense on the premises, without disconnecting them, by means of a proven or test meter. By closely watching the registration and prior tests, it becomes an easy matter to decide which meters are overtaxed and in need of retesting and adjustments.

During the year 1914, 268 of these large meters were retested. The average loss by under-registration per meter was .38 per cent; in 1911 the loss per meter by under-registration was found to be 9 per cent. The showing thus made since these tests were inauguarted proves that it is time well spent and checks a loss of thousands of dollars each year.

BUILDINGS

A Comprehensive Set of Tables for Determining the Bending Moments and Shears in Simple Beams and in Beams Fixed at One and Both Ends.*

Contributed by S. M. Cotten, Tucson, Ariz.

The data in the accompanying tables give the bending moment and reaction functions for beams fixed at both ends, for beams fixed at one end and simply supported at the other, and for beams simply supported; for load distributions varying by one-tenth of the span, from a concentration to a uniform distribution, and in each possible one of nineteen positions varying by one-twentieth of the span. The tables also give the percentages of the maximum moment, or moments, existing at any section corresponding to these positions, due to a concentration at any other of these sections.

NOMENCLATURE.

The tables are based on the formulas developed in Merriman's "Mechanics of Materials," and the same nomenclature is employed, as far as possible, which is as follows:

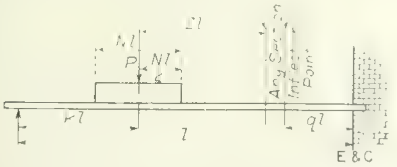

Fig. 1. Diagram Illustrating Nomenclature Used in Computing Functions for Both Fixed and Supported Beams.

P = load.
l = clear span.
x = distance of center of load from left support.
$k = x/l$ = distance of center of load from left support, expressed as a percentage of the span.
d = length of distribution along beam.
$N = d/l$ = length of distribution expressed as a percentage of the span.
y = distance from center of load to any section of beam.
$Z = y/l$ = distance from center of load to any section of beam, expressed as a percentage of the span.

The inflection points are expressed as a percentage of the span distant from the supports.

For beams fixed at one end and simply supported at the other, the left end is regarded as simply supported.

For a diagram illustrating the nomenclature employed see Fig. 1.

METHOD OF COMPUTATION

The computations for the data for simply supported beams, given in Table I, were effected by the use of the usual formulas, and require no further explanation. The values of the functions are exact to the number of places given.

The data for fixed beams, given in Tables VI, VII and VIII, and for beams fixed at one end and simply supported at the other, given in Tables II, III, IV and V, were computed by methods devised by the writer, except those values given under the heading of $N = 0.1$. These exceptions, upon which the other values are based, were derived from the formulas given in Merriman's "Mechanics of Materials," and are the exact values of the functions for a theoretical concentration.

The computations for the data given in Tables IX, X and XI require no comment.

TABLE I.—SIMPLY SUPPORTED BEAM—FUNCTIONS OF END REACTIONS AND MAXIMUM MOMENTS.

Values of k	Reaction Functions		Values of N										
	Left End	Right End	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
.05	.95	.05	.047	.035									
.10	.90	.10	.090	.077	.065								
.15	.85	.15	.127	.115	.102	.090							
.20	.80	.20	.160	.147	.135	.122	.110						
.25	.75	.25	.187	.175	.162	.150	.137	.125					
.30	.70	.30	.210	.197	.185	.172	.160	.147	.135				
.35	.65	.35	.227	.215	.202	.190	.177	.165	.152	.140			
.40	.60	.40	.240	.227	.215	.202	.190	.177	.165	.152	.140		
.45	.55	.45	.247	.235	.222	.210	.197	.185	.172	.160	.147	.135	
.50	.50	.50	.250	.237	.225	.212	.200	.187	.175	.162	.150	.137	.125
.55	.45	.55	.247	.235	.222	.210	.197	.185	.172	.160	.147	.135	
.60	.40	.60	.240	.227	.215	.202	.190	.177	.165	.152	.140		
.65	.35	.65	.227	.215	.202	.190	.177	.165	.152	.140			
.70	.30	.70	.210	.197	.185	.172	.160	.147	.135				
.75	.25	.75	.187	.175	.162	.150	.137	.125					
.80	.20	.80	.160	.147	.135	.122	.110						
85	.15	.85	.127	.115	.102	.090							
.90	.10	.90	.090	.077	.065								
.95	.05	95	.047	.035									

$M_B = Pl \times$ function
$R = P \times$ function

ACCURACY OF TABULAR DATA.

The tabular values given are not necessarily exact, and in some cases are known not to be. Whatever departure from exact values there may be is due to the slightly incorrect assumption, indicated above, that the functions for $N = 0$ are the same as those for $N = 0.1$. While the values given are approximate, this is true only in a mathematical sense; for all practical purposes they are more than absolute. Much more exact than any hypothesis upon which they will ever be applied.

While it would have been possible to secure exact values of the functions of negative moments and reactions by the aid of the calculus, it is obvious that no value would attach to such extreme accuracy, and the labor involved in the computations would have been prohibitive. Also, it would not have been pos-

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TABLE II. BEAM FIXED AT ONE END—FUNCTIONS OF REACTION AT SUPPORTED END.

Values of k	Values of N									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
.05	925									
.10	850	.850								
.15	.776	.777	.778							
.20	.704	.704	.706	.707						
.25	.633	.633	.635	.637	.640					
.30	.563	.564	.566	.569	.572	.576				
.35	.496	.497	.500	.503	.507	.511	.517			
.40	.432	.433	.436	.439	.444	.449	.456	.463		
.45	.370	.372	.375	.379	.384	.390	.397	.406	.415	
.50	.312	.314	.317	.322	.327	.334	.342	.352	.362	.374
.55	.258	.260	.263	.268	.274	.282	.291	.301	.313	
.60	.208	.210	.214	.219	.226	.234	.244	.255		
.65	.162	.164	.169	.174	.182	.190	.201			
.70	.121	.124	.128	.134	.142	.152				
.75	.086	.088	.093	.100	.108					
.80	.056	.059	.064	.071						
.85	.032	.035	.040							
.90	.014	.017								
.95	.003									

R = P × function

TABLE IV.—BEAM FIXED AT ONE END—FUNCTIONS OF MAXIMUM NEGATIVE BENDING MOMENTS.

Values of k	Values of N									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
.05	.025									
.10	.049	049								
.15	.073	.077	.072							
.20	.096	.095	.094	.092						
.25	.117	.116	.114	.112	.109					
.30	.136	.135	.133	.131	.127	.123				
.35	.153	.152	.150	.147	.143	.138	.132			
.40	.168	166	.164	.160	.156	.150	.144	.136		
.45	.179	.177	.175	.171	.166	.160	.152	.144	.134	
.50	.187	.185	.182	.178	.172	.165	.157	.148	.137	.125
.55	.192	.190	.186	.182	.175	.168	.159	.148	.137	
.60	192	.189	.186	.180	.174	.165	.156	.144		
.65	.187	.185	.181	.175	.168	.159	.148			
.70	.178	.175	171	.165	.157	.148				
.75	.164	.161	.156	.150	.141					
80	.144	.141	.136	.129						
.85	.118	.114	.109							
.90	.085	.082								
.95	.047									

$M_B = Pl \times$ function

sible to derive positive moment functions by such a method.

As an indication of the accuracy of the methods employed, and the degree of exact-

TABLE III.—BEAM FIXED AT ONE END—FUNCTIONS OF REACTION AT FIXED END.

Values of k	Values of N									
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
.05	0.075									
.10	.149	.149								
.15	.223	.223	.222							
.20	.296	.295	.294	.292						
25	.367	.366	.364	.362	.359					
.30	.436	.435	.433	.431	.427	.423				
35	.503	.502	.500	.497	.493	.488	.482			
.40	.568	.566	.564	.560	.556	.550	.544	.536		
.45	.629	.628	.625	.621	.616	.610	.602	.594	.584	
.50	.687	.686	.682	.678	.672	.665	.657	.648	.637	.625
.55	.742	.740	.736	.731	.725	.718	.709	.698	.687	
.60	.792	.790	.786	.781	.774	.766	.756	.745		
.65	.837	.835	.831	.825	.818	.809	.798			
.70	.878	.876	.871	.865	.857	.848				
.75	.914	.911	.906	.900	.891					
.80	.944	.941	.936	.929						
.85	.968	.965	.959							
.90	.985	982								
.95	996									

R = P × function

TABLE VI.—FIXED BEAM—FUNCTIONS OF END REACTIONS.

Values of k	Values of N										For Reaction at Right End.
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	
.05	.992										.95
.10	.972	.965									.90
.15	.939	.934	.925								.85
.20	.896	.891	.884	.873							.80
.25	.843	.840	.833	.825	.813						.75
.30	.784	.780	.776	.768	.760	.748					.70
.35	.717	.716	.711	.707	.699	.692	.681				.65
.40	.648	.645	.644	.639	.636	.630	.624	.616			.60
.45	.574	.574	.572	.571	.568	.566	.562	.559	.554		.55
.50	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.50
.55	.424	.426	.426	.429	.430	.434	.436	.441	.444		.45
60	.352	.352	.356	.358	.364	.368	.376	.382			.40
.65	.281	.284	.287	.293	.299	.308	.317				.35
.70	.216	.218	.224	.225	.240	.250					.30
.75	.155	.160	.165	.175	.185						.25
.80	.104	.107	.116	.125							.20
.85	.059	.066	.073								.15
.90	.028	.032									.10
.95	.006										.05
For Reaction at Left End.	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	Values of k
	Values of N										

R = P × function

ness of the given values, the following comparisons are made:

For a beam fixed at both ends and uniformly loaded, the function of the maximum negative moment by the approximate method emloyed is 0.0834, and the exact value is 0.0833; while the approximate value for the function of the maximum positive moment is 0.04116, and the exact value, 0.0416+.

For a beam fixed at one end and uniformly loaded, the approximate value of the maximum negative moment function is 0.1255, and the exact value is 0.1250.

Comparisons of other functions for like conditions are equally favorable.

Functions for partial distributions have been selected at random and checked by the calculus, and they have always been found to be practically exact. The error increases as N decreases, but it is believed that the greatest error does not exceed three one-thousandths. While this error occurring in certain cases might constitute a considerable percentage of the moment, in these cases the bending moment, or the reaction, would be so small in any case as to have virtually no bearing upon the design, and may be wholly disregarded.

As a further check on the accuracy of these tables the equations,

$$M_B + = M_B - - \left[\frac{P}{2}\right] \frac{N}{4} + R_1 k,$$

R_1 being the left reaction, and

$$M_B + = M_B - -PR_2 \left[\frac{NR_2}{2}\right] + R_2 (1 - k');$$

R_2 being the right reaction, may be applied. The first equation is applicable to beams fixed at both ends; the second to those fixed at one end and supported at the other. For example, let $P = 1$, $l = 1$, $k = 0.60$, and $N = 0.4$. Then, from the tables, $M_B + = -0.093 - 0.5 \times 0.1 + 0.358 \times 0.60 = 0.0718$. The table gives 0.072.

It should be understood that, with one exception, the functions given in these tables were independently computed, and that no effort has been made to "harmonize" the results. The exception is the table of functions of maximum positive moments for a beam

TABLE V.—BEAM FIXED AT ONE END—FUNCTIONS AND LOCATIONS OF MAXIMUM POSITIVE BENDING MOMENTS.

Values of k	Values of N																			
	.1		.2		.3		.4		.5		.6		.7		.8		.9		1.0	
	k′	Funct	k′	Funct	k′	Funct	k′	Funct.	k′	Funct	k′	Funct	k′	Funct	k′	Funct.	k′	Funct.	k′	Funct.
.05		.046																		
.10		.085	.17	.072																
.15		.116	.20	.099	.23	.091														
.20		.141	24	.121	.26	.110	.28	.100												
.25		.158	.28	.135	29	.124	.30	.113	.32	.103										
.30		.169	.31	.144	.32	.133	.33	.122	.34	.110	.35	.099								
.35		.173	.35	.149	.35	.138	.35	.127	.35	.115	.36	.104	.36	.093						
.40		.173	.39	.148	.38	.138	.38	.126	.37	.116	.37	.106	.37	.095	.37	.085				
.45	Same as k	.166	.42	.144	41	.133	.40	.123	.39	.113	.38	.104	.38	.095	.37	.086	.37	.078		
.50		.156	.46	.135	.44	.126	.43	.117	.41	.109	.40	101	.39	.092	.38	085	.38	.077	.37	.071
.55		.142	.50	.123	.48	.116	.46	.108	44	.101	.42	.094	40	088	.39	.082	.38	.075		
60		.125	.54	.110	.51	.103	49	.097	.46	.092	44	.087	.42	.082	40	.077				
.65		.105	.58	.093	.55	089	.52	.085	.49	.081	46	.077	.44	.075						
.70		.085	.62	.076	.59	.073	.55	.070	.52	.069	49	.068								
.75		.064	.67	.058	.63	.057	.59	.057	.55	.057										
.80		045	.71	.042	.67	.042	.63	.044												
.85		.027	.76	.026	.71	.028														
.90		.013	.80	.014																
.95		.003																		

$M_B = Pl \times$ function

$k'l$ = distance from left support to section of max. moment.

TABLE VII.—FIXED BEAM—FUNCTIONS OF MAXIMUM NEGATIVE BENDING MOMENTS.

Values of k	Values of N										For Moment at Right End.
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	
.05	.045										.95
.10	.081	.076									.90
.15	.108	.104	.098								.85
.20	.128	.124	.119	.110							.80
.25	.140	.137	.132	.125	.115						.75
.30	.147	.144	.140	.133	.125	.115					.70
.35	.148	.145	.141	.136	.129	.120	.110				.65
.40	.144	.142	.137	.134	.128	.120	.112	.102			.60
.45	.136	.134	.132	.128	.123	.117	.110	.102	.092		.55
.50	.125	.123	.122	.118	.115	.110	.105	.098	.092	.083	.50
.55	.111	.110	.109	.107	.104	.101	.097	.093	088		45
.60	096	.095	.095	.093	.092	.090	.088	.085			40
.65	079	.079	.079	.079	.078	.078	.077				.35
.70	.063	.062	.064	.064	.065	.065					.30
.75	.046	.047	.048	.050	.051						.25
.80	.032	.032	.035	.036							.20
.85	.019	.020	.022								.15
.90	.009	.010									.10
.95	.002										.05
For Moment at Left End	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	Values of k
	Values of N										

$M_B = Pl \times$ function

TABLE VIII.—FIXED BEAM—FUNCTIONS OF MAXIMUM POSITIVE BENDING MOMENTS.

Values of k	Values of N									
	.1	.2	.3	.4	.5	.6	7	.8	.9	1.0
.05	.004									
.10	.016	.000								
.15	.032	.011	.010							
.20	.051	.029	.025	.014						
.25	.070	.048	.042	.031	.027					
.30	.088	.065	.060	.047	.043	.034				
.35	.103	.080	.074	.061	.056	.047	.043			
.40	.115	.091	.085	.072	.066	.056	.052	.044		
.45	.122	.099	.092	.079	.073	.062	.057	.049	.045	
.50	.125	.101	.095	.081	.075	.064	.059	.051	.047	.042
.55	.122	.099	.092	.079	.073	.062	.057	.049	.045	
.60	.115	.091	.085	.072	.066	.056	.052	.044		
.65	.103	.080	.074	.061	.056	.047	.043			
.70	.088	.065	.060	.047	.043	034				
.75	.070	.048	.042	.031	.027					
.80	.051	.029	.025	.014						
.85	.032	.011	.010							
.90	.016	000								
.95	.004									

$M_B = Pl \times$ function

TABLE IX—SIMPLY SUPPORTED BEAM—PERCENTAGE OF MAX. BENDING MOMENT AT VARIOUS SECTIONS FOR CONCENTRATED LOAD AT VARIOUS POINTS.

VALUES OF x	VALUES OF Z																																						VALUES OF x
	SECTION LEFT OF LOAD																				SECTION RIGHT OF LOAD																			
	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	.20	.15	10	.05	0	.05	.10	15	.20	25	.30	.35	40	45	50	.55	60	65	.70	.75	.80	85	.90	95	
05																			0	100	.95	90	84	.79	74	.68	.63	.58	.53	47	42	.37	32	.27	.21	.16	11	.05	0	05
10																		0	.50	100	.94	.89	.83	.78	.72	.67	.61	.56	.50	.45	.39	.33	.28	22	.17	.11	.06	0		10
15																	0	33	.67	1.00	.94	.88	82	.76	.71	.65	.59	.53	.47	.41	.35	29	23	.18	12	06	0			15
20																0	.25	.50	.75	100	94	.88	.81	.75	.69	.63	.56	.50	.44	.38	.31	.25	.19	.13	.06	0				20
25															0	.20	40	.60	.80	1.00	94	.87	.80	.73	.67	.60	.53	.47	.40	.33	.27	20	.13	.07	0					25
30														0	17	.33	.50	67	.83	100	.93	.86	.79	.72	.64	.57	.50	.43	.36	.28	.21	.14	07	0						30
35													0	.14	.28	.43	.57	.72	86	1.00	.92	.85	.77	.69	.62	.54	46	.39	.31	.23	.16	.08	0							35
40												0	.13	25	.37	.50	.62	.75	.88	1.00	.92	.84	.75	.67	.58	.50	42	.33	.25	.17	.08	0								40
45											0	.11	.22	.33	.45	56	.67	.78	.89	1.00	91	.82	.73	.64	.55	.46	.36	.27	.18	.09	0									45
50										0	.10	20	.30	40	.50	.60	.70	.80	.90	1.00	.90	.80	.70	.60	.50	.40	.30	.20	.10	0										.50
55									0	.09	.18	27	36	46	55	.64	.73	.82	.91	1.00	.89	.78	.67	.56	45	.33	.22	.11	0											.55
60								0	.08	.17	.25	.33	42	.50	.58	.67	.75	.84	.92	100	.88	.75	.62	.50	.37	.25	.13	0												.60
65							0	.08	.16	.23	31	.39	46	.54	.62	.69	.77	.85	.92	100	.86	.72	.57	.43	.28	.14	0													65
70						0	.07	.14	.21	.28	.36	.43	.50	.57	.64	.72	.79	.86	.93	1.00	.83	.67	.50	.33	.17	0														70
75					0	.07	.13	.20	27	.33	.40	.47	53	.60	.67	.73	.80	.87	.94	1.00	.80	.60	.40	20	0															.75
80				0	.06	.13	.19	.25	.31	.38	.44	.50	.56	.63	.69	.75	.81	.83	.94	1.00	.75	50	.25	0																80
85			0	.06	.12	18	.23	29	35	.41	47	.53	.59	.65	.71	.76	.82	.88	.94	1.00	.67	.33	0																	.85
.90		0	.06	.11	.17	.22	.28	.33	.39	.45	.50	.56	61	.67	.72	.78	.83	.89	94	1.00	.50	0																		.90
95	0	.05	.11	.16	.21	.27	.32	.37	42	.47	.53	.58	.63	.68	.74	.79	.84	.90	.95	1.00	0																			.95

TABLE X—BEAM FIXED AT ONE END—PERCENTAGE OF MAXIMUM BENDING MOMENT AT VARIOUS SECTIONS FOR A CONCENTRATED LOAD AT VARIOUS POINTS. ABOVE HEAVY LINE, POSITIVE MOMENTS, BELOW HEAVY LINE, NEGATIVE MOMENTS.

VALUES OF x	VALUES OF Z																																						VALUES OF x	INFLECTION POINT
	SECTION LEFT OF LOAD																				SECTION RIGHT OF LOAD																				
	95	90	85	80	75	70	.65	60	55	50	45	40	35	30	.25	.20	.15	.10	.05	0	.05	10	.15	20	25	.30	.35	.40	45	.50	.55	.60	.65	70	.75	.80	.85	.90	.95		
05																			0	100	.92	.84	.76	.68	.60	.51	.43	.35	.27	.19	.11	.03	.10	.25	.40	.55	.70	.85	100	.05	333
.10																		0	50	1.00	91	.82	.74	.65	.56	.47	.38	.30	21	.12	.03	.10	.25	.40	.55	.70	.85	100		.10	331
15																	0	33	67	100	90	.81	.71	.61	.52	.42	.33	.23	.14	.04	.09	.24	.39	.55	.70	.85	100			15	329
.20																0	25	50	75	100	89	.79	.69	.58	.48	.37	.26	.16	.05	08	.23	.38	54	.69	.84	1.00				20	324
.25															0	.20	40	60	80	1.00	.88	.77	.65	.54	.42	.31	.19	.07	.06	.22	.37	.53	.68	.84	1.00					25	319
.30														0	.17	.33	.50	.67	.83	1.00	.87	.74	.61	.48	.35	.22	.09	.04	.20	.36	.52	.68	.84	1.00						.30	313
35													0	.14	.28	.43	.57	.72	86	1.00	.85	.71	.56	42	.27	.13	.02	.18	.35	.51	.67	.84	1.00							.35	305
40												0	.13	.25	.37	.50	62	.75	.88	1.00	.83	.67	.51	.34	.18	.02	.15	.32	.49	.66	.83	1.00								40	296
45											0	.11	.22	33	.45	.56	.67	.78	.89	1.00	.81	.62	.44	.25	.06	.12	.30	.47	.65	.83	1.00									45	288
50										0	.10	.20	.30	40	50	.60	.70	.80	.90	1.00	.78	.56	.34	.12	.08	.27	.45	.63	.82	1.00										50	273
55									0	.09	.18	27	36	46	55	.64	.73	.82	.91	1.00	.74	.48	.21	.03	.23	42	.61	.81	1.00											55	259
60								0	.08	.17	.25	.33	.42	.50	58	.67	.75	.84	.92	1.00	.68	.36	.04	.17	.38	.59	.79	1.00												60	243
65							0	08	.16	.23	31	39	46	54	.62	.69	.77	.85	92	1.00	.60	.21	10	.33	.56	.78	1.00													65	224
70						0	07	14	.21	.28	.36	43	50	.57	.64	.72	.79	.86	93	1.00	.48	.02	.27	.51	.76	1.00														70	204
.75					0	.07	13	20	.27	.33	.40	47	53	.60	.67	.73	.80	.87	.94	100	.29	.17	.44	.72	1.00															.75	179
80				0	.06	13	19	25	.31	38	.44	50	56	.63	.69	.75	.81	88	.94	1.00	.01	.34	.67	1.00																.80	152
85			0	.06	.12	18	.23	.29	.35	41	47	.53	.59	.65	.71	.76	.82	.88	.94	1.00	.19	.59	1.00																	.85	.122
90		0	.05	.11	.17	.22	.28	.33	.39	.45	.50	.56	.61	.67	.72	.78	.83	.89	.94	1.00	.43	1.00																		.90	087
.95	0	.05	.11	.16	.21	.27	.32	.37	.42	.47	.53	.58	.63	.68	.74	.79	.84	.90	.95	1.00	100																			.95	.047

fixed at one end and supported at the other. Except for $N = 0.1$, this was computed on the basis of the table of left reaction functions, this procedure being necessary in order to determine the section of zero shear, and hence the section of maximum positive moment.

It should be noted in this connection that the method of computation of the maximum positive moment functions for beams fixed at both ends was necessarily different from that used to derive the others, and introduced a second approximation. Hence, when the value of M_B+ derived from the foregoing formula, using M_B- and R as shown in the tables, the error may properly be supposed to lie mainly in the tabular value of M_B+.

The scope of these tables is sufficiently broad to cover all practical conditions of loading, but intermediate values may be obtained by interpolation, if desired.

PRINCIPAL APPLICATION OF THE TABLES.

The tables were designed primarily for use

TABLE XI.—FIXED BEAM. PERCENTAGE OF MAXIMUM BENDING MOMENT AT VARIOUS SECTIONS FOR A CONCENTRATED LOAD AT VARIOUS POINTS. BETWEEN HEAVY LINES, POSITIVE MOMENT; OUTSIDE OF HEAVY LINES, NEGATIVE MOMENT.

Inflection Point	Values of k	Values of Z																																							Values of k	Inflection Point
		Section Left of Load																			Section Right of Load																					
		.95	90	85	80	.75	.70	.65	.60	.55	.50	.45	.40	.35	.30	.25	.20	.15	.10	.05	0	.05	.10	.15	.20	.25	.30	.35	40	45	.50	.55	.60	.65	.70	.75	.80	.85	90	.95		
045	.05																			1,00	1.00	.92	.84	.76	68	60	.52	.44	.36	.28	.20	12	.04	.08	.23	39	.54	.69	.85	1.00	.05	.327
.083	10																		1.00	.39	1.00	.91	.83	74	.65	.57	.48	.40	.31	.22	.14	.05	.06	.22	.37	.53	.69	.84	1.00		.10	.321
115	.15																	1.00	.56	.12	1.00	.91	.81	.72	.63	.54	.44	.35	.26	.16	.07	.04	.20	.36	.52	.68	.84	1.00			.15	.311
.143	20																1.00	.64	.30	.13	1.00	.90	.80	.70	.60	49	.39	.29	.19	.09	.02	.18	.35	.51	.67	.84	1.00				.20	.308
166	25															1.00	.70	.39	.09	.41	1.00	.89	.78	.67	.56	.45	.34	.23	.12	.01	.16	.32	.49	.66	.83	1.00					.25	.297
188	30														1.00	.73	.46	.20	.11	.56	1.00	.88	.75	.63	.51	.39	.27	.14	.02	.14	.31	.48	.65	.83	1.00						.30	.292
206	35													1.00	.76	.51	.27	.03	.30	.65	1.00	.86	.73	.59	.46	.32	.19	.05	.11	.29	.46	64	.82	1.00							.35	281
222	40												1.00	.77	.55	.32	.10	.16	.44	.72	1.00	.85	.69	.54	.39	.23	.08	.08	.27	45	.63	.81	1.00								40	272
237	45											1.00	.79	.58	.37	.15	.06	.30	.53	.77	1.00	.83	.65	48	.31	.13	.04	.23	.43	.62	.81	1.00									45	262
250	50										1.00	.80	.60	.40	.20	0	.20	.40	.60	.80	1.00	.80	.60	.40	.20	0	.20	.40	.60	.80	1.00										.50	.250
262	55									1.00	81	62	.43	.23	04	.13	.31	.48	.65	.83	1.00	.77	.53	.30	.06	.15	.37	.58	.79	1.00											55	.237
272	60								1.00	.81	.63	45	.27	.08	.08	23	.39	.54	.69	.85	1.00	.72	.44	.16	10	32	.55	.77	1.00												60	.222
281	65							1.00	.82	.64	.46	.29	.11	05	19	.32	.46	.59	.73	.86	1.00	.65	.30	.03	.27	.51	.76	1.00													65	206
292	70						1.00	.83	.65	.48	.31	.14	.02	.14	.27	.39	.51	.63	.75	.88	1.00	.56	.11	.20	.46	.73	1.00														70	188
297	75					1.00	83	.66	.49	32	16	.01	.12	.23	.34	.45	.56	.67	.78	.89	1.00	.41	.09	.39	.70	1.00															75	.166
308	80				1.00	.84	.67	.51	.35	18	.02	.09	.19	.29	.39	.49	.59	.70	.80	.90	1.00	.13	.30	.64	1.00																80	143
311	85			1.00	84	68	52	36	.20	.04	07	.16	.26	35	.44	.54	.63	.72	.81	.91	1.00	.12	.56	1.00																	85	115
321	90		1.00	84	69	.53	.37	.22	06	05	.14	22	31	40	.48	.57	.65	.74	.83	.91	1.00	.39	1.00																		90	.083
.327	.95	1.00	.85	.69	.54	.39	.23	.08	.04	.12	.20	.28	.36	.44	.52	.60	.68	.76	.84	.92	1.00	1.00																			95	045

TABLE XII.—DATA FOR PROBLEM EXPLANATORY OF THE USE OF TABLES I-XI—VALUES HAVE BEEN ROUGHLY COMPUTED.

Value of k for		Reaction Functions				Reactions Thousands of Pounds						Section ft. from left end	Max. Shear Thousands of lbs	Negative Moment Functions				Maximum Negative Moments Thousands of Foot-Pounds						Inflection Point Feet from	
		Lt End		Rt End		Left End			Right End					Lt End		Rt End		Left End			Right End				
P_1	P_2	$(f)P_1$	$(f)P_2$	$(f)P_1$	$(f)P_2$	R_1	R_2	Sum	R_1'	R_2'	Sum	a		$(f)P_1$	$(f)P_2$	$(f)P_1$	$(f)P_2$	$-M_1$	$-M_2$	Sum	$-M_1'$	$-M_2'$	Sum	Lt End	Rt End
05		992		006		15.9		15.9	0.1		0.1	.05	+15.9	.045		.002		28.8		28.8	1.3		1.3		13.3
10		972		.028		15.5		15.5	0.4		0.4	.10	+34.7	.081		009		51.8		51.8	5.8		5.8	㉝	
15		939		059		15.0		15.0	0.9		0.9	.15	+32.8	.108		.019		69.1		69.1	12.2		12.2		
20		896		104		14.3		14.3	1.7		1.7	.20	+30.6	.128		.032		81.9		81.9	20.5		20.5	(57)	
25		843		155		13.5		13.5	2.5		2.5	.25	+28.2	140		.046		89.5		89.5	29.4		29.4		
.30		784		216		12.5	0	12.5	3.5		3.5	30	+25.5	.147		063		94.2		94.2	40.3		40.3	(75)	
.35	10	717	965	281	.032	11.5	23.2	34.7	4.5	0.8	5.3	.35	+22.8	.148	076	.079	.010	94.7	73.8	168.5	50.5	9.6	60.1		11.5
40	15	648	934	352	066	10.4	22.4	32.8	5.6	1.6	7.2	40	+20.0	144	.104	096	.020	92.2	99.8	192.0	61.5	19.2	80.7	(58)	
45	20	574	891	.424	107	9.2	21.4	30.6	6.8	2.6	9.4	.45	+17.3	.136	124	.111	032	86.0	119.0	205.0	71.0	30.7	101.7		10.6
50	25	500	840	500	160	8.0	20.2	28.2	8.0	3.8	11.8	50	+14.5	125	137	.125	.047	80.0	131.4	211.4	80.0	45.1	125.1	7.5	
55	30	424	780	574	218	6.8	18.7	25.5	9.2	5.2	14.4	.55	−14.4	111	144	.136	.062	71.0	138.3	209.3	86.0	59.5	145.5	8.2	10.1
60	35	352	716	.648	284	5.6	17.2	22.8	10.4	6.8	17.2	60	−17.2	.096	145	144	.079	61.5	139.2	200.7	92.2	75.8	168.0	8.8	
65	40	281	645	717	352	4.5	15.5	20.0	11.5	8.4	19.9	65	−19.9	.079	.142	.148	.095	50.5	136.3	186.8	94.7	91.2	185.9	9.3	9.4
70	45	216	.574	784	426	3.5	13.8	17.3	12.5	10.2	22.7	70	−22.7	.063	134	.147	.110	40.3	128.6	168.9	94.2	105.5	199.7	9.8	
75	50	155	500	843	500	2.5	12.0	14.5	13.5	12.0	25.5	75	−25.5	.046	.123	.140	123	29.4	118.0	147.4	89.5	118.0	207.5	10.0	8.1
80	55	104	426	896	574	1.7	10.2	11.9	14.3	13.8	28.1	80	−28.1	.032	110	.128	134	20.5	105.5	126.0	81.9	128.6	211.5	10.6	7.5
85	60	059	352	939	645	0.9	8.4	9.3	15.0	15.5	30.5	.85	−30.5	.019	095	.108	.142	12.2	91.2	103.4	69.1	136.3	205.4	11.1	(67)
90	65	028	284	972	716	0.4	6.8	7.2	15.5	17.2	32.7	90	−32.7	.009	.079	.081	.145	5.8	75.8	81.6	51.8	139.2	191.0	11.5	
95	70	.006	218	992	780	0.1	5.2	5.3	15.9	18.7	34.6	.95	−34.6	.002	.062	.045	.144	1.3	59.5	60.8	28.8	138.3	167.1	11.5	
	75		160		840	0	3.8	3.8		20.2	20.2				.047		.137		45.1	45.1		131.5	131.5	11.9	
	80		107		891		2.6	2.6		21.4	21.4				.032		124		30.7	30.7		119.0	119.0	–	
	85		066		934		1.6	1.6		22.4	22.4				.020		104		19.2	19.2		100.0	100.0	12.0	
	90		032		965		0.8	0.8		23.2	23.2				.010		.076		9.6	9.6		72.9	72.9	12.0	
	95				–					24.0	24.0				–		–							13.3	

Value of k for		Positive Moment Functions		Maximum Positive Moments Thousands of Foot-lbs		Part M ± effective under P_2		Part M ± effective under P_1		Max. M_B under P_1	Max M_B under P_2	Section ft. from left end	Maximum Possible $+M_B$
P_1	P_2	$(f)P_1$	$(f)P_2$	$+M_1$	$+M_2$	%	1000's ft lbs	%	1000's ft lbs			a	
05		004		2.5						2.5		05	2.5
10		016		10.2				average		10.2		10	10.2
15		032		20.5						20.5		15	20.5
20		051		32.6						32.6		20	32.6
25		070		44.8						44.8		25	46.0
.30		088		56.3						56.3		30	72.4
.35	10	103	0	65.9		−51	−48.2	57	0	65.9	−48.2	35	93.6
40	15	115	.011	73.6	10.6	−32	−29.5	54	5.7	79.3	−8.9	40	103.8
45	20	122	029	78.2	27.8	−15	−12.9	50	13.9	92.1	+14.9	.45	117.0
50	25	125	048	80.0	46.0	0	0	45	20.7	100.7	46.0	50	117.2
55	30	122	065	78.2	62.3	.13	+10.1	40	24.9	103.1	72.4	55	111.0
60	35	115	080	73.6	76.7	23	+16.9	33	25.6	99.2	93.6	60	98.4
65	40	103	091	65.9	87.3	32	16.5	25	21.8	87.7	103.8	65	82.5
70	45	088	099	56.3	95.0	39	22.0	14	13.3	69.6	117.0	.70	63.8
75	50	070	101	44.8	97.0	.45	20.2	01	1.0	45.8	117.2	.75	46.1
80	55	.051	099	32.6	95.0	.49	16.0	−15	−19.3	13.3	111.0	80	27.8
85	60	.032	091	20.5	87.3	54	11.1	−32	43.6	−23.1	99.4	85	10.6
90	65	016	080	10.2	76.7	57	5.8	−51	−71.0	−60.8	82.5	90	+0
95	70	.004	065	2.5	62.3	60	1.5	−73	−100.9	−98.4	63.8	95	
	75		048		46.1	0		0			46.1		
	80		029		27.8						27.8		
	85		011		10.6						10.6		
	90		0		0						0		
	95												

in the design of reinforced concrete girder and slab bridges, where the main factors are two or more related moving concentrations or partial distributions (a 20-ton road roller, say), and where, for an intelligent distribution of steel, it is necessary to know the maximum possible moments and shears at every section. In such a case the tables are invaluable, effecting easily and rapidly the determinations, which without them would be extremely laborious and complicated. As an example of their use in such a case the following problem and its detailed solution are given.

Problem.—Required the maximum shear and the maximum negative and positive moments for every section of a beam fixed at both ends and having a span of 40 ft., due to rolling loads of 16,000 and 24,000 lbs., distant 10 ft. on centers longitudinally. The first load is to be regarded as a concentration, and the second as distributed over 0.2 of the span, i. e., $N = 0.2$.

Consider the 16,000-lb. load as entering first upon the left end. Call this P_1, and the 24,000-lb. load P_2. Other quantities are designated as follows:

(f) = function of.

a = distance of any section from the left end, expressed as a percentage of the span.

$-M_1$ = negative moment at left end due to P_1.

$-M_1'$ = negative moment at right end due to P_1.

$-M_2$ = negative moment at left end due to P_2.

$-M_2'$ = negative moment at right end due to P_2.

$+M_1$ = positive moment due to P_1.

$+M_2$ = positive moment due to P_2.

R_1 = left reaction due to P_1.

R_2 = left reaction due to P_2.

R_1' = right reaction due to P_1.

R_2' = right reaction due to P_2.

The value of Z is 0.25.

In foot-pounds, $P_1l = 640{,}000$ and $P_2l = 960{,}000$.

In Table XII, under the foregoing hearings, and others which are self-explanatory, there are given all the required quantities. The arrangement explains their derivation.

(It should be noted that the percentage of M_2 effective under P_1, given in the solution, is the average value of two loads of $N = 0.1$, or two assumed concentrations, composing the load P_2, where $N = 0.2$. Up to a value of $N = 0.4$ it would be permissible to use this average, but the error would become quite large for greater values of N. For these larger values it will be necessary to consider the moment of each unit of distribution ($N = 0.1$) in connection with the percentage given, and to get the sum of the products for the effect of the load at any section other than that at the center of load.)

The columns which give the distances of the inflection points, in feet, from the supports are for the purpose of locating the curve of maximum negative moments between the support (where it is a maximum) and the one-third point (where it becomes 0). These distances are the potient of $\frac{\Sigma - M}{\Sigma R}$, ΣM and ΣR being corresponding values of the moment and the reaction. The value of the maximum negative moments for sections other than that at the support can only be determined by this graphical method—by scaling the ordinates to the determined curve for numerical values. The curve determined by this method will give values somewhat in excess of the true ones if the point representing the negative moment at the support and the point of inflection be connected by a straight line; because (except in the case of a single concentration) this line is truly curved slightly inward toward the support. The straight line connection is the only practicable one, however, and the error in the curve resulting therefrom is insignificant, for all practical purposes.

The circle enclosing some of the inflection distances indicates that these are of no value in the determination of the curve; they are given merely to call attention to this fact.

Some Data on the Use of Synthetic Stone for the Catskill Aqueduct Buildings.

To house the valve-operating and unwatering machinery of the Catskill Aqueduct will require the construction of 53 buildings, located at the headworks and along the line of the aqueduct. After thorough investigation and experimentation it was decided to use synthetic stone as a building material for these structures. The following data apply to the preliminary investigations made, and to the testing and use of synthetic stone on this work; the data were abstracted from a paper by H. Lincoln Rogers, presented before the 11th annual convention of the American Concrete Institute, Philadelphia, Pa.

PRELIMINARY INVESTIGATIONS.

Inquiries, begun in 1906, showed a sufficient number of experienced and reliable manufacturers of synthetic stone to warrant open competition in public lettings. Numerous plants were then visited, and a close observation was made of the methods and care with which the details of manufacture were carried on at each place.

The kinds and quality of aggregates, and their grading, proportioning, mixing and curing, were carefully examined, including the means employed for maintaining a constant agitation of the mix until poured into the molds. The organization, plant layout, and general equipment for handling large work were also noted.

These preliminary investigations were highly favorable to synthetic stone, but were not fully conclusive. If satisfactory, it was evident that the use of this material in the Catskill Aqueduct buildings offered many opportunities to effect economies and yet indulge in architectural designs that would be extravagant if produced in acceptable natural stone. It was also apparent, with the rapid growth foreseen for this product, that many inexperienced manufacturers, producing doubtful and inferior material, would have to be reckoned with. Great care would also need to be exercised in drawing up the specifications and contract for public letting so as to secure synthetic stone of the best quality and only that manufactured by skilled, experienced men in well organized and equipped plants.

TABLE I.—RESULTS OF COMPRESSIVE AND TRANSVERSE TESTS OF TYPICAL SYNTHETIC STONE SPECIMENS.

Specimen No.	Size of specimen.	Transverse load, lbs.	Compressive strength at 28 days, lbs. per sq. in.
A-1	2x4x8 ins.	1,340	.....
	2x4x8 ins.	1,460	.....
	2x4x8 ins.	1,540	.....
A-2	2x4x8 ins.	1,820	.....
	2x4x8 ins.	1,830	.....
	2x4x8 ins.	1,930	.....
A-3	8-in. dia. x 16-in. cyl.	.....	3,145
	8-in. dia. x 16-in. cyl.		3,220
	8-in. dia. x 16-in. cyl.		4,250
A-4	8-in. dia. x 16-in. cyl.	.....	4,540
	8-in. dia. x 16-in. cyl.		3,735
	8-in. dia. x 16-in. cyl.	.....	3,095

Notes: A-1 and A-3 cast in rigid molds. A-2 and A-4 cast in sand molds. See specification for details.

TABLE II.—RESULTS OF ABSORPTION TESTS OF TYPICAL SYNTHETIC STONE SPECIMENS.

Specimen No.	Weight after drying.	Weight after 48 hrs. immersion.	Absorption, per cent.
15	1466.0	1517.0	3.5
16	1120.6	1161.2	3.6
17	1362.3	1411.5	3.6
18	1209.6	1248.1	3.2
19	1268.6	1305.7	2.9
20	1552.5	1596.5	2.8
Average	.....	......	3.3

In most instances it was found that the best manufacturers were eager to profit by suggestions in regard to improving the artistic appearance of their product, which in many aspects was lacking from an architect's point of view. For example, much of the synthetic stone was dull, lifeless and timid in appearance, and lacked the variations, color and charm usually found in most natural stones. To overcome this, and to secure the appearance of natural stone tints, the admixture of small proportions of mineral color, hornblende, block marble and similar natural colored aggregates was experimented with. The first results along this line were not very satisfactory. After many experiments and trials the "made up" appearance was overcome, and there was produced variegated, accidental tones in several chosen, warm, mellow shades, each developed as a general color scheme suitable for an entire building or group of buildings.

Attention was then directed to the surface finish. Few of the manufacturers had given effective thought to procuring that wide range in texture—so familiar and attractive in natural stone. Eventually a complete set of specimens was produced which satisfactorily ran the whole gauntlet of natural stone texture, including some interesting variations made with a sand blast before the stone was very hard.

TESTS OF TYPICAL SPECIMENS.

From the beginning a collateral series of tests was conducted, in conjunction with the observations above described, at the laboratory of the Board of Water Supply. Samples of staple and special output from the factories visited were here subjected to tests, under prescribed regulations, which required that an inspector of the Department of Water Supply should visit the factory and take pourings from the regular commercial output—in molds 2x4x8 ins. in size, and in cylinders 8 ins. in diameter and 16 ins. long. These were marked for identification by the Board's inspector and shipped to the laboratory for tests when 28 days old. Half specimens from transverse tests were also used for absorption tests.

The schedules in Tables I and II are fair examples of the tests on acceptable manufacturers' products.

COMPARATIVE COSTS.

Comparative estimates of cost, based on tentative designs, were made between structures embodying good, durable synthetic stone, various available natural stones, and combinations of suitable brick and natural stones. These estimates showed economies in the use of synthetic stone, ranging from 10 per cent to as high as 35 per cent, varying according to the simplicity or ornateness of the architectural designs.

EXTRACTS FROM SPECIFICATIONS.

After being satisfied with the results of physical tests, and assured of economies and freedom in design, plans and specifications were prepared for five buildings to be faced with synthetic stone simulating granite of a pinkish hue. The specifications required the contractor to submit for approval the name and address of the manufacturer from whom it was proposed to order the synthetic stone, also the names of at least three buildings not less than five years old in which the product of the concern might be seen exposed to weather. Large samples showing surface finish and color tone were required to be submitted for approval before placing the order.

The specifications also contained the following requirements:

Test specimens of the concrete-stone shall be made under the observation of the engineer or architect from the concrete mixture being used in the manufacture of concrete-stone. There shall not, however, be demanded more than 5 sets of 3 specimens each for any building, unless some of the tests show that concrete-stone of unsatisfactory quality is being produced.

Test specimens, each 2x4x8 ins. in size, not less than 28 days old, shall, when placed flatwise on supports 7 ins. apart, sustain without fracture a transverse center load of 1,000 lbs.

Test cylinders 8 ins. in diameter, 16 ins. long, not less than 28 days old, shall support, when dry, without cracking, a compressive load of 2,500 lbs. per square inch, each specimen being properly supported on its bed.

Half specimens from transverse tests after drying at about 180° F. to constant weight shall be placed in water flatwise so that their upper surfaces are ½ in. above the surface of the water and shall so be maintained for 48 hours. At the expiration of this time the upper surfaces of the specimens shall be dry, and no specimen shall have absorbed more than 4 per cent by weight of water.

All concrete-stone shall be sufficiently reinforced with steel to withstand transportation and erection, and to prevent cracking from any cause. All lintels and similar members shall be additionally reinforced to carry the loads to be borne. Each stone shall be provided with a suitably placed lifting ring or other device for handling it without marring the revealed faces.

Concrete-stone shall be manufactured sufficiently in advance of the requirements of erection to have attained an age of about 2 months before shipment unless permission be given to ship sooner on satisfactory evidence that the concrete-stones will not be damaged thereby. . . . Any concrete-stones marred before their acceptance in the buildings, walls, balustrades or cartouches shall be promptly replaced with satisfactory concrete-stones.

Exposed faces of concrete-stones shall be tooled equivalent to approved samples, in general similar to the following kinds of stone cutting: bull pointed, rough pointed, fine pointed, or patent hammered, 4, 6 or 8 cuts to the inch. . . . Other styles of finish of approximately equal cost may be ordered or approved for any concrete-stones.

SUMMARY OF WORK ALREADY DONE.

Emerson & Norris of New York and Boston supplied the synthetic stone for the first buildings constructed. Specimens of the mix as poured for the work were taken from time to time and tested for transverse and compressive strengths and for absorption.

The stones were delivered at the work and set sand cast, care being taken to roughen slightly the beds and builds to get a good bond. As each building was completed the synthetic stone was tooled in place. Several advantages resulted from this procedure. Stones on which arrises were marred in transportation or handling were set forward sufficiently to permit new arrises to be cut when tooled, at little expense. Contrast in texture was better judged, and desired modifications, which were not seen at the shop, were made possible, whereas in the shop at best only a limited number of tooled stones can be piled up for inspection. Moreover, as the stones have had more time to harden, the tooling is made sharper and more crisp. All mortar slop, rust from steelwork, and other stains are entirely removed in this way, and the stonework left thoroughly clean.

The next contract let comprised seven buildings of brick with synthetic stone trim. The bricks used were the culls of shale paving brick, 3½x4x9 ins., laid up with raked out 1 in. white cement mortar joints. These culls, due to their bent and twisted faces and their varying red shades ranging to a blue black, gave a general tapestry-brick effect on a large scale, harmonizing well with the purpose of the building, its size and setting.

The synthetic stone for this set simulated buff sandstone, and was produced by the admixture of mineral pigment made by the Clinton Metallic Paint Co. Added character was furnished by the aggregate which included "Gouverneur" (white) and (blue) marble.

The Onondaga Litholite Co., of Syracuse, through the Watson Engineering Co., of New York, furnished the stone for this work. This synthetic stone was entirely cut at the factory in Syracuse. Several specimen stones were first cut and tentatively approved, after which an entire doorway was cut and set up in the factory for criticism.

The synthetic stone delivered for these buildings was highly satisfactory, and the work progressed with no delay due to its delivery.

The next contract was for nine buildings and for the balustrades and cartouches for a bridge near the Ashokan reservoir. This work contained about 100,000 cu. ft. of synthetic stone, in addition to the balustrade (about 2,500 lin. ft.) and cartouches for the bridge.

The contract price for these nine buildings and for the bridge balustrades and cartouches was $345,535. The synthetic stone is dark warm gray, simulating granite. The synthetic stone for one building is now delivered, and the remainder is being manufactured as needed by the general contractor. This work will be tooled in place when the buildings are completed.

The balustrades and cartouches for the Ashokan bridge are to have a surface finish made with a sand blast, to harmonize more nearly with the finished surfaces of the substructure of the bridge. The concrete-stone for this work is being made by the Emerson Norris Co.

Another contract now in progress includes eleven buildings of brick and synthetic stone, similar to those previously described. The synthetic stone is being made by the Art Stone Co., of Millers Falls, Mass. The stone, as delivered for the first two buildings, was tooled at the factory. This policy was abandoned as the advantages of tooling in place were soon apparent to the manufacturers.

There are now ready for contract six large buildings near the Kensico reservoir. These buildings are to be similar in design and color to the Ashokan reservoir buildings.

In the designs adopted, synthetic stone was used in the same manner as is natural building stone. No attempt was made to originate any new architectural style for this material, nor was one needed. The typical construction motive of today—the steel frame—is only masked—with a make-believe front, full of contradiction and pretense. Synthetic stone, reinforced, at least offers a constructive system, and its apparent form is an honest expression of its real form; whereas in natural stone there is often no organic relation between the real and apparent construction. It has the salient advantage of expressing honestly its true function as a structural member, together with the practical advantage of being fireproof. Its susceptibility to repetitive modeling offers to the designer the opportunity of adding fitting details to a design—details which are often prohibitive in cost when executed in natural stone and which, if lacking, rob the design of its potential interest and charm.

Comment on St. Louis Ordinance Creating Office of Quantity Surveyor.

To the Editors: I have been much interested in the efforts of the Engineers' Club of St. Louis to have an ordinance passed creating the office of "Quantity Surveyor," as noted in the March 3, 1915, issue of Engineering and Contracting. This seems to be a very important matter, one that will have a tendency to stabilitate the relation between costs and profits, lessening the risks of loss, and eliminating excessive profits. It will necessitate more care in the preparation of plans and specifications, and a greater sense of moral responsibility on the part of the engineer or architect. It may lead to an establishment of the apprentice system, and this will do more to eliminate the objectionable features of current experience than any licensing act that may be passed by any state legislature, on the lines that have been suggested in several places. It makes for the elimination of guessing, the rock which many a man has found responsible for his financial and business destruction.

The application of the ordinance as finally adopted will be a matter requiring very careful and conservative, although sometimes radical, judgment. The common law, and the custom of the country, may, and probably will, complicate the situation, but careful and continuous study of the various phases appearing in the many types of construction will surely bring about satisfactory results. Chapter IX of "Leaning's" Quantity Surveying, Third Edition, is worthy of the careful perusal of any one interested in the matter.

Very truly yours,
BENJAMIN THOMPSON,
Contracting Engineer.
224 American National Bank, Tampa, Fla.

ROADS AND STREETS

Methods and Cost of Constructing a Mountain Road System in Wise County, Virginia.

Contributed by Wm. F. Cocke, Assistant Engineer, Virginia State Highway Commission, Richmond, Va.; formerly County Engineer of Wise County.

Wise County, located in the extreme southwest section of Virginia, is bounded on the north by the main ridge of the Cumberland Mountains which form the Kentucky state line, and is traversed by the Black Mountains, Stone Mountain and Powells Mountain, all of these ridges having a general direction of east and west and rising to a mean elevation of about 1,000 ft. above the intervening valleys. The highest point crossed by a highway has an elevation of about 2,700 ft. above sea level. The principal streams are the Clinch, the Pound and the two forks of Powells River fed by a number of typical mountain streams with narrow valleys and a very rapid run off. The entire county lies in the coal measures, with the exception of the valley of the south fork of Powells River and a narrow belt adjacent to the Clinch River which are in a limestone formation. The general contour in both the freestone and limestone sections is very abrupt, some of the ridges reaching an inclination of 48° from horizontal. Figure 1 shows the location of the railroads traversing the county and the relative position of the principal towns.

Prior to 1910 no road improvement had been undertaken in Wise County except two pieces of macadam built under the State Highway Commission with state aid money. One of these sections of road lay between the towns of Norton and Wise, 3½ miles, and the other, between Big Stone Gap and Appalachia, 2 miles in length.

The county at that time was maintaining approximately 800 miles of dirt roads which had gradually developed from the old mountain trails. These dirt roads were too narrow for two vehicles to pass except at intervals where pass ways had been widened, and no provision had been made for drainage except an occasional water break or "thank you marm." Some of the grades were as steep as 21 per cent, light vehicles were little used and most of the travel was on horse back.

The area of the county is 413 square miles and the population in 1910 was 41,556. The assessed valuation of property in 1910 was $8,643,643.00, not including that located inside the incorporated towns. Of this amount, approximately 60 per cent was owned by various corporations, principally coal mining companies.

In the latter part of 1910 the county became so enthused over the two short pieces of state aid road, already constructed, that a campaign was started for a bond issue of 700,000, with which to construct 125 miles of improved highway. The several roads to be improved with this bond issue were decided upon at a large mass meeting and named in an order of count, authorizing the election, which was carried at the polls by an overwhelming majority.

The Virginia law provides that when a county bonds for road improvement, that the surveys, estimates and construction shall be supervised by an engineer appointed or approved by the State Highway Commissioner. There is no provision for making the surveys and estimates before the bond issue has been voted, so after construction begins, there frequently arises the situation of attempting to draw a straight line through three given points, viz.: the length of road, the character of construction and the cost.

Two locating parties were put in the field during the following winter and the surveys and estimates completed by the latter part of April, 1911. Twelve roads were provided for in the order of court, authorizing the bond issue, aggregating 125 6/10 miles. For convenience, these 12 roads were blocked into 11 sections and each section treated as a separate unit in letting contracts. Preliminary cross sections were taken over all of the adopted loca-

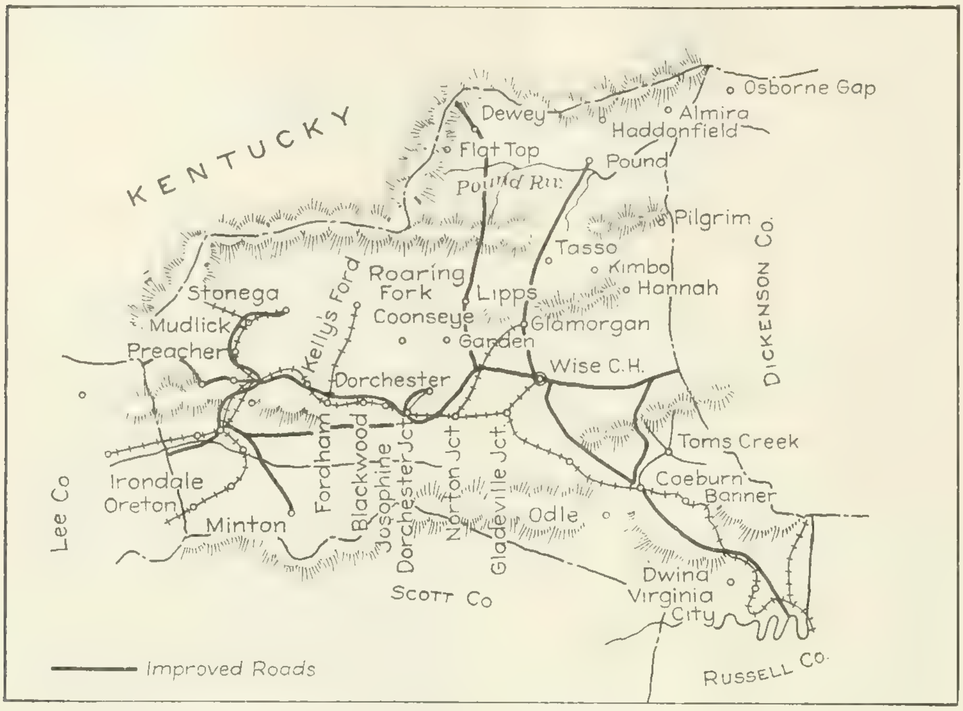

Fig. 1. Map of Wise County, Virginia, Showing the Location of the Roads Improved.

tions and the cross sections platted with ½:1 slopes and the areas calculated with the aid of a planimeter. It was anticipated that the excavation would run from 65 to 70 per cent solid rock and the ½:1 slope was selected as a fair average between earth taken out at a 1:1 slope and solid rock taken at a ¼:1 slope.

The cuts were figured for a 24 ft. base and the fills 20 ft. wide on top. Vitrified pipe was estimated on for all openings up to 2 ft., reinforced concrete slabs for openings from that size up to 20 ft. in span, and steel superstructure with wooden flooring for streams requiring a span greater than 20 ft.

Nineteen miles of proposed road traversed the limestone section of the county and the remaining 127 miles lay in the coal measures, or freestone section, where only a sandstone of varying hardness and no bonding quality was available. Where limestone could be obtained with a reasonable haul either from quarry or railroad point, the estimates were based on a limestone macadam 12 ft. in width and 6 ins. in dept after being compacted.

It will be noted from the map that about 35 miles of road lay in the northern end of the county, very remote from any railroad, and entirely in the sandstone section. For these roads, the estimates were based on a sandstone foundation 5 ins. in depth after rolling with a 3-in. limestone wearing surface.

The preliminary estimates, when completed, show the following quantities:

Unclassified excavation, cu. yds.	930,624
Vitrified clay pipe, 12 to 24-in., lin. ft.	25,947
Masonry (not including bridges over 20-ft. span), cu. yds.	3,650
Water bound macadam, sq. yds.	861,754
Masonry substructure (in bridges more than 20 ft. in span), cu. yds.	7,100
Steel superstructure (in bridges more than 20 ft. in span), tons	250

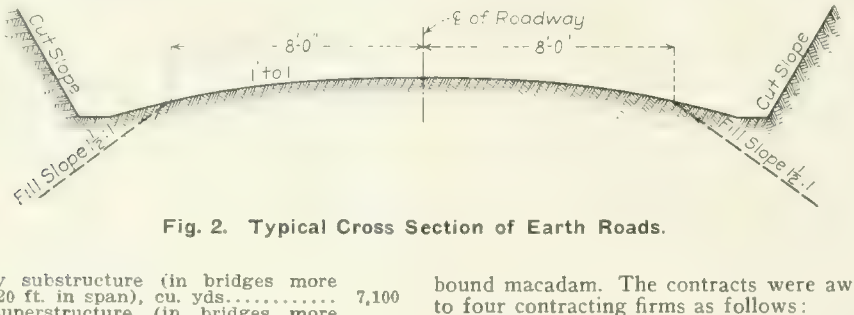

Fig. 2. Typical Cross Section of Earth Roads.

It was evident from this approximate estimate that $700,000 was insufficient to construct the total amount of road called for in the court order, but it was decided to advertise for bids and then determine what portion of the work could be let to contract. All of the work, with the exception of steel bridges, was accordingly advertised and bids opened on May 28th, 1911.

The bids received at that time ranged as follows:

Unclassified excavation, per cu. yd.	$0.47 to 0.88
Water bound macadam (1 mile wagon haul), per sq. yd.	.42 to .85
Cement rubble masonry, per cu. yd.	4.50 to 8.00
Concrete (1:2:4), per cu. yd.	10.00 to 12.00

The total cost of the 125 miles of road (exclusive of steel bridges), based on preliminary quantities at the lowest prices bid aggregated $1,334,500.00. A part of the work was let to contract at this time and the balance readvertised.

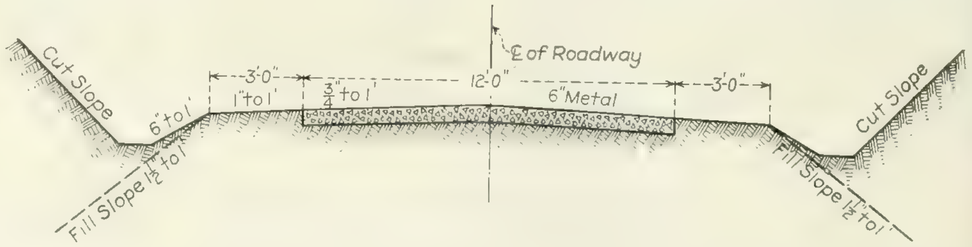

Fig. 3. Typical Cross Section of Macadam Roads.

All of the work, for which funds were available, was let to contract before the last of October, 1911, and consisted of, the grading on the entire 125 miles, together with all drainage structures and about 25 miles of water bound macadam. The contracts were awarded to four contracting firms as follows:

Name.	Miles.
T. Towles & Co., Princeton, W. Va.	65
Bunn & Co., Big Stone Gap, Va.	46
Clarke County Construction Co., Winchester, Ky.	8
W. B. Taylor & Co., Big Stone Gap, Va.	6

The 27 steel bridges were let to the Roanoke Bridge Co.

The average unit prices at which the work was awarded were as follows:

Item.	Bid price.
Unclassified excavation, cu. yd.	$0.53
Dry rubble masonry, cu. yd.	3.75
Cement rubble masonry, cu. yd.	5.75
Concrete (1:3:6), cu. yd.	9.75
Concrete (1:2:4), cu. yd.	12.00
Vitrified pipe culverts, lin. ft.:	
12-in.	.95
15-in.	1.15
18-in.	1.35
24-in.	2.00
Waterbound macadam (local stone), sq. yd.	.55
Waterbound macadam (stone by rail), sq. yd.	.85

The average stone haul from quarries and railroad points was 1¾ miles.

As fast as the work was let to contract, resident engineers were placed in charge, and each provided with a party similar to a residency party on railroad work. Eight residency parties was the largest number employed at any one time. The countv engineer had an office in the town of Norton and was provided with a clerk.

Only about 30 per cent of the roads as located remained on the right-of-way of the old roads and when it became necessary to secure the rights of way for the relocations, a considerable amount of opposition was aroused. This was not surprising, as all of the dwellings faced the old roads and the revisions in many cases cut through gardens and orchards. In a country as broken as this, there was generally only one desirable location, so many condemnations were necessary. As has been stated, this bond issue was voted by an overwhelming majority, but if a vote could have been taken about this time, it would probably have been defeated by ten to one.

The work of referencing the center line and setting slope stakes was very tedious, owing to the steepness of the ground, and 2,000 ft. per day was a fair average for one party. About 70 per cent of the grading was side hill cut, some of the slopes being as steep as 48°. It was found to be useless to stake out the fill side of the section where the slope of the ground exceeded 20°, as the material would gain such momentum as to run far past the slope stakes and lose itself along the mountain side.

From actual observation the following table of slopes was compiled giving the percentage of roadbed which must be thrown into the solid on side hill cutting:

Slope in degrees.	Per cent of solid cutting.
Level section to 5	50
5 to 10	55
10 to 15	61
15 to 20	70
20 to 25	83
25 to 30	100

Actual construction was begun about July, 1911, and by the latter part of the summer, practically 125 miles was under construction by the contractors' forces. The grading was pushed during the first six months to such an extent that at the end of that time it was more than 60 per cent complete. The heaviest months work was done in September, 1911, when 120,000 cu. yds. of excavation was allowed the contractors on their monthly estimates.

The best record for material handled with pick and shovel was made by two Italian forces who averaged 11 cu. yds. per man for each 10 hour day during two months. This material was approximately 70 per cent earth, 20 per cent loose rock and 10 per cent solid rock. The average per man over the entire work during the first six months was 5.3 cu. yds. per 10 hour day. So small a part of the excavation was handled with wheel scrapers that no careful record was kept of material moved in this manner.

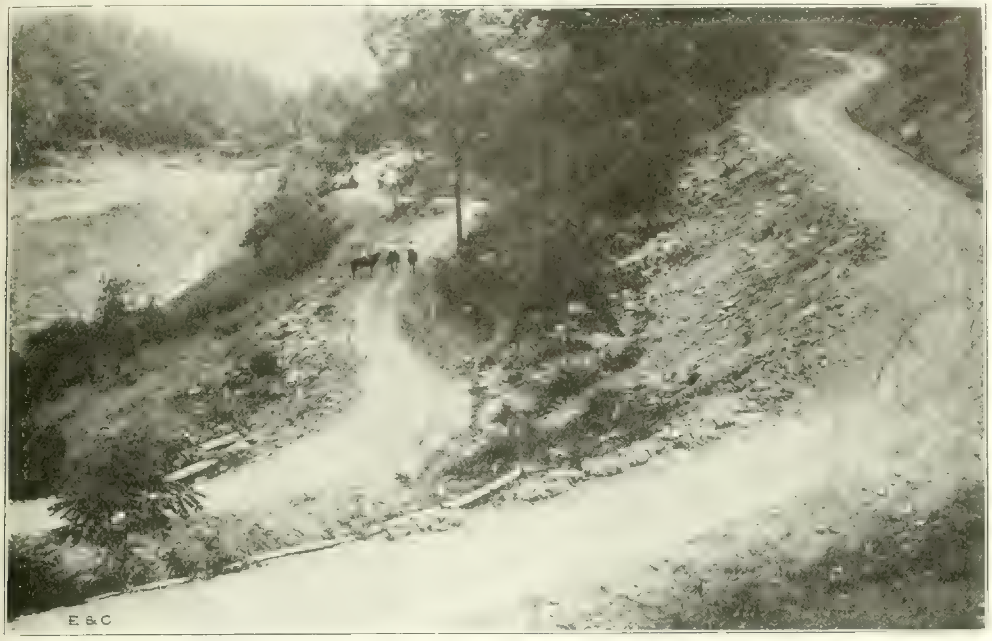

Fig. 4. Typical Mountain Road Grade Development.

Two steam shovels were operated, one being a 48-ton Marion and the other an 18-ton revolving Marion. The average daily output of the 48-ton Marion shovel was 800 cu. yds. The time spent in moving was included in making up this daily average. The material handled by this shovel ran approximately 50 per cent earth, 30 per cent loose rock and 20 per cent solid rock. The small revolving shovel was so poorly handled that it was impossible to estimate its daily average, as it was run only a part of the time and the hand forces were worked at intervals in the same cut.

The spring rains caused the slopes to break at many points and some of the slides assumed serious proportions, the largest containing approximately 6,000 cu. yds. These slides were removed by the contractors on "force account," that is, actual cost plus 10 per cent. It was not practical to measure these slides by cross sectioning, as in most cases, the ground was in motion far up the mountain side.

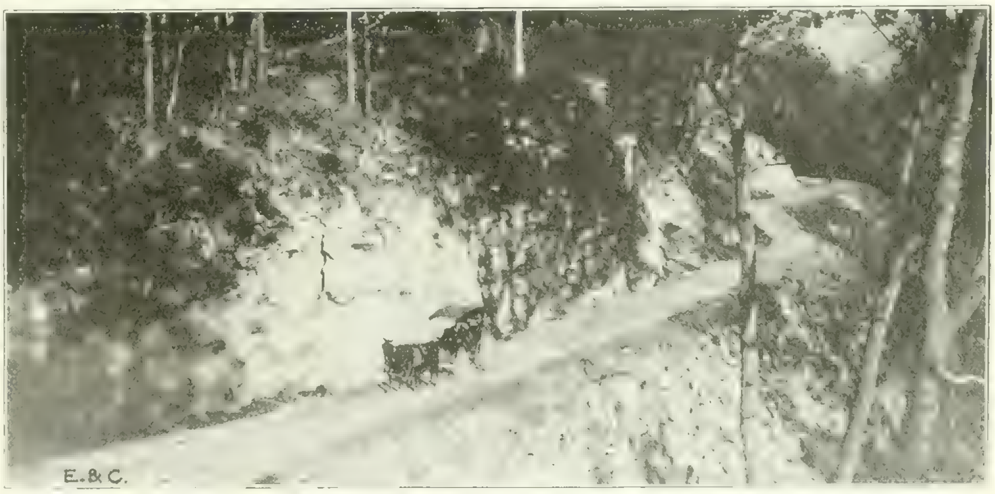

Fig. 6. A Road on Which Side Hill Excavation Averaged 27,000 Cu. Yds. Per Mile.

A rather unusual feature in connection with this highway work was two large channel changes, each of which eliminated two 70-ft. bridges at a saving in actual cost of construction and a great saving in cost of maintenance. The 27 steel bridges contracted for, consisted of one 90-ft. truss span with 100-ft. trestle approach, five 70-ft. truss spans, three 54-ft. truss spans, five 50-ft. truss spans, seven 40-ft. beam spans, one 36-ft. beam span and five 30-ft. beam spans. These bridges were built on the standard plans of the State Highway Commission and were designed to carry a moving load of 12 tons with a factor of safety of four. Wooden flooring was used and cement rubble substructure. These 27 bridges (superstructure and substructure complete) were contracted for at the lump sum of $23,350.

Funds derived from the bond issue fell short of the sum required to lay macadam on all of the roads. Therefore, about 100 miles were completed as earth road. These roads lay almost entirely in the sandstone section where the soil consisted chiefly of a yellow clay which absorbed water very readily. A number of miles of these earth roads have since been surfaced with crushed sandstone which has made something nearly approaching a sand-clay road. On a part of the roads on which no macadam was laid, a shale was obtained which made a very fair surface for light travel. Figure 2 shows the standard section of earth road.

About 25 miles of water bound macadam, of good limestone was laid. Figure 3 shows the standard macadam section. The work was remeasured for the final estimates as fast as it was completed. These final measurements showed some increase in yardage over the slope stake quantities, largely due to breakage in the slopes. The contractors were not allowed for breakage due to heavy shooting but where this breakage was unquestionably due to natural causes, full allowance was made. Some of the heaviest work ran 27,000 cu. yds. of excavation per mile. The final measurements showed an average of about 9,100 cu. yds. of excavation per mile.

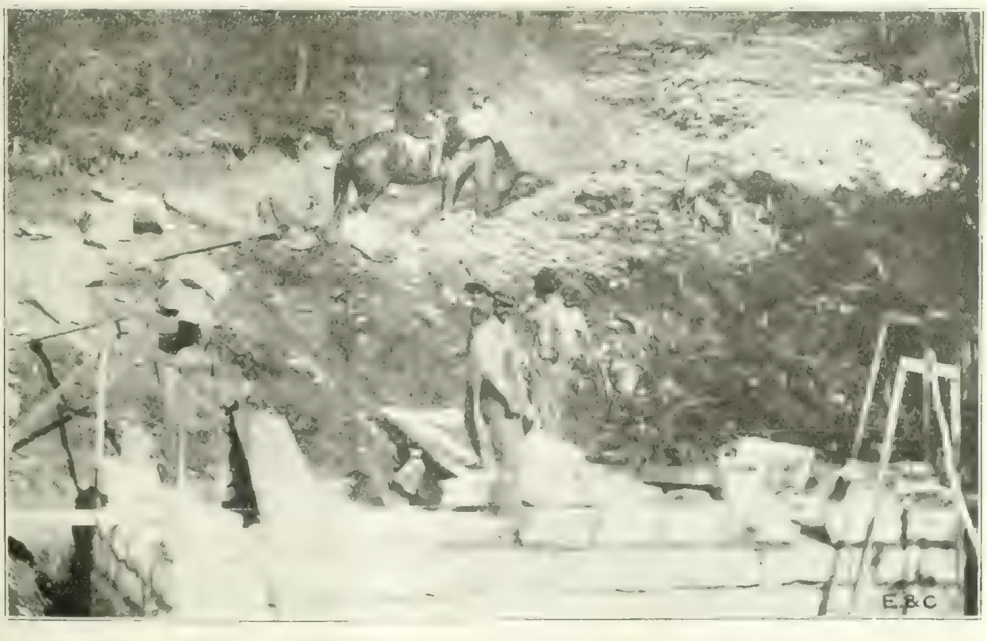

Fig. 5. Rubble Masonry Constructed with Local Labor.

The aim was to make five per cent the maximum grade, but in crossing principal mountain ridges, it was frequently necessary to go as high as 7 per cent, but in no case was this exceeded. Owing to the abrupt nature of the country, the radius of some of the curves was necessarily shorter than was desirable. Figure 1 shows a very difficult piece of location where a radius of 25 ft. was the best that could be obtained without exceeding the maximum grade.

The engineering expense on this work was about 5½ per cent of the total cost. All classes of work were simple in character and as economically done as was consistent with good engineering, and there was very little connected with it worthy of notice except its magnitude.

The writer was in charge of this work from April, 1911, to January, 1913, and was succeeded by Mr. B. S. Crawford who remained in charge until the completion about June, 1914. At the time this work was begun, it was the largest highway project undertaken by a southern county, and the best indication of the benefits derived from it is that another bond issue has since been voted to add to the system of roads originally laid out.

Method of Assessing the Cost of Street Improvements in Two Iowa Cities.

A method of assessing the cost of street improvements under the new Iowa assessment law was discussed by M. G. Hall, of Centerville, Ia., in a paper prepared for presentation before the Iowa Society of Engineers. A general method of equitable assessment for lots of all areas is developed in the discussion which is given here:

SPECIAL ASSESSMENT LAWS.

Previous to Jan. 1, 1914, the Iowa statutes required the special assessment for street improvements to be made against the abutting property in proportion to the special benefits conferred upon the property and not in excess of such benefits and not in excess of 25 percent of the actual value of the property.

Instances have occurred where the abutting property consisted of a narrow strip of ground, privately owned and lying along the street improved where the value of the tract was very small when taken by itself, but under the law it was abutting property and assessable only to the extent of 25 per cent of its actual value, resulting in a deficiency in the amount which could be raised by special assessment and which was therefore payable only out of some fund of the city, usually the so-called improvement fund authorized by statute.

There are many arguments to be made as to what constitute benefits and methods of apportionment, but I will not discuss these arguments further than to say that it is absurd to assume that only the property abutting on the improvement is benefited and especially is this true when the conditions are as mentioned above.

It has also been held unlawful in Iowa to assess benefits according to the front foot rule. There are cases where this rule, if applied, would result in an unfair apportionment of benefits especially when the improvement is made on both sides of a corner lot, and on acreage or unplatted tracts which under the law existing previous to Jan. 1, 1914, was not assessable over 150 ft. from the street improved. In the former case the property would stand an excessive assessment, and in the latter case the value of the assessable area would not be sufficient to carry the assessment within the 25 per cent limit, thus causing further deficiencies.

Although it was supposed to be unlawful to make assessments according to the front foot rule there remained little else on which to measure the benefits; and a large proportion of the assessments were made so near this rule that the difference could not be discovered.

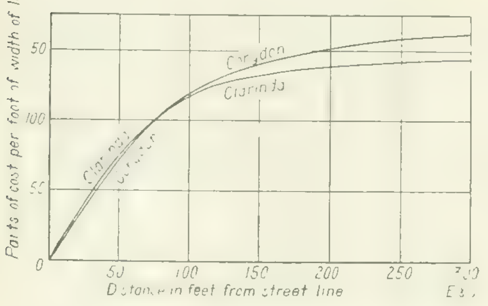

Fig. 1. Curve Used in Determining Amount to Assess.

On Jan. 1, 1914, a new law passed by the 35th General Assembly came into effect which, after reciting other provisions of the assessment laws makes the following statement: "and shall be limited to the amount to be assessed against private property, against all lots and parcels of land according to area so as to include one-half of the privately owned property between the street improved and the next street, whether such privately owned property abut upon said street or not; but in no case shall privately owned property situated more than 300 ft. from the street so improved be so assessed. In case of improvement upon an alley, such assessment shall be confined, according to area, to privately owned property within the block or blocks improved and if not platted into blocks for not more than 150 ft. from the improved alley."

This law has made a radical change in the manner of making assessments and I will endeavor to explain how this new method has been worked out in two Iowa cities during the past year.

NEW METHOD OF PROCEDURE.

It is the province of the engineer to prepare the plat and schedule of assessment for street improvements under the instructions of the city council. Here again comes in the question of apportioning the benefits over the assessable area as compared with the assessable frontage as heretofore.

The method adopted in the cases to be mentioned was to secure some statement from the council in the way of instructions as to what proportion of the cost should be apportioned to the lot abutting on the improvement taking a standard lot for the city in question as a basis; then for the lot next to the abutting lot, and so on for each successive lot until all the lots assessable within the limits fixed by law are covered.

If all lots were the same size and shape then our instructions would be complete and sufficient. But as is frequently the case lots are subdivided and unplatted property is subdivided into all sizes and shapes and it is necessary to devise some method of making an equitable distribution of the costs, so as to arrive at the proper proportion of the cost for each lot or tract regardless of shape, that will be equitable or as nearly so as possible.

The method herein explained is believed to be logical, convenient, easily explained, and one that can be worked out exactly without any assumptions other than that first made by the council. It has been found that there have been very few objections made by the owners of the assessed property, chiefly because it could be shown that the same method had been used for each case and the whole operation of arriving at the assessment could be checked by almost any property owner who looked into the method. It has been unnecessary to use the frontage of the lot as a primary basis for making the assessment.

METHOD OF PLATTING CURVES.

The curves shown in Fig. 1 are marked Corydon and Clarinda, being the names of two towns where this method has been used by the writer during the past year.

At Corydon the plan was to assume the assessment on the first 75 ft. abutting the improvement, measuring at right angles to the improvement, would bear an assessment of 100; the next 75 ft. 40 per cent of the first, or 40 parts; the third, 75 ft. 40 per cent of the second, or 16 parts; and the fourth 75 ft. 40 per cent of the third, or 6.4 parts, making the total assessment for the full limit of 300 ft. from the improvement 162.4 parts.

This curve was constructed by assuming as the horizontal ordinate the distance from the street in feet with zero at the street line; and the vertical ordinate the sum of values given above for the relative proportion of the cost of the improvement. These points of given value were then platted and an irregular curve drawn between the points as shown.

The Clarinda curve was drawn in much the same way except that the percentages used were less than for the Corydon curve. In this case taking the same points, namely: the first 75 ft. assumed at 100; the second 31.1 per cent of the first; the third 32.8 per cent of the second; and the fourth 25.4 per cent of the third, making a total of 143.9 points at 300 ft. from the street.

As the law says the area of the lot must be taken into consideration this curve as applied takes into account the length and width of the lot; the two dimensions of area.

COMPUTATION OF ASSESSMENTS.

To illustrate the method used a section of the area assessable for the improvement at Corydon is shown in Fig. 2. The manner in which a few of these assessments were determined is shown below:

Case A: Here the property extends 80 ft. back from the street and has a frontage on the street of 140 ft. Referring to the Corydon curve we read 104 on the curve for a lot 80 in depth, and multiply this by the frontage 140 ft. and we have 14,560 as the proportional parts of the assessment for A.

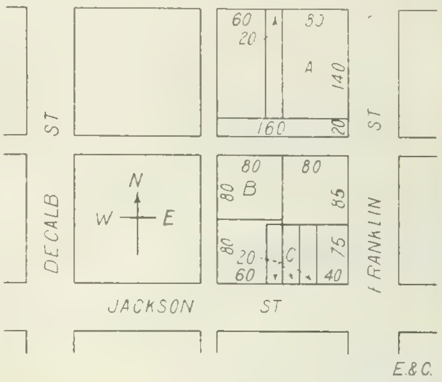

Fig. 2. Plan of a Block in the City of Corydon, Iowa.

Case B: Here the line of the lot nearest the improvement is 80 ft. from the street and the corresponding point on the curve is 104. The line of the lot farthest from the street is 160 ft. and on the curve is represented by 142; or the difference in ordinates being 38 multiplied by the width of the lot, 80 ft., gives the portion of the assessment for B, namely, 3,040 parts.

Case C: Here it is assumed that both streets are improved and C is assessable for both. The East line of C lot being 60 ft. from Franklin street the ordinate corresponding is 83. For 80 ft. the west line of the lot it is 104; or 21 points for the lot multiplied by 75 (the length of the lot in feet), making 1,575 points for the pavement on Franklin street. But it is also assessable on Jackson street for 100 points times 20 ft. (the width of the lot), making a total of 2,000 points, or a total for the whole improvement of 3,575 parts.

And so on for all of the properties assessable. When this is all figured in the manner described above it is evident that the sum of all these parts represents the total cost of the improvement or so much of it as is to be assessed. It is then a short and simple problem to find the value of each unit and apply it to each of the properties to be assessed, in proportion as they have been previously weighted as described above.

This method has been found to be very satisfactory and one which when worked out in tabular form as it should be, is very easily explained and defended as being definite, equitable, consistent and to the interests of all.

The only cause for complaint is the original assumption as to relative benefits to adjacent and abutting properties upon which the curve is based, and it must be said that it is an assumption in the beginning and liable to objections as to equity on the part of different individuals, but represents the opinion of the city council which the writer has found has almost without exception been arrived at after careful consideration by men whose judgment taken collectively is as good as that of any other body of men that might be selected for the purpose.

The Engineers' Club of Seattle has recently been incorporated under the laws of the State of Washington.

The Price in Illinois of Three Popular Types of Road.

(Staff Abstract.)

There is a distinction in meaning between cost and price. Cost may be defined as the sum required to produce an article complete ready for consideration by the consumer; price is the total sum given in exchange by the consumer for the complete ownership and use of the article. The price of a road is made up of, construction cost, interest cost, up-keep cost, and depreciation cost. So much uncertainty exists in estimating depreciation cost that it will for the present purpose not be considered.

In the light of the present road situation in Illinois it is interesting to consider, so far as available data will permit, the probable price to the tax-payers of the three popular types of road, namely, vitrified brick, Portland cement concrete and water-bound macadam. During the latter half of the year 1914, the Illinois Highway Commission entered into contract for the construction of 18 vitrified brick roads, aggregating 114,188 sq. yds., in 17.7 miles, and located in eleven counties. During the same time contracts were entered into also for the construction of 57 Portland cement concrete roads, aggregating 539,933 sq. yds., in 75 miles, and located in 37 counties. From having awarded these contracts it is practically assured that if such items as rough grading, bridges and culverts and the like, be excluded the brick pavement proper can be built at a construction price to the tax payers of $1.90 per square yard, and the concrete pavement proper at a corresponding price of $1.20 per square yard, where the haul does not exceed about two miles. For the brick road, the construction cost is $1.90 per square yard. Assuming the issuance of 20 year serial bonds, payable annually, and rating interest at 5 per cent, the interest cost on this $1.90 is $1.00. From the experience that various cities throughout Illinois have had with vitrified brick pavements it is reasonably well assured that the total up-keep cost on the pavement proper for the first 25 years would not exceed an average of 1 ct. per square yard per year. These three costs give a price to the tax-payers of $3.15 per square yard, for a 4-in. vitrified brick pavement for the first 25 years. As mentioned before, the depreciation cost with respect to so-called permanent highway improvement is such an excessive refinement in this day as not to warrant much consideration, providing the construction, interest and up-keep costs are duly considered.

For the concrete pavement, the construction cost is $1.20 per square yard. Computing interest as before, one gets an interest cost of 63 cts. per square yard. In the probable up-keep cost for the concrete pavement is where the greatest uncertainty lies. One would be presumptuous, indeed, to assume that under mixed traffic conditions concrete pavement would endure longer than 15 years without economically admitting of resurfacing. From present knowledge it would appear that the most practicable low first-cost resurfacing for a concrete pavement, unevenly worn, would be a bituminous concrete some 3 ins. in average thickness. Considering the necessarily high quality that this surface would need to be, it is quite likely that its application would incur an expense to the tax-payers of as much as 75 cts. per square yard. To meet this expense, if five year serial bonds, payable annually, are issued, and interest is computed as before, the interest cost is 11 cts. But in addition to this, the pavement would need what might be termed strict maintenance throughout the 25 years. From our present knowledge of this type of construction, we are not warranted in estimating that this strict maintenance cost would be less than 2 cts. per square yard per year, making 50 cts. for the 25 years. These four costs, namely, construction cost, $1.20; interest on same, 63 cts.; resurfacing cost with interest, 86 cts.; strict maintenance cost, 50 cts., total up to $3.19 as the probable price to the tax-payers for the concrete pavement proper for the first 25 years.

For the macadam pavement, one is warranted in saying that under conditions similar to the foregoing, its average construction cost would be about 75 cts. per square yard. On this 75 cts., the interest cost would amount to 39 cts. It is quite probable that where macadam as a type would appear on the face of the situation to prove a feasible proposition, its total up-keep cost per year for the first 25 years would not exceed 5 cts. per square yard, making a total up-keep cost of $1.25. These three costs, namely, construction cost, 75 cts.; interest cost, 39 cts.; and up-keep cost, $1.25, total up to $2.39 as the probable price to the tax-payers of a macadam road for the first 25 years. Summarizing we get the following prices per square yard to the tax-payers for the first 25 years: Brick, $3.15; concrete, $3.19; macadam, $2.39.

It becomes interesting to consider this matter a step further. For the macadam pavement, the sum of the construction and interest costs amount to $1.14. Deducting this amount from the total price to the tax-payers of a brick pavement, we have $2.01 as the amount that would need to be spent on the macadam pavement during the first 25 years, in order to make the total price to the tax-payers the same as that for brick. Without question, there are many counties in Illinois where the total up-keep cost on a macadam pavement for the first 25 years would considerably exceed $2.01 per square yard, and consequently, under these conditions the macadam pavement could not be considered the economical type. There are many other counties in Illinois, moreover, where the conditions are such that the total up-keep cost per square yard on the macadam pavement for the first 25 years could not reach $1, and under these conditions the tax-paying public will do well to look deeply into the real economics of the various types of construction before committing their expenditures to the so-called fool-proof types.

The original from which these data and comments have been abstracted is a paper by H. E. Bilger, Road Engineer, State Highway Department, Springfield, Ill.

DRAINAGE AND IRRIGATION

Method and Cost of Constructing Reinforced Concrete Drops, Canadian Pacific Ry., Irrigation Projects.

Contributed by Robert S. Stockton, Strathmore, Alberta, Canada.

The Western Section of the Irrigation Block now being developed by the Department of Natural Resources of the Canadian Pacific Railway Co., has a large system of canals and ditches, the aggregate length of which is about 1,600 miles. There are a very large number of structures on the various canals and ditches. Some of the timber structures were built as early as 1905 and have had eight years in the ground. Most of these structures, especially the highway bridges and division gates, are good for a number of years yet, but some of the drops, of which there are a large number, are beginning to develop signs of weakness, and as they must be replaced without stopping the flow of water during the irrigation season, May 1 to Oct. 1, the reconstruction must take place before or after the water season, or during that time by diverting the water around the structure by temporary works.

The policy of the company has been to replace the large timber structures as they approached the end of their life with permanent concrete structures of approved design. The program of betterments for 1913 included the replacement of the large timber holdup drop known as drop No. 2A in the Secondary "A" Canal, Langdon District, S. E. ¼ section 19-23-27. The new 10-ft. drop was designed to be built of reinforced concrete with a central pier and two openings that can be closed with stop plank 5 ft. 9 ins. long. The holdup feature of this drop is required to insure the delivery of water to "B" Distributary in Langdon district, which takes out 3 ft. above canal grade. The drop is designed to discharge 1,000 sec. ft. of water over the crest when the canal carries 8 ft. depth of water. Previous experience indicated the economy of diverting the water and building the drop during favorable weather, especially as rains and other conditions made it reasonably certain that a by-pass carrying 100 sec. ft. would satisfy the irrigation requirements. It was necessary, however, to carry 220 sec. ft. for a few days, which caused some additional bank erosion below the temporary drop. The construction crew was moved to the site July 17 to 19 and began the work of excavating the by-pass and building a diverting dam in the canal. The by-pass was completed July 29 and the work of tearing out the old timber drop commenced. The old structure was heavily built, having 2,200 lin. ft. of piling and 54,243 ft. B. M. of lumber incorporated in it. Certain timbers in the old drop proved to be pretty well decayed, particularly above the

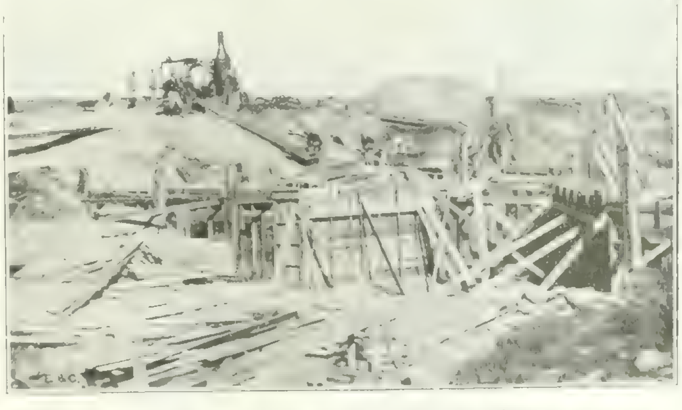

Fig. 1. Drop Under Construction.

water line. The piling behind the breast wall was rotted and constituted the weakest spot in the structure.

The excavation disclosed 4 ft. of soil underlaid by a compact boulder clay which proved to be quite impervious, and after the footings and lower concrete floor was in place, there was no pumping required.

The nearest gravel pit was about 15 miles distant and 42 cu. yds. of unscreened material was hauled and used. The pit contains good sand but poor gravel, and when the cost of screening was added and quality considered, it was thought best to ship the larger part of the sand and gravel to Bennett Siding, about two miles from the work. The gravel received from the Calgary Sand & Gravel Co., however, had some oversize that was picked out by hand. The steel shipped to Bennett Siding was mixed up with steel for Strathmore, which necessitated a team haul to straighten out.

A carload of lumber was delivered at Bennett Siding for building the forms, chute, and cement shed, and 1,421 F.B.M. was hauled from Dalroy Watermaster's Headquarters. The carpenters started building forms on August 6 and the cut-off walls were poured on Aug. 27. The last concrete was put in on Sept. 20.

The general mixture was intended to be 1 sack of cement to 2½ cu. ft. of sand and 5 cu. ft. of gravel. For thin walls and copings a mixture of 1-2½-4 was used, and for the lip of the drop 2-2½-5. Since 948 sacks of cement were used, the average was 4.74 sacks per cubic yard of concrete. The concrete was mixed wet enough to spade and was spaded so as to require little patching when the forms were removed. The concrete appears to be of excellent quality. The concrete was mixed with a No. 1 Smith Mixer with steam engine, boiler and side loader mounted on steel trucks.

All labor was paid at prevailing rates, stated at so much per day of 10 hours. Every rate is stated in full and so carried in the time books with board deduction of $5.50 per week. The cost of team feed is taken at 90 cts. per day per team and pro-rated to all work on which team time is charged.

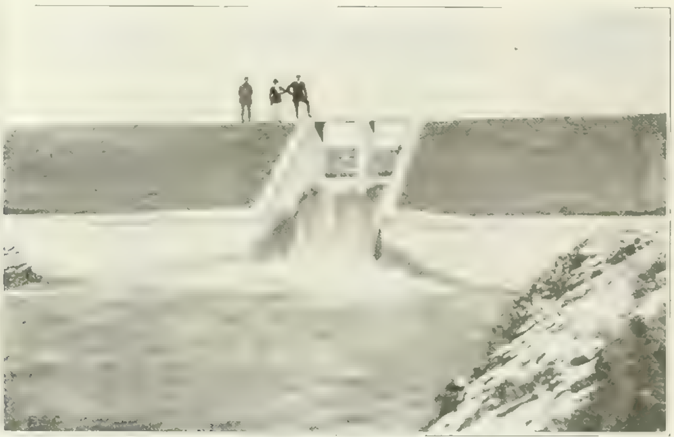

Fig. 2. Completed Drop.

The wages of foreman, barn boss, and for Sunday time of teamsters are pro-rated to all labor items. Two rates of wages were paid, as it has been necessary to make a raise at harvest time to hold the men; even at the increased rate, considerable trouble was experienced, as farmers were then paying about $2.50 per day and board. The wages paid were as follows: Laborers at $2.50 to $2.75 per day of 10 hours; teamsters at $2.10 to $2.35 per day of 10 hours, and including Sundays; carpenters at $3.50, $4 and $5 per day, and foreman at $120 per month. The foreman, Jack McMullen, ran the mixer when necessary. The work was directed by Mr. R. B. Stevens, watermaster, and Mr. G. H. Patrick, canal supt., who reports to the Superintendent of Operation and Maintenance for the Western Section. The plans were furnished by the chief engineer, who is in general charge of operation, maintenance and construction for all the irrigation projects being developed by the Canadian Pacific Ry. Co. The detailed cost records follow:

LABOR COST—DROP NO. 2A—LANGDON DISTRICT.

Feature.	Labor cost.	Unit cost.	Quantity and unit.		Remarks.
Moving camp...	$ 68.00	......			About 16 miles
Setting up camp.......	19.55	......			About 24 men
Camp expenses..........	7.00	.....			Dishes and repairs
Hauling supplies..........	159.30	......			Groceries, hay and oats
Excav. of by-pass....	210.00	$0.139	1,507	cu. yds.	Clay loam
Excav. of old drop.......	1,250.00	0.636	1,967	cu. yds.	Hand work around old structure
Removal of old drop......	126.80	2.338	54.243	M. ft. B. M.	Piling removed above grade
Building cement shed....	8.96	8.070	1.112	M. ft. B. M.	Temporary structure
Building chute in by-pass	34.00	33.660	1.010	M. ft. B. M.	Drops water back into canal
Hauling lumber	46.60	1.987	23.438	M. ft. B M.	Haul 2 miles
Hauling steel	4.10	0.031	129.96	cwt.	Haul 2 miles
Hauling cement	40.00	0.042	948.00	cwt.	Haul 2 miles
Hauling gravel	162.90	0.975	167	cu. yds.	Haul 2 miles
Hauling sand	72.00	1.060	68	cu. yds.	Haul 2 miles
Hauling sand and gravel	88.60	2.685	33	cu. yds.	Haul 15 miles
Hauling mixer and pump.	29.30	. ....			Haul 21 miles
Pumping water...........	13.10	......			
Building forms...........	591.00	0.100	5,929	sq. ft.	
Bending and placing steel and wire fabric.........	110.65	0.851	123.96	cwt.	
Mix. and placing concrete	336.10	1.680	200.00	cu. yds.	
Removal of forms...... .	51.25	0.009	5,929	sq. ft.	
Backfilling by-pass . . .	113.40	0.090	1,600	cu. yds.	
Backfilling drop	375.70	0.237	1,588	cu. yds.	
Removal of chute........	6.88	6.812	1,010	M. ft. B. M.	
Repairs to bank..........	106.88	0.822	130	cu. yds.	Erosion by water from by-pass
Riprap to bank...........	30.10	1.027	29.3	cu. yds.	Extending 25 feet below drop
Cleaning up, etc..........	13.72				
Total labor cost.	$4,105.89		......	....	Includes team feed.

MATERIAL COST—DROP 2A—LANGDON DISTRICT.

Feature.	Quantity.	Cost.	Freight.	Total cost.	Unit cost.	Remarks.
Reinforcing steel..	11,921 lbs.	$229.72	$60.55	$290.27	$0.024	600 ⅝" and 300 ½" bars
Wire fabric.......	1,075 s. f.	22.84	6.73	29.57	0.027	Clinton fabric.
Cement	237 bbls.	482.86	45.75	528.61	2.230	Canada Cement Company.
Gravel	167 yds.	183.70	61.30	245.00	1.467	Calgary Sand & Gravel Co.
Sand ...	68 yds.	74.80	25.10	99.90	1.469	Calgary Sand & Gravel Co.
Lumber	23,438 ft. B. M.	323.94	54.80	290.13	12.380	Less $88.61 salvage value.
Rope repairs, etc........		44.35	.....	44.35	...	
Total material cost ..		$1,362.21	$254.23	$1,527.83	.....	

Total labor cost, including team feed...		$4,105.89
Total material cost......................		1,527.83
Depreciation on concrete mixer, pump, wagons, harness, horses, etc.	$302.44	
Depreciation on camp equipment	42.45	
		344.89
Overhead expense of superintendence, engineering, office work, accounting, etc		938.00
		$6,916.61

SUMMARY OF FEATURE COSTS—DROP NO 2A—LANGDON DISTRICT, 1913.

	Cost.	Cost per yd of concrete.
Camp and supplies . .	$ 311.92	$ 1.560
Excavation and backfilling.	2,085.98	10.430
Preparatory work..........	219.04	1.095
Hauling materials	414.20	2.071
Building forms	591.00	2.955
Bending and placing steel..	110.65	0.554
Mixing and placing concrete	336.10	1.681
Removal of forms..........	51.25	0.257
Steel and wire fabric.......	319.84	1.595
Cement	528.61	2.643
Gravel and sand...........	341.90	1.725
Lumber	290.13	1.451
Riprap below drop..........	30.10	0.151
Depreciation	344.89	1.725
Overhead expense	938.00	4.690
	$6,916.61	$34.583
Camp and supplies and preparatory work ....$	530.96	$ 2.655
Excavation and backfilling.	2,085.98	10.430
Concrete work	2,986.68	14.932
Riprap below drop.........	30.10	0.151
Depreciation	344.89	1.725
Overhead expense	938.00	4.690
	$6,916.61	$34.583

Methods and Costs of Waterproofing Concrete Surfaces to Decrease Disintegration by Frost.

Mr. J. L. Lytel, project manager of the Strawberry Valley project, Utah, records in the "Reclamation Record" for April, 1915, an interesting experience in waterproofing of concrete surfaces. The storage works and tunnel of the Strawberry Valley project are located in the Wasatch Mountains at an elevation of 7,500 ft. There is a wide variation in temperatures in this vicinity and the climate is very severe during the winter months, the lowest temperature on record being 50° below zero. The snow fall ranges from 10 to 24 ft. in depth.

The extreme cold, with alternate thawing and freezing of water in the pores of the exposed faces of the structures, was found to have a very destructive effect on these concrete structures and the waterproofing of the surfaces was decided upon as a preventive against their continued disintegration.

It was decided to treat the vertical surfaces with alum and soap solutions and the horizontal surfaces with paraffine. The alum solution was made by dissolving 2 ounces of alum in 1 gal. of hot water. The soap solution was composed of ¾ lb. of castile soap dissolved in 1 gal. of hot water. The paraffine was boiled to drive off water as the presence of water rendered it hard to apply. Ordinary commercial products were used.

The surface to be treated with paraffine was first thoroughly dried and cleaned of loose concrete, dirt, and other foreign substances. The paraffine was then heated and applied with a paint brush, and was forced into the pores by the heat of a blow torch on the surface. Only one coat of paraffine was applied as the concrete would not absorb more.

The surface to be treated with soap and alum was prepared as above stated. The alum solution was applied at a temperature of 100° F. with a moderately stiff brush and was then worked in with a stiff horse brush. While the surface was still moist from this treatment the hot soap solution was applied in the same manner as the alum solution. One treatment by each solution in the manner described above constituted a coat. If other coats were considered necessary, they were applied in like manner after the preceding coat had been allowed to stand 24 hours or more.

Twelve structures were given this treatment, the surface area covered being approximately 28,000 sq. ft. Four thousand square feet were treated with paraffine, at the rate of 1 lb. for 11¾ sq. ft., and the remainder with soap and alum. It required 1 gal. of alum solution and a ½ gal. of soap solution to cover 50 sq. ft. with two coats. Two coats of alum and soap were applied at an average total cost of 76 cts. per 100 sq. ft., and the cost varied from 41 cts. minimum to $1.28 maximum. The cost of one coat of paraffine varied from $1.70 to $3.78 per 100 sq. ft., and averaged $2.11. This cost covers everything except general expense. The two men who did this work received $75 and $80 per month. Brushes cost $6.06, Castile soap 12½ cts. per pound, alum 18 cts. per pound, and crude paraffine $4.80 per hundred weight.

The results obtained by this waterproofing are considered very satisfactory. The structures that were repaired and treated have gone through two severe winters and no further disintegration of the concrete on any part has occurred.

Some Structural Details and Construction Costs of a Small Irrigation System.

(Staff Abstract.)

The plan for irrigating a 40-acre orchard lying above canal level is illustrated by Fig. 1. The highest point of the quarter section was 230 ft. above the canal, but some 62 per cent of the acreage was below the 115-ft. contour. To reduce pumping the plan was to build two reservoirs, one at 230 ft. and one at 115 ft. From the pump at the ditch a wood stave 6-in. pipe runs to the lower reservoir and from this 6-in. line near the lower reservoir a 4-in line extends to the high reservoir.

The heavy contour in the sketch map (Contour 120) shows the division between the high and low levels. Considering the low level first, a pipe was run from the reservoir following the contour 20 ft. below hydraulic grade; this was to obtain 20 ft. head in the line and insure a pressure that would keep the staves saturated. From this line to the land below and from the 6-in. pump line below the reservoir to the same land pipe lines were run as indicated. To water the strip of land above the pipe line from the reservoir spurs were extended up hill to elevations equal to hydraulic gradient at their hydrant ends. For the land above contour 120 ft., the distribution pipe system is sufficiently explained by the sketch.

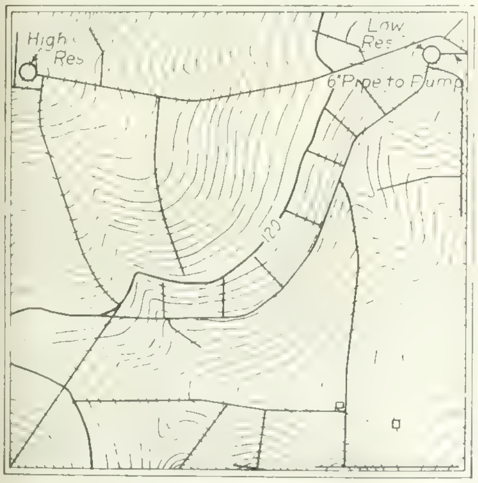

Fig. 1. Plan of Quarter Section Showing Pipe Line System.

All pipe except the spurs is wood stave. This was laid 2 ft. deep in trench and all but some 5 per cent is under 20 ft. head. The spurs are ¾-in. galvanized iron. To bring water to the surface from the pipe lines hydrants constructed, as shown by Fig. 2, are employed. A detail to be noted is the foundation brick to take the thrust from operating the valve and thus prevent loosening the nipple into the wood stave pipe. These hydrants cost $1.49 each and have proved entirely satisfactory.

The pumping plant consisted of a Gould triplex pump delivering 4 gals. per stroke and operated by a 10-hp. Westinghouse motor. It delivers 200 gals. per minute to the low reservoir, or half this amount, to the 230 ft. level.

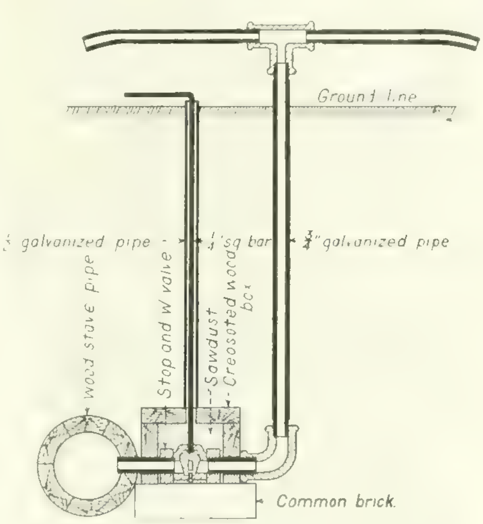

Fig. 2. Hydrant for Wood Stave Pipe Line.

The reservoirs are 10 ft. deep, 20 ft. in diameter at bottom and, with side slopes of 1 on 1½, are 50 ft. in diameter at the top. The walls and floor are 1-5½ gravel concrete, with a ½-in. plaster coat of 1-2½ sand mortar. The concrete aggregate cost $3 per cubic yard on the site, owing to a 1 mile uphill haul. Four expansion joints in each reservoir extended from circular bottom to the top of the sloping walls. A foundation 6 ins. thick and 12 ins. wide was placed directly under each expansion joint and was covered with building paper. (See Fig. 3.) The walls were laid within 2 ins. of each other. The building paper prevented a bond between the concrete walls and the supporting concrete. The 2 in. space was filled with a high boiling paving pitch.

The general costs of the works described were:

Wood stave pipe and hauling	$1,342.11
Hydrants delivered on the ground	494.77
Pumping plant and joint pipe line	946.25
Surveying	3.00
Shut-off wrenches	20.50
Equipment and supplies	56.70
Digging ditches and refilling	472.59
Laying pipe	97.50
Setting hydrants	96.89
Cement	239.00
Sand and gravel	175.65
Excavating reservoirs	107.80
Placing concrete	205.51
Paving pitch	18.92
Supervision	168.51
Total	$4,445.83
Per acre	111.15

These costs and the preceding description have been taken from a paper before the Pacific Northwest Society of Engineers by O. M. P. Goss, the engineer of the works.

Costs of Keeping Down Vegetation on Irrigation Canal Banks by Grazing.

(Staff Abstract.)

A considerable item of expense in irrigation canal maintenance is the cutting of Johnson grass and other vegetation which springs up on the banks. On the Salt River Project of the U. S. Reclamation Service, beginning in 1913, experiments have been conducted in sheep grazing as an aid to ordinary cutting for keeping down the bank vegetation. There follows a comparative statement showing decrease in cost of maintaining canals and laterals before and after introduction of sheep:

	Main canals.	Laterals.	Header ditches.	Total cost.
Clearing:				
Before	$1,356.88	$3,275.14	$2,226.53	$6,858.55
After	908.05	1,174.69	659.70	2,742.44
Repairing breaks:				
Before	166.43	211.64	121.87	499.94
After	50.48	......	94.00	144.48
Gopher poisoning:				
Before	39.42	......	96.93	136.35
After	......	......	10.00	10.00
Total:				
Before	$1,562.73	$3,486.78	$2,445.33	$7,494.84
After	958.53	1,174.69	763.70	2,896.92
Decrease, 1914 over 1912	$604.20	$2,312.09	$1,681.63	$4,597.92
Mileage	8	22	10	[illegible]
Average decrease per mile (after introduction of sheep)	$75.525	$105.095	$168.16	$114.95

Note.—Cost of repairing breaks and gopher poisoning are included because this expense has been greatly reduced by the grazing of sheep. The cost of cleaning in 1912 is based on a unit cost per mile.

These data are from a report in "Reclamation Record," April, 1915, by A. J. Halton, Assistant Engineer.

Suggested Design of Proportional Division Box for Irrigation Water.

(Staff Abstract.)

A division box is a structure introduced into an irrigation canal to divide the water between two small laterals or between one user and others below him on a lateral. A proportional division box is intended to divide the water in any proportional manner determined by the conditions. For example assume the property rights to water carried in a canal to be divided into 50 shares and that one user owns 20 shares, another owns 14 shares, another 8 shares and two others 4 shares each. The first division box then is designed to divert 20/50 or ⅖ of the water to the first owner; the second is designed to divert 14/30 or 7/15 of the water to the second owner, and so on. The accompanying drawing shows a proportional division box of improved form designed by F. C. Scoby, irrigation engineer, Office of Experiment Stations, U. S. Department of Agriculture.

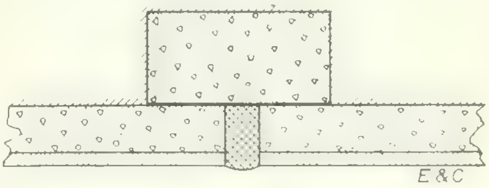

Fig. 3. Expansion Joint in Reservoir Lining.

The box illustrated is designed to deliver water to 11 shares of stock out of a total of 36 shares. Assuming the division wall to be 2-in. lumber, then the total width of opening is 70 ins. On this basis the position of the division wall is found by the following proportion: $x : 70 = 11 : 36$, when x is the desired width of the opening leading to the delivery box, expressed in inches: Therefore $x = (70 \times 11) \div 36 = 770 \div 36 = 21.39$ ins. or 21⅜ ins., and on the plans as shown the width of opening for the smaller channel would be 21⅜ ins.; then comes the 2-in. division board and then the remainder of the 6-ft. width of main box, or 48⅝ ins.

Assuming that the width of the ditch remains about the same and that the next consumer has 8 of the 36 shares of stock, after passing the first box the water represents 36 shares less 11 shares, or 25 shares, and the width of the opening leading to the delivery box becomes $\frac{x}{70} = \frac{8}{25}$ [illegible]

All of the posts supporting the division wall are set in the larger channel since any influence due to these posts will affect the larger channel less in proportion than the smaller one. These posts go through the floor but are not set into the sill as are the outside posts. The check or weir board goes completely across both channels and the lower board of the division wall is cut to set down over the check board. For a large division box on this plan, or where the soil of the channel below the box is eroded easily, a lower cut-off wall and a wing on the side opposite to the delivery box should be added to the structure.

The siding and floor of this structure are 2-in. stuff. In southern California, where densely fibered redwood is obtainable, 1-in. stuff would suffice. The thickness of the boards may be altered to suit the local lumber.

The only piece of hardwood in the structure is the cutwater, which should be of oak or it will not last long. It should be screwed into the ends of the division wall boards and tightly screwed to the cap and to the sill. This construction saves the use of any side posts above the weir board, which posts would alter the proportionate division of water. Thin strips of sheet iron may be fastened to each side of the division wall with stove bolts to strengthen it. The up-stream side of the cutwater is beveled to a knife edge, from the floor to the cap.

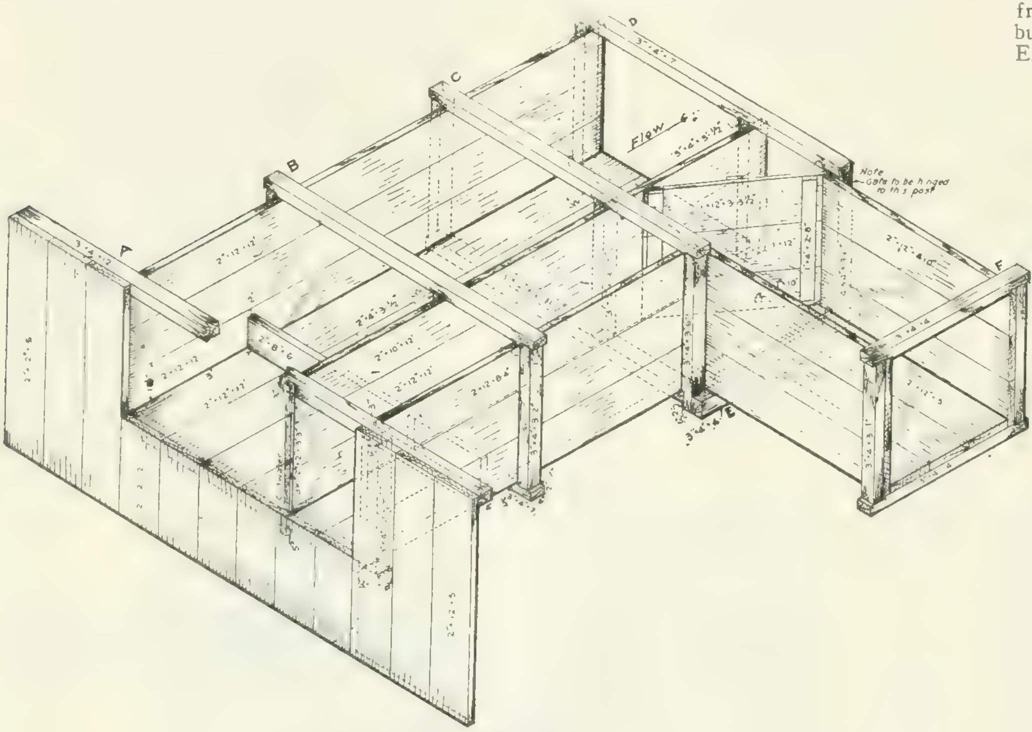

Fig. 1. Improved Design for Proportional Division Box.

The weir board is placed 3 ft. down the channel of the box in order to suppress the contraction and make the flow over the board approximately proportional to the length between walls. This box is designed to be used where there is not sufficient fall to the land to make a clean drop in the ditch at the division box, but this board will reduce the influence of the water below the board so that the flow is divided as nearly proportional as the expense will justify. Greater refinements of division mean greater cost to the device in length of channel, baffle boards, etc. The weir board need not be made sharp for this kind of a box, as the discharge over the square edge is quite proportional to the length of the crest. Even though partially submerged, the two discharges will hold the true proportion quite closely.

When it is desired that no water be turned to the delivery box, then the gate is closed on its hinges and the water passes through the box and back into the channel below the box, keeping both sides of the division wall clear of silt. The crack under the gate, left so that the gate may swing freely, is closed by a stop board nailed across the channel by the delivery box, as shown. The box contains about 650 ft. b. m. of lumber.

Increase in Operating Costs Due to Pumping, Minidoka Irrigation Project.

(Staff Abstract.)

The largest irrigation pumping scheme yet undertaken is that of the U. S. Reclamation Service, known as the South Side Unit of the Minidoka Project. It includes about 48,000 acres of land along the Snake River in the vicinity of Burley and Marshfield, Idaho. Water is raised by large pumping stations up three 30-ft. steps. At each level some water is taken out for the lands that can be covered. The power required is the same as though all the water were lifted to an average height of 66 to 69 ft.

Electricity is supplied from a power plant utilizing a 45-ft. fall in the Snake River at Minidoka Dam. Power is transmitted about eleven miles from the power house to the pumping stations over 33,000-volt transmission lines. Power house and transmission lines are operated as part of the project and energy is supplied at cost. A part of the output of the power plant is used for some small pumping stations across the river on the North Side Unit and part supplies the electricity needed by the towns and farms within reach. In winter a large amount of power not then needed for irrigation is used in the towns for heating the stores and houses. The sale of this power helps to reduce the charges against the pumping load.

The South Side Pumping Unit has been operated since 1909, long enough to permit of an interesting record. However, only a small portion of each plant was in use in 1909 and the main installation was not completed until early in 1912.

In a paper before the Idaho Society of Engineers Mr. Barry Dibble, electrical engineer, U. S. Reclamation Service, says: To get at the amount by which the running costs of this project are increased because pumping is necessary we combine all the items chargeable against it. Using 1914 as an example we have:

Item.	Operation and maintenance.	Depreciation.	Total.
Power house.....	$10,570.00	$10,169.00	$20,739.00
Transmission lines	1,103.00	2,372.00	3,475.00
Pumping stations	14,239.00	17,993.00	32,232.00
Totals	$25,912.00	$30,534.00	$56,446.00

Cost per foot acre foot	.00254	.00300	.00554
Cost per acre foot	.176	.207	.383
Cost per acre in project (48,000).	.54	.636	1.176
Cost per acre irrigated (35788) ...	.725	.854	1.579

As has been noted above only items here included in the first column are charged to the Minidoka settlers. It may be in this case that the increase in the outside sale of power in the winter time will help to keep down the increase in charges which would otherwise occur when the time comes that depreciation has to be reckoned with.

Included in the North Side Unit of the Minidoka Project are a number of small pumping stations of various types. These have not been operated long enough to make the cost data of much present value. In general it is to be expected that the cost of pumping will be greater per foot acre foot with the smaller plants.

A Silt Basin Constructed of Sewer Pipe.

A convenient silt basin for tile drainage systems is illustrated by Fig. 1, reproduced from "Land Drainage in Maryland," a recent bulletin issued by the Maryland Agricultural Experiment Station. The basin is made from a 2-ft. section of 18-in. sewer pipe, placed below the tile, with bricks or stone laid in cement mortar on the bell and high enough to take in all the tile lines entering the basin. Enough lengths of 24-in. sewer pipe are then placed on the masonry to carry the opening to the surface. A little care in fitting the brick work around the tile will save any chipping of the sewer pipe either for entrance holes or for the lengths of pipe extending to the surface. No sewer pipe smaller than the sizes given above should be used as experience has proved that pipe smaller than 24-in. for the top piece makes the basin troublesome to clean. The earth should be well tamped around the sewer pipe forming the basin.

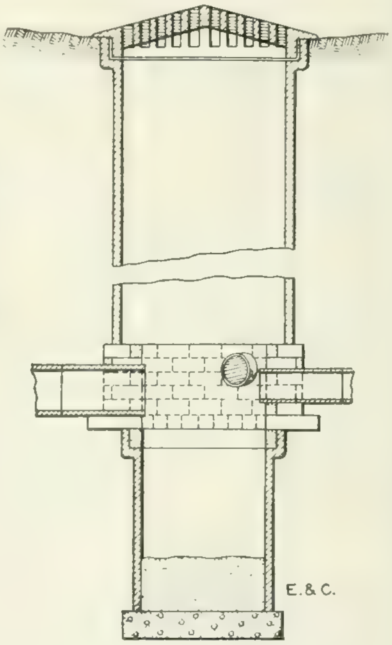

Fig. 1. Silt Basin for Tile Drains.

Special sections of pipe with holes in them can be bought but they are rather expensive. If a basin made entirely of sewer pipe is desired, the holes for the tile can be chipped with a cold chisel. The chance of breakage will be lessened if the pipe is stood on end and filled with sand before the holes are cut. The joints of the sewer pipe should be cemented, as well as the connections where the tile enter, in order that no water shall enter except through the grating or through the tile. This will prevent dirt from washing in through the sides of the basin and loosening it.

Engineering and Contracting

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An editorial suggesting the appointing of a joint committee, by interested societies, to formulate a set of standard specifications to govern the manufacture, testing and strength of alloys used in water works construction. E. & C., April 14, 1915; 1 col.

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Gives some data on the preliminary investigation made to determine the desirability of using synthetic stone (concrete-stone) for the Catskill Aqueduct buildings. Also gives the results of some tests of typical synthetic stone specimens, and describes some of the work already completed. E. & C., April 14, 1915; 3½ cols.

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FOREIGN TRADE NOTES

The following foreign trade apportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409, U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank Bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should eb made to the file numbers.

Lumber.—Firm in Spain wishes to communicate with American exporters of lumber. No. 16349. [For address see first paragraph.]

Machinery, Railway Supplies.—A general wholesale and commission firm in India desires to enter into commercial relations with American firms or business people who are in a position to act as its American purchasing agent for such commodities as light railway materials, locomotives, etc., band and circular saws, wood-working machinery, oil engines, iron bars, sugar machinery, etc. No. 16356. [For address see first paragraph.]

Building Materials.—Committee in charge of erection of $75,000 church building in Canada desires to receive catalogues, quotations, etc., for structural steel, glass, heating and ventilating apparatus, lighting fixtures. No. 16307. [For address see first paragraph.]

Tubes and Fittings.—Firm in Italy desires to obtain an agency from American manufacturers of iron tubes and fittings, ranging in size from ¼ in. to 4 ins. No. 16332. [For address see first paragraph.]

Valves.—Firm in Italy desires to obtain an agency from American manufacturers of brass valves. Weights and measures should be given in the metric system. Prices should be stated in francs. Correspondence may be conducted in English. No. 16335. [For address see first paragraph.]

Machinery.—An engineering company in Russia wishes to correspond with American manufacturers of woodworking machinery and machinery for flour mills. Catalogues, price lists, etc., should be forwarded at once. Prices and weights, etc., should be stated in Russian equivalents, and quotations should be made c. i. f. Russian ports. Correspondence should be conducted in the Russian, German, or French language. No. 16339. [For address see first paragraph.]

Machinery.—Firm in Italy wishes to correspond with American manufacturers and exporters of machinery and supplies for working metal and wood. Correspondence should be conducted in the Italian or rFench language. No. 16342. [For address see first paragraph.]

Machinery.—Russian firm wishes to get in communication with American manufacturers of textile machinery. Prices, weights, etc., should be stated in Russian equivalents. Quotations should be made c. i. f. Russian ports. Correspondence may be in English. No. 16331. [For address see first paragraph.]

Iron and Steel Rods, Bars, etc.—A firm in Italy desires to correspond with American manufacturers of iron and steel rods, bars, etc. Correspondence may be conducted in English. Weights and measures must be stated in the metric system, and quotations should be given in francs. No. 16329. [For address see first paragraph.]

INDUSTRIAL NOTES

Announcement has been made of the resignation of J. P. Beck as Publicity Manager of the Universal Portland Cement Co. of Chicago. He will be succeeded by Robert F. Hall, who for several years has been connected with the sales department of the Universal Company. Mr. Beck has been with the company for eight years. No statement of his future plans has been made public.

The Willys-Overland Co., Toledo, O., automobile manufacturers, has awarded another contract to the MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York, for the foundations of the new assembling building and power house. About 1,000 Pedestal concrete piles will be driven. Mills, Rhines, Bellman & Nordoff, Architects, Toledo. The MacArthur Concrete Pile & Foundation Co. also has been awarded a contract for the foundation of the screening plant and water tower at the Lynn Gas & Electric Co. plant, Lynn, Mass.

W. B. Huey, one of the founders and until recently president of the American Blue Print Paper Co., and A. H. Huey, until recently sales manager for that concern, have formed a new company, under the name of The Huey Co., with offices and plant located at 59 East Adams St., Chicago. The latest and most approved equipment has been installed, for the production of high-grade blue prints, direct blue line prints, negative prints, black line prints, litho reproductions, hectograph copies, photostat reproductions. A complete line of sensitized papers and drawing materials of all kinds will be carried in stock.

NEW CATALOGUES

Asphalt Pavement.—Paper, 6x9 ins.; 8 pp. The Barber Asphalt Paving Co., Philadelphia, Pa.

"New Pavements for Old" is the title of this pamphlet on the resurfacing of old pavements with sheet asphalt and asphaltic concrete. Points out the best methods to be followed and mistakes to be avoided. Illustrated.

Loading Equipment.—Paper, 9x6 ins.; 20 pp. Lee Loader Co., 824 W. 36th St., Chicago.

Describes the various styles of Lee loaders and shows their operation by means of photographs of actual work. Gives tables of speed, capacities, time and costs, showing the saving in labor, time and money gained on various team or motor truck hauls by the use of these loading devices.

Tractor.—Paper, 11x14 ins.; 4 pp. Knox Motors Co., Springfield, Mass.

Describes, illustrates and gives specifications for the new Knox Tractor, model 35. The special features of this model are the hydraulic brakes, differential lock and separate spring construction; also shows the Bull Dog Double Dump Trailer to be used in connection with the tractor.

Compressors.—Paper, 6x9 ins.; 36 pp. Chicago Pneumatic Tool Co., Fisher Bldg., Chicago.

Bulletin No. 34-M., describing class "O" Chicago pneumatic steam and power driven compressors, gives very complete, general description of the type and shows numerous photographs of styles and parts, with tables of dimensions, etc.

Air Meters.—Paper, 6x9 ins.; 4 pp. New Jersey Meter Co., Plainfield, N. J.

Air Meter Bulletin No. A-4. describing the New Jersey compressed air meters, and especially the Tool-om-eter, used with small pneumatic tools, chipping and riveting hammers, plug, hammer and air feed drills, wood boring and metal drilling machines, etc. Illustrated.

Concrete Roads.—Paper, 6x9 ins.; 36 pp. The Atlas Portland Cement Co., 30 Broad St., New York City.

"A Text Book for Highway Engineers, Officials and Builders." Describes methods of construction followed by concrete road builders, giving quantity and cost data, typical sections, and showing views of actual work in progress and completed pavements. Also suggests proper method for asking for bids.

Dump Wagons.—Paper, 8x10½ ins.; 32 pp. Watson Wagon Co., Canastota, N. Y.

"On the Job" is the title of an attractive book of photographs taken in various parts of America and in several foreign countries, illustrating the many sizes of Watson dump wagons. The views cover a wide range of territory and application, and the brief explanatory notes give considerable data and information of undoubted interest to the users of dump wagons.

Wagon Loader.—Paper, 6x9 ins.; 4 pp. Hudson Machinery Co., 15 Park Row, New York.

The Hudson Duplex wagon loader, designed to give increased capacity with reduced power consumption and weight, is described and illustrated. The chief feature is the duplex bucket elevator, in which the two lines of buckets are spaced alternately or staggered.

Metal Forms.—Paper, 9x6 ins.; 16 pp. Hotchkiss Lock Metal Form Co., Binghamton, N. Y.

Describes Hotchkiss Gang Blocks and the Hotchkiss system of concrete construction by means of steel forms. Shows the method of making building blocks, the forms used for cistern, cesspool and well construction and silo forms. Gives table of costs, proportions of mix, etc.

Air Lift Pumping.—Paper, 6x9 ins.; 32 pp. Sullivan Machinery Co., 122 S. Michigan Ave., Chicago.

Bulletin No. 17-A, a brief treatise on air-lift pumping in general, and a detailed description of Sullivan air-lift pumps and well heads. Well illustrated and contains tables for reference relative to pipe weights and diameters) inserted joint casing, decimal parts of an air inch, pipe capacities, etc.

Electric Appliances.—Paper, 8x10½ ins.; 5 bulletins. Fort Wayne Electric Works, Fort Wayne, Ind.

Bulletin No. 45,201—6 pp. Type A. Transformers of Large Capacities.

Bulletin No. 46,100—12 pp., Type M. Demand Indicators.

Bulletin No. 46,101—12 pp., Type P. Demand Indicators or Printometers.

Bulletin No. 48,100—20 pp., commutating pole direct current crane and hoist motor, CO—1,800 line, enclosed, reversible, series wound, intermittent service.

Bulletin Index, giving a subjective index to the active bulletins published by the company.

All except the last mentioned are well illustrated and considerable data with diagrams, etc., are given in each.

CATALOGUE REVIEWS

Metal Lath Hand-Book.—Cloth, 6x9¼ ins.; 128 pp. Associated Metal Lath Manufacturers, 812 Wick Bldg., Youngstown, O.

This hand-book on metal lath and its uses contains in concise form much valuable material for the contractor and architect. Illustrations and descriptions of the various kinds of metal lath, records of tests and experiments and extensive data relative to each kind give evidence of the value of metal lath construction.

The fire tests made in Cleveland by V. D. Allen, inspector of buildings, and the more recent experiments conducted at the Columbia University testing station by Prof. J. S. MacGregor are described in full with photographs and diagrams. Pages 45 to 104 inclusive are descriptive of the various kinds of construction in which metal lath may be used to advantage. The subjects covered include: Vertical openings, beltways, elevator inclosures, beam and girder protection, column protection, suspended ceilings, partitions, corner strips, interior plaster, lime mortar, gypsum plaster, acoustics, stucco, fire stops, furring, wood protection and mill construction. Standard sections, photographs of construction and considerable data elucidate the text. The last 23 pages are devoted to cuts, data and description of the several kinds of metal lath manufactured by the various members of the association. These include expanded metal lath, ribbed lath, corrugated lath, integral lath, sheet lath and wire lath. The price of this hand-book is $1.

CURRENT NEWS

The Doings of the Week.

No developments affecting adversely business and finances cropped up during the past week. It was a week of quiet and gradual improvement. Reports from national bank examiners made public by the Treasury Department on April 8 indicated that business conditions throughout the country were showing marked improvement. Of the 90 examiners in the United States 80 reported a permanent improvement in their districts. There was much activity in the securities market during the past week and as a result stock values advanced sharply, some of the leading issues rising as much as 10 points in one or two days. The Government crop report on winter wheat was very favorable. Export business continued heavy, and railroad returns were better. Copper production last week was at about 85 per cent capacity as compared with 80 per cent capacity the previous week. Steel mills were working at about 75 per cent capacity. The municipal elections on April 6 resulted in the authorizing of many bond issues for construction work. In Chicago alone, seven issues aggregating $3,972,000 were authorized. In the construction field there has been some slowing up of activity as indicated by the amount of work reaching the calls for bids stage during the past week. This refers particularly to municipal undertakings. Many cities have not as yet begun on their construction programs for the present season. A large amount of work in this field is planned for this season, and the indications are that the next few weeks will see important developments. Paving work, highway construction and bridge building predominate in the call for bids items of this week. The U. S. corps of engineers has completed its allotment of the $30,000,000 river and harbor appropriation and as a result much work in this line will be advertised at once. The route for the Government railway in Alaska has been selected and construction will be started shortly. The work will be done by contract and will be in charge of the present Alaska Engineering Commission. In the iron and steel trade large export orders were a feature of the week. Nearly 200,000 tons of export orders, not including war munitions, have been placed since April 1. *The Iron Age* reports that the pig iron output on April 1 was 26,000,000 tons, an increase of 44 per cent since Jan. 1. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending April 7 were as follows:

Finished Iron and Steel.	Apr. 7	Mar. 31.
Per lb. to large buyers	Cts	Cts
Bess. rails, heavy, at mill.....	1.25	1.25
Iron bars, Philadelphia ..	[illegible]	[illegible]
Iron bars, Pittsburgh..........	1.20	1.10
Iron bars, Chicago.....	1.15	1.12½
Steel bars, Pittsburgh.	1.20	[illegible]
Steel bars, New York. .	1.319	1.319
Tank plates, Pittsburgh......	1.15	1.10
Tank plates, New York. .	1.269	[illegible]
Beams, etc., Pittsburgh......	1.20	1.15
Beams, etc., New York	1.269	1.269
Skelp, grooved steel, P'gh	1.12½	1.12½
Skelp, sheared steel, P'gh	1.17½	[illegible]
Steel hoops, Pittsburgh......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers		
Sheets, blk. ga., No. 28, P'gh	1.80	1.80
Galv. sheets, No. 28, P'gh	[illegible]	[illegible]
Wire nails, Pittsburgh	1.60	[illegible]
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh.......	1.40	1.40
Barb wire, galv., P'gh	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 to 1.20 cts.

Railways.—The chief development of the week in the railway construction field was the announcement Saturday of the selection of the route for the Federal railway in Alaska and the statement that work would be commenced at once and would be done by contract. The Norfolk & Western Ry.'s contracts, noted in our last issue, involve 3,000,000 cu. yds. of grading. The estimated cost of the low-grade line is $2,200,000. The contracts for the first section of the Chesapeake & Ohio Northern Ry. (the new C. & O. line in Ohio) were to be awarded on Monday. There are rumors that several important undertakings by larger railroads are to be placed under contract soon. Nothing definite, however, can be ascertained at this time.

Roads and Streets.—A large amount of work in the highway and municipal pavings fields is now being advertised for bids. California is taking proposals on six contracts for concrete paved roads, the aggregate mileage being about 35, and Connecticut is calling for bids on several state road jobs. Los Angeles, Cal., awarded a $151,822 asphalt paving contract; Whatcom County, Washington, let a five-mile road job at $68,800; Harrison County, Texas, awarded a $41,915 contract for 20 miles of gravel road; the contract for the Iowa post road was awarded to Donald Jeffrey, Delmar Junction, Ia., the estimated cost of the improvement being about $140,000; Louis Lawson, Norfolk, Va., was low bidder on the $150,000 paving work for Cumberland, Md.; Charleston, W. Va., awarded contracts for paving 15 streets; Elliott & Vance, Parsons, Kan., were awarded the contract for 35,000 cu. yds. of vertical fibre brick pavement for Cushing, Okla.

Bridges.—The principal bridge contract advertised the past week appears to be the Alum Creek structure for Franklin County, Ohio. This will be a reinforced concrete bridge about 1,166 ft. long and 27 ft. wide. Philadelphia, Pa., will ask bids shortly on bridge work to cost about $1,000,000. Ordinances for these improvements have been passed by the council.

Drainage and Irrigation.—One interesting feature of the week was the call for bids on a private irrigation development. This work calls for the construction of a large dam in New Mexico for the Costilla Estates Development Co. This is one of the first contracts to be advertised for some time by a private project. The U. S. Reclamation Service is calling for bids on three or four contracts. The largest drainage job of the week appears to be the work for the Bayou County Drainage District of Darrow, La. This undertaking requires about 1,000,000 cu. yds. of excavation. Thompson & Moseley, Greensboro, N. C., were awarded a $90,000 contract for work for Wayne County Drainage District No. 2 of Goldsboro, N. C.; the Cowlitz Bridge Co., Portland, Ore., received the $60,000 contract for dikes for Diking District No. 2, South Bend, Wash.

Waterworks.—A number of water works jobs are being advertised by smaller cities. No particularly large undertakings in this line seems to have reached the call for bids stage. The low bids on the fire service pumping station for Toledo, O., total about $170,000. Frederic W. Burnham, 30 E. 42nd St., New York City, was awarded the contract, at $149,420, for six superstructures at Kensico.

The Alaska Railway.

Good news from Washington: The route for the government railway in Alaska has been selected and construction will be started at once. The work will be done by contract under the direction of the present Alaska Engineering Commission, W. C. Edes, the chairman, being in immediate charge. The first section will be constructed in large part by stationmen, who will make direct contracts with the commission for building distinct units of the road. For the heavier work, larger contracts, in all probability, will be let. The Susitna route, extending from Seward to Fairbanks, has been adopted. The total length will be 471 miles. This includes the existing Alaska Northern R. R., 71 miles in length, which has been purchased by the Government, and will form part of the system. In addition a 38-mile branch line will be constructed to the Matanuska coal fields. The total cost of the 509 miles of line is estimated at $26,800,000. President Wilson has shown good judgment in deciding to undertake the construction by contract and in placing the work in charge of so experienced a railroad builder as the present chairman of the Alaska Engineering Commission.

Government Contract Work.

Quite a bit of coin of realm will be put in circulation shortly by the Government via contractors. The better part of $2,000,000 will be expended this year by the Alaska Engineering Commission on the Federal railway in Alaska. The allotment of the lump appropriation of $30,000,000 in the last river and harbor bill has been completed by the U. S. corps of engineers, and funds were made available for improvements from Maine to California. The sundry civil expense bill passed by Congress last March carries appropriations of $15,530,000 to be expended by the U. S. Reclamation Service for construction, operation and maintenance of the various irrigation projects. Liberal provision is made in the bill for the building of post offices and for construction undertakings of other governmental departments. Uncle Sam is doing something this year to reduce the number of idle contractors.

Construction in New England.

The development of new sources of water supply or the extension and improvement of existing systems by cities of New England will furnish many construction opportunities in the next few years. Many municipalities in Massachusetts, Rhode Island and Connecticut already have taken steps to improve their waterworks. Springfield and Pittsfield, Mass., have completed extensive projects. Hartford, Conn., has about finished developing a new supply. Providence, R. I., the largest city in New England, with the exception of Boston, contemplates expending $8,000,000 or $9,000,000 for an increased supply. Other cities have engineering work underway for improvements involving the expenditure of hundreds of thousands of dollars. Millions will be spent by New England cities in the next five years for the building of dams, reservoirs, pipe lines and filtration plants. There is something doing in the construction line in the extreme northeast section of this country.

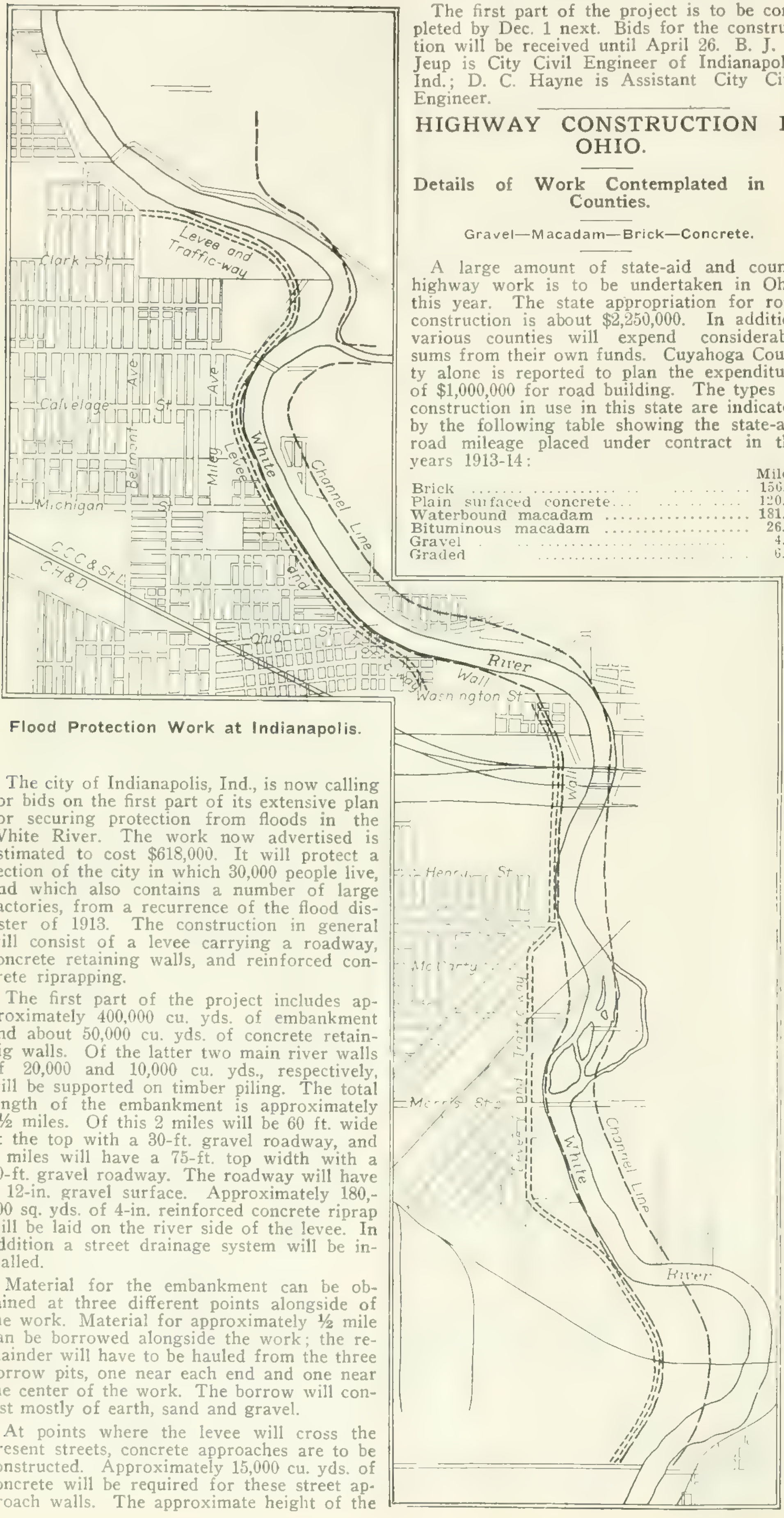
F. Hopkinson Smith.

A remarkable man died last week. Few men have achieved success in so many branches of activity as F. Hopkinson Smith. Engineer, contractor, author, artist and lecturer, in all these professions he held high rank. The sea walls at Tompkinsville, Staten Island, at Governors Island in New York harbor, the Race Rock lighthouse near New London, Conn., and the substructure of the Statue of Liberty in New York harbor are monuments to his ability as a contractor. As an author he ranked high. Many people considered him one of the greatest of American novelists of the present day. His reputation as an artist was second only to his standing as a writer.

WHITE RIVER FLOOD PROTECTION PROJECT.

Bids Asked By Indianapolis on First Section.

Estimated Cost $618,000; 400,000 Cu. Yds. Embankment; 50,000 Cu. Yds. Concrete.



Flood Protection Work at Indianapolis.

The city of Indianapolis, Ind., is now calling for bids on the first part of its extensive plan for securing protection from floods in the White River. The work now advertised is estimated to cost $618,000. It will protect a section of the city in which 30,000 people live, and which also contains a number of large factories, from a recurrence of the flood disaster of 1913. The construction in general will consist of a levee carrying a roadway, concrete retaining walls, and reinforced concrete riprapping.

The first part of the project includes approximately 400,000 cu. yds. of embankment and about 50,000 cu. yds. of concrete retainnig walls. Of the latter two main river walls of 20,000 and 10,000 cu. yds., respectively, will be supported on timber piling. The total length of the embankment is approximately 4½ miles. Of this 2 miles will be 60 ft. wide at the top with a 30-ft. gravel roadway, and 2 miles will have a 75-ft. top width with a 40-ft. gravel roadway. The roadway will have a 12-in. gravel surface. Approximately 180,000 sq. yds. of 4-in. reinforced concrete riprap will be laid on the river side of the levee. In addition a street drainage system will be installed.

Material for the embankment can be obtained at three different points alongside of the work. Material for approximately ½ mile can be borrowed alongside the work; the remainder will have to be hauled from the three borrow pits, one near each end and one near the center of the work. The borrow will consist mostly of earth, sand and gravel.

At points where the levee will cross the present streets, concrete approaches are to be constructed. Approximately 15,000 cu. yds. of concrete will be required for these street approach walls. The approximate height of the levee ranges between 8 and 14 ft. It will be 4 ft. above the high water line of 1913.

The work is on the west bank of the White River. Its location is shown on the accompanying map. Plans are now being prepared for protecting the east bank and for the widening and deepening of the channel, and the lengthening of all bridges across the river to conform to the new channel width.

The first part of the project is to be completed by Dec. 1 next. Bids for the construction will be received until April 26. B. J. T. Jeup is City Civil Engineer of Indianapolis, Ind.; D. C. Hayne is Assistant City Civil Engineer.

HIGHWAY CONSTRUCTION IN OHIO.

Details of Work Contemplated in 37 Counties.

Gravel—Macadam—Brick—Concrete.

A large amount of state-aid and county highway work is to be undertaken in Ohio this year. The state appropriation for road construction is about $2,250,000. In addition various counties will expend considerable sums from their own funds. Cuyahoga County alone is reported to plan the expenditure of $1,000,000 for road building. The types of construction in use in this state are indicated by the following table showing the state-aid road mileage placed under contract in the years 1913-14:

	Miles.
Brick	156.49
Plain surfaced concrete	120.54
Waterbound macadam	181.46
Bituminous macadam	26.17
Gravel	4.38
Graded	6.05

Table I gives a summary of the road construction proposed or under contract in 37 counties. Further details of this work follow:

Ashtabula County has issued bonds for highway construction. It contemplates building during 1915, 4 miles of gravel road, 14 miles of concrete and 18 miles of brick pavement. The concrete pavement is already under contract. Contracts will be let April 17 for 8½ miles of the brick roads. The balance of the brick pavement will be constructed by the State Highway Department. The date of letting for this has not been announced. Ray N. Case, Jefferson, O., is County Surveyor.

Belmont County will have 29.4 miles of brick road. Of this 24.4 miles are under contract. The work is in charge of the State Highway Department. D. C. Kennon, St. Clairsville, O., is County Surveyor.

Butler County has 5 miles of brick highway under contract. It will not undertake the construction of any other paved roads this summer. Fred M. Hammerle, Hamilton, O., is County Surveyor.

Champaign County will have 1.4 miles of macadam and 2 miles of concrete highway constructed this season. All road work in this county this summer is state highway. Contracts for part of the improvement were to be let on April 5. The remainder will be awarded on May 3. R. F. Darnell, Urbana, O., is County Surveyor.

	Type of Road			
County.	Gravel, miles.	Mac., miles.	Brick, miles.	Concrete, miles.
Ashtabula	4	..	18	14
Belmont	..	..	29.4	.
Butler	..	..	5	.
Champaign	..	1.4	..	2
Clark	..	8	..	
Darke	6	..	..	.
Delaware	..	27	?	?
Erie	..	6	..	12
Fairfield	..	3[1]	3.52	.
Fayette	..	..	4	
Franklin	..	40	..	..
Geauga	..	..	..	3.5
Hancock	..	70	..	..
Hardin	..	9	1	½
Harrison	..	5	..	..
Highland	..	12	..	..
Holmes	..	0.5	1.6	0.5
Huron	..	20	..	20
Jackson	..	2	..	..
Knox	..	4	3	..
Lake	..	2[3]	7	9.7
Logan	8	5½	..	..
Lorain	..	2[1]	..	1
Lucas	..	15[1]	..	
Monroe	..	..	4.5	1
Montgomery	.	?	5⅓	..
Muskingum	?	?	?	.
Paulding	.	75	..	
Pickaway	.	2½	..	
Pike	..	6	..	.
Portage	..	10[3]	5	10
Putnam	..	65	..	..
Seneca	2½	12	..	0.12
Shelby	..	4.78[1]	..	..
Summit	..	..	7	
Tuscarawas	..	..	6	.
Wood	..	30	..	..

[1]Bituminous. [2]Tar bound. [3]Also 5 miles bituminous work.

Clark County construction program provides for 8 miles of macadam. This will be state highway work. Bids on 2.87 miles of this were opened at Columbus on April 3. About 2.5 miles of state highway in this county were let last fall and will be completed this summer. S. Van Bird, Springfield, O., is County Surveyor.

Darke County will construct 6 miles of gravel or stone road, the funds for this being raised by special tax. Contracts will be let about May 1. H. C. Miller, Coshocton, O., is County Surveyor.

Delaware County proposes to construct 27 miles of macadam this season. The first letting was held on March 10; other lettings will take place about April 27. There probably will also be some brick and concrete state highway constructed in the county this year. F. C. Higley, Delaware, O., is County Surveyor.

Erie County has $225,000 available for construction purposes. It will build 6 miles of macadam and 12 miles of concrete. The work will be done by contracts, which will be let as soon as plans are completed. L. A. Schultz, Sandusky, O., is County Surveyor.

Fairfield County has about $60,000 available for road purposes. Of this sum $40,000 is for pikes, $6,000 for county roads and $14,000 state aid. Contract has been awarded for 2.4 miles of 18-ft. brick road costing about $46,000, and this will be built this summer. About 1.12 miles additional brick road is proposed. Three miles of 16 ft. bituminous road also are proposed. The work will be done by contract, and the letting probably will be held late in the summer. J. R. Schopp, Lancaster, O., is County Surveyor.

Fayette County will have 4 miles of brick road constructed this year. The contract for this has been let. Tom J. Grove, Washington, O., is County Surveyor.

Franklin County's present plans contemplate construction of 40 miles of macadam this season. Bids on this were opened March 31 and April 2. An additional amount of macadam probably will come up in a few months. John Peake, Columbus, O., is County Surveyor.

Geauga County has approximately $20,000 available for construction purposes. About 3.5 miles of concrete will be built with state aid. The work will be done by contract. E. A. Fiedler, Chardon, O., is County Surveyor.

Hancock County has $300,000 available for road purposes. It contemplates constructing 70 miles of macadam. Lettings on this were held on March 15 and April 2. Other lettings will be held at later dates. A. R. Taylor, Findlay, O., is County Surveyor.

Hardin County has 6½ miles of macadam under contract and 2½ miles yet to be let. In addition 1 mile of brick state road and ½ mile of concrete state road are under contract. L. R. Anspach, Kenton, O., is County Surveyor.

Harrison County proposes to construct about 5 miles of macadam during 1915. Some of this may be of the bituminous type. The work will be done by contract. J. A. Gordon, Cadiz, O., is County Surveyor.

Highland County will have 12 miles of waterbound macadam constructed during the present year. The work will be done by contract, the lettings to be held by the State Highway Department. B. O. Pratt, Hillsboro, O., is County Surveyor.

Holmes County has $30,000 available for road construction purposes. Contracts have been let for ½ mile of macadam and ½ mile of concrete. In addition 1.6 miles of brick road will be built. Contracts will be let in July or August. W. L. Reidenbach, Millersburg, O., is County Surveyor.

Huron County proposes to construct in 1915 about 20 miles of macadam and 20 miles of concrete road. Most of the above is now under contract. Additional contracts will be let at various times. L. C. Herrick, Norwalk, Ohio, is County Surveyor.

Jackson County will have 2 miles of macadam constructed this season. This will be state highway work and probably will be built by force account. The county has no funds available for construction purposes, and will do only a small amount of turnpike repairing. A. E. Campbell, Jackson, Ohio, is County Surveyor.

Knox County has 4 miles of macadam under contract. This will be built by state aid. Contract also has been awarded for 1 mile of brick paved road; 2 miles additional will be let in the near future. Arthur C. Wolfe, Mt. Vernon, Ohio, is County Surveyor.

Lake County's construction program for 1915 includes 2 miles of tar-bound macadam by state maintenance and repair department, 7 miles of 18 ft. wide brick paved road, of which 4¾ miles is state aid and 2¼ miles county, and 9.7 miles of 16-ft. concrete road to be built by county. Bids on 4¾ miles of brick highway were opened on April 2. Bids on 2 miles of macadam are to be opened two or three weeks later. The balance of the work will be let about the middle of May. H. P Cummings, Painesville, Ohio, is County Surveyor.

Lorain County will construct 1 mile of concrete road and 2 miles of bituminous road. The work will be done by contract. There probably will be other road work coming up later. F. P. Crosse, Elyria, Ohio, is County Surveyor.

Logan County will construct 8 miles of gravel road and 5½ miles of macadam. Of the latter, 2 miles were let on March 29. Other contracts will be let later. E. H. Bushong, Bellefontaine, Ohio, is County Surveyor.

Lucas County has $200,000 available for road construction purposes. It will build about 15 miles of bituminous road. The work will be done by contracts to be let at various times. A. J. Hatch, Toledo, O., is County Surveyor.

Muskingum County in all probability will construct 10 miles of improved roadway this coming summer. The type will not be determined upon for at least 60 days. R. H. Strait, Zanesville, O., is County Engineer.

Monroe County has $28,000 available for road construction purposes. It contemplates constructing 4 miles of earth road and 4½ miles of brick paved road this year. The work will be done by contracts, some of which already has been awarded. Others will be let later. Chas. W. Christman, Woodsfield, Ohio, is County Surveyor.

Montgomery County contemplates constructing in 1915 3 miles of macadam and 5⅓ miles of brick paved roads. The work will be done by contract. Contract for 1½ miles of the brick road was let on April 2. Victor C. Smith, Dayton, Ohio, is County Surveyor.

Paulding County has $225,000 available for highway construction purposes. It will build 75 miles of macadam. Of this amount 45 miles have been let and the remaining 30 miles will be awarded in July. F. J. Stinchcomb, Paulding, Ohio, is County Surveyor.

Pickaway County has $30,000 available for road purposes. About 3½ miles of waterbound macadam will be constructed. The work will be done by contract. J. H. Sweetman, Circleville, Ohio, is County Surveyor.

Pike County will construct 3 miles of earth road and 6 miles of macadam. The work will be done by contract. About 2 miles will be let about May. Harold McCormick, Waverly, Ohio, is County Surveyor.

Portage County has $96,000 available for road construction purposes. Of this sum $16,000 is from the state and $80,000 from the county. The construction program for 1915 includes 10 miles of macadam, 5 miles of brick, 10 miles of concrete and 5 miles of bituminous roads. One-half the improvements will be carried out by force account and the other half by contract. Lettings will be held in the near future. J. L. Walter, Ravenna, Ohio, is County Surveyor.

Putnam County will construct 65 miles of macadam. It has $300,000 available for road purposes. About 61 miles of the macadam are under contract, and the remaining 4 miles will be let on April 15. J. S. Cartwright, Ottawa, Ohio, is County Surveyor.

Seneca County will construct 2½ miles of gravel road, 12 miles of macadam and about ⅛ mile of concrete. About half the work is already under contract. The remainder also will be done by contract. C. J. Peters, Tiffin, Ohio, is County Surveyor.

Shelby County has about $60,000 available from state funds for road construction purposes. One section of about 1.78 miles of bituminous macadam will be constructed. In addition probably 3 miles more will be constructed on the Sidney and Wapakoneta road. Bids on the 1.78 miles of state aid work were opened April 2 at Columbus. C. A. Maurer, Sidney, Ohio, is County Surveyor.

Summit County has $200,000 available for road purposes. Seven miles of brick road with concrete base will be constructed. Four miles of this are now under construction and 3 miles will be let in April. Edward W. Paul, Akron, Ohio, is County Surveyor.

Tuscarawas County has $100,000 available for road purposes and 6 miles of brick paved road will be constructed. Letting was held April 2 by State Highway Department. Letting on 1 mile of road by county will take place at a later date. Edward Stingle, New Philadelphia, Ohio, is County Surveyor.

Wood County has $50,000 available for repairing macadam roads. Contracts for road materials will be let about May 1. About 30 miles of macadam are to be constructed or improved. Contract for this will be let about May 10. L. H. Wismar, Bowling Green, Ohio, is County Surveyor.

Bids Asked on Eight Small Bridges.

Bids are being asked on eight small bridge jobs in Carroll County, Illinois. The work will be done under the plans and specifications of the State Highway Commission, Springfield, Ill., and proposals will be opened at 1 p. m., April 17, at the Court House, Mt. Carroll, Ill. All of the improvements call for reinforced concrete structures, particulars of which are given in Table I:

TABLE I.

Name of bridge	Span, ft	Roadway, ft	Height over all, ft.	Concrete, cu. yds.	Reinforcing steel, lbs.	Estimated cost
Lost Creek	40	18	14	120.5	17,300	$1,813
Michaels	6*	24	10.5	30	2,470	415
Hileman	8	18	12	49.3	3,146	815
Dimon	35	18	14	102.2	14,630	1,645
Heath	40	16	14	101.9	14,555	1,734
Hawk	50	18	20	204	27,637	3,026
Richter	24	16	16	83.9	8,086	1,216
Lamb	16	20	10.5	70†	3,180	830

*6 ft. by 6 ft. box culvert. †17 cu. yds. reinforced concrete; 53 cu. yds. plain concrete.

The Lost Creek bridge is located in Shannon Township, the nearest railroad station being Shannon, 2 miles from the work. Concrete material must be shipped in. Low water flow is 6 ins.; high water 6 ft. Excavation will average 9 ft. through loam to about 4 ft. below stream bed. Present bridge consists of wooden stringers. The Michaels structure is a 6 ft. by 6 ft. reinforced concrete box culvert. It is located in Lima Township, the nearest railroad station being Shannon, 5 miles. Gravel pits are 2 miles distant, but quality is not known. Present bridge is wood box. Excavation will average 7 ft. through loam to about 3 ft. below stream bed. The Hileman bridge is located in Lima Township, 8 miles from Hazelhurst and Shannon, the nearest railroad stations. Gravel is obtainable at Hazelhurst. Low water flow, dry; high water, 6 ft. deep. Excavation will average 9 ft. through loam and clay to rock about 3 ft. below stream bed. The Dimon bridge is in Rock Creek Township, 4 miles from Lanark, the nearest railroad station. Concrete material must be shipped in. Low water is 1 ft.; high water, 7 ft. Excavation will average 11 ft. in loam to about 4 ft. below stream bed. The Heath bridge is in Rock Creek Township. The nearest railroad stations are Chadwick, 4½ miles, and Lanark, 5 miles. Concrete material must be shipped in. Present bridge is old stone arch, 9-ft. span, 24-ft. head walls. Low water flow, 1 ft.; high water, 7 ft. Excavation will average 10 ft. through loam to about 4 ft. below stream bed. The Hawk bridge is in Salem Township, the nearest railroad station being Mt. Carroll, 4 miles distant. Gravel pit is about ¼ mile distant. Present bridge is a wrought iron truss, 42-ft. span, on stone abutment. Contractor is to move it down stream for temporary crossing. Low water flow, 2 ft.; high water, 10 ft. Excavation will average 14 ft. through loam and gravel to about 4 ft. below stream bed. The Richter bridge is in Salem Township, the nearest railroad station being Mt. Carroll, 1½ miles. Concrete material must be shipped in. Present bridge is wooden stringer, 16-ft. span, on stone abutment. Low water flow is 6 ins.; high water is 6 ft. Excavation will average 10 ft. through loam to extend about 4 ft. below stream bed. The Lamb bridge is in Gush Township. For the work, prepaid shipments of tools and materials may be made to Fay on C., M. & St. P. Ry. Concrete materials must be shipped in. Present bridge is wooden stringer, 14-ft. span on piles. Low water flow, dry; high water, 4 ft. Excavation will average 6 ft. through loam and sand to about 4 ft. below stream bed. Piles probably will be found necessary.

HOW $30,000,000 IS TO BE SPENT.

Allotment of Appropriation to Government River and Harbor Projects.

The River and Harbor Bill authorized at the last session of Congress carries a lump sum appropriation of $30,000,000. The distribution of this amount to the various river and harbor projects was left to the corps of engineers. The allotments were announced last week. Of the $30,000,000 the Mississippi River Commission receives $4,000,000; $500,000 is set aside for examinations, surveys, etc., and $3,241,522 is reserved for contingencies. The remainder is distributed over the following improvements:

NEW ENGLAND.

St. Croix River, Maine	$ 50,000
Portland, Me	105,000
Boston, Mass.	135,760
New Bedford and Fairhaven, Mass.	56,010
Fall River, Mass.	12,000
Harbor of Refuge at Point Judith, R. I.	75,000
Pawcatuk River, Connecticut	1,000
Thames River, Connecticut	14,500
Connecticut River below Hartford	30,000
Branford, Conn.	4,000
Housatonic River, Connecticut	6,000

NEW YORK, NEW JERSEY, PENNSYLVANIA, DELAWARE AND MARYLAND.

Port Chester, N. Y.	$ 10,000
Mamaroneck, N. Y.	14,800
East Chester Creek, N. Y.	5,000
Bronx River, N. Y.	100,000
Harlem River, N. Y.	75,000
Plattsburg, N. Y.	2,000
Narrows of Lake Champlain, N. Y. and Vt.	3,000
Hudson River, N. Y. (In addition to this there has been aloted by separate act $622,220, thus making available for Hudson River a total of $1,500,000.)	877,780
Rondout, N. Y.	3,000
Tarrytown, N. Y.	3,000
Channel in Gowanus Bay, N. Y., and Bay Ridge and Red Hook Channels	125,000
Newton Creek, N. Y.	15,000
Great South Bay, N. Y.	5,000
Brown's Creek, N. Y.	2,000
Sheepshead Bay, N. Y.	5,000
Huntington, N Y.	5,000
Arthur Kill or Staten Island Sound, N. Y. and N. J.	400,000
Passaic River, N. J.	100,000
Shrewsbury River, N. J.	18,000
Raritan Bay, N. J.	20,000
Keyport Harbor, Matawan Creek, Raritan, South and Elizabeth Rivers, Shoal Harbor and Compton Creek and Cheesequake Creek, N. J.	24,000
Woodbridge Creek, N. J.	6,000
Delaware River, Pa. and N. J., above Lalor street, Trenton, N. J.	6,612
Delaware River, Pa. and N. J., from Philadelphia to the sea	1,000,000
Wilmington, Del.	45,000
Absecon Inlet, N. J.	60,000
Raccoon Creek, N. J.	5,000
Appoquinimink, Murderkill and Mispillion Rivers, Del.	15,000
Inland waterway between Rehoboth Bay and Delaware Bay, Del.	41,000
Broadkill River, Del.	5,000
Tuckerton Creek, N. J.	5,000
Inland waterway, Chincoteakue Bay, Va., to Delaware Bay, Del.	1,000
Elk and Little Elk Rivers, Md.	5,000
Harbors at Rockhall, Queenstown, Claiborne and Cambridge and Chester, Choptank, Warwick, Pocomoke, La Trappe, Wicomico and Manokin Rivers, and Tyaskin Creek, Md.	35,800
Corsica River, Md.	4,800
Potomac River at Washington, D. C.	20,000

VIRGINIA, NORTH CAROLINA AND SOUTH CAROLINA.

York, Mattaponi and Pamunkey Rivers, Va.	$ 5,000
Rappahannock River, Va.	8,000
James River, Va.	50,000
Pagan River, Va.	2,000
Appomattox River, Va.	5,000
Waterway from Norfolk, Va., to Sounds of North Carolina	5,000
Waterway from Norfolk, Va., to Beaufort Inlet, N. C.	400,000
Scuppernong River, N. C.	2,900
Shallow Bag Bay, N. C.	2,000
Fishing Creek, N. C.	1,000
Pamlico and Tar Rivers, N. C.	35,800
Bay River, N. C.	1,900
Contentnia Creek, N. C.	1,000
Smith's Creek, N. C.	1,400
Neuse and Trent Rivers, N. C.	22,500
Waterway from Pamlico Sound to Beaufort Inlet, N. C.	9,000
Beaufort, N. C.	17,000
Waterway connecting Core Sound and Beaufort Harbor, N. C.	2,000
Morehead City, N. C.	3,800
New River, N. C., including inland waterways between Beaufort Harbor and New River and between New River and Swansboro	37,300
Cape Fear River above Wilmington, N. C. (locks and dams)	173,000
Cape Fear River at and below Wilmington, N. C.	150,000
Shallotte River, N. C.	1,100
Waccamaw River, N. C. and S. C.	40,000
Winyah Bay, S. C.	70,000
Santee, Wateree and Congaree Rivers, S. C.	15,000
Charleston, S. C.	5,150

GEORGIA, FLORIDA, ALABAMA AND MISSISSIPPI.

Savannah, Ga. (26-foot project)	235,000
Savannah River below Augusta, Ga.	15,000
Waterway from Savannah, Ga., to Beaufort, S. C.	5,000
Sapelo, Ga.	2,000
Altamaha, Oconee and Ocmulgee Rivers, Ga.	10,000
Fancy Bluff Creek, Ga.	2,000
St. Marys River, Ga. and Fla.	2,000
Channel between St. Johns River and Cumberland Sound, Ga. and Fla.	2,500
St. Johns River, Fla., Jacksonville to the ocean	350,000
Jacksonville to Palatka	10,000
Palatka to Lake Harney	10,000
Indian River, Fla.	10,000
Caloosahatchee River, Fla.	5,000
Manatee River, Fla.	35,000
St. Petersburg, Fla.	1,500
Hillsboro Bay, Fla.	120,000
Channel from Clearwater Harbor to Tampa Bay, Fla.	3,000
Anclote River, Fla.	5,000
Removing the water hyacinth in the state of Florida	5,000
Carrabelle Bar and Harbor, Fla.	20,000
Apalachicola Bay, Fla.	25,000
Apalachicola River, Fla.	30,000
Flint River, Ga.	40,000
Chattahoochee River, Ga. and Ala.	75,000
St. Andrews Bay, Fla.	25,000
Choctawhatchee River, Fla. and Ala.	25,000
Holmes River, Fla.	5,000
Narrows in Santa Rosa Sound, Fla.	5,000
Blackwater River, Fla.	5,000
Pensacola Fla.	25,000
Alabama River, Ala.	75,000
Coosa River, Ga. and Ala., lock in dam 4 and dam 5	56,000
Rome, Ga., to lock 4, Ala.	50,000
Mobile, Ala.	107,000
Mobile Bar, Ala.	10,000
Tombigbee River, Ala., mouth to Demopolis, Ala.	42,500
Demopolis, Ala., to Walker's Bridge, Miss.	6,300
Pascagoula River, Miss.	10,300
Gulfport Harbor and Ship Island Pass, Miss.	62,500
Wolf and Jordan Rivers, Miss.	6,250
Pearl River below Rockport, Miss.	11,000

LOUISIANA, TEXAS AND ARKANSAS.

Southwest Pass, Mississippi River	400,000
South Pass Channel. Mississippi River	50,000
Bayou Plaquemine, La.	20,000
Bayou Teche, La.	10,000
Waterway, Franklin to Mermentau, La.	75,000
Waterway, Mermentau River to Sabine River, La. and Tex.	5,000
Calcasieu River. La.	3,000
Bogue Falia, Bayou Manchac and Amito, Chefuncto and Tickfaw Rivers, La.	5,000
Bayou Vermilion and Mermentau River, La., including Bayou Plaquemine Brulo	8,000
Removal of water hyacinth in Mississippi, Louisiana and Texas	20,000
Bayou Terrebonne, La.	15,000
Atchafalaye River, La.	20,000
Bayou Grosstete, La.	3,000
Galveston Channel, Tex.	100,000
Channel from Galveston Harbor to Texas City, Tex.	50,000
Channel to Port Bolivar, Tex.	40,000
Houston Ship Channel, Tex.	200,000
West Galveston Bay and mouths of adjacent streams, Tex.	20,000
Inland waterway on coast of Texas, West Galveston Bay, Brazos River section	15,000
Brazos River, Matagorda Bay section	30,000
Aransas Pass, Pass Cayallo section	30,000
Guadalupe River section	15,000
Mouth of Brazos River, Tex.	30,000
Brazos River, Tex., Velasco to Old Washington	10,000
Old Washington to Waco	200,000
Port Aransas, Tex.	180,000
Channel from Aransas Pass to Corpus Christi, Tex.	15,000
Sabine Pass and Port Arthur Canal, Tex.	100,000
Trinity River, Tex., open channel work	25,000
Compilation of instrumental survey	12,000
Cypress Bayou, Tex. and La.	5,000
Red River above Fulton, Ark.	40,000
Ouachita River, Ark. and La., locks and dams	11,000
Open channel work to Camden	25,000
Bayous Bartholomew, Macon, D'Arbonne and Corney and Boeuf and Tensas Rivers, La.	4,000
Yazoo River and tributaries, Miss.	15,000
Big Sunflower River, Miss.	104,000
Arkansas River, Ark.	193,350
White River, Ark.	14,000
Cache River, Ark.	3,000
Black and Current Rivers, Ark and Mo.	24,000
St. Francis and L'Anguille Rivers and Blackfish Bayou, Ark.	8,000

MISSISSIPPI RIVER AND TRIBUTARIES.

Mississippi River, between mouths of Ohio and Missouri Rivers	300,000
Mouth of Missouri River to Minneapolis, Minn.	1,000,000
St. Paul to Minneapolis, Minn.	65,000
Brainerd to Grand Rapids, Minn.	6,000
Warroad Harbor and River, Minnesota	2,000
Zippel Bay, Lake of the Woods, Minn.	1,000
Missouri River: Kansas City to mouth	1,000,000
Kansas City to Sioux City	50,000
Sioux City to Fort Benton	50,000
Osage River, Mo.	7,500
Gasconade River, Mo.	15,000
Cumberland River, below Nashville, Tenn.	[illegible]
Tennessee River, Tenn., Ala. and Ky., above Chattanooga	150,000
Between Florence and Riverton, Ala.	100,000
Below Riverton, Ala.	251,000
French Broad River, Tenn.	20,000

MIDDLE WESTERN STATES.

Monongahela River, Pa.	211,200
Pittsburgh Harbor, Pa.	7,500
Ohio River, open channel work	310,000
Locks and dams	3,330,000
Ashland, Wis.	15,000
Harbor of Refuge, Keweenaw Point, Mich.	30,000
Ontonagon, Mich.	8,000
Harbor of Refuge, Grand Marais, Mich.	10,000
Menominee Harbor and River, Mich. and Wis.	7,500
Two Rivers, Wis.	12,000
Port Washington, Wis.	5,000
Milwaukee, Wis.	15,000
Racine, Wis.	150,000
Kenosha, Wis.	25,000
Waukegan, Ill.	10,000
Fox River, Wis.	20,000
Chicago, Ill.	500,000
Chicago River, Ill.	20,000
Calumet, Ill.	18,000
Calumet River, Ill. and Ind.	22,000
Indiana, Ind.	150,000
Illinois River, Ill.	50,000
St. Joseph, Mich.	15,000
South Haven, Mich.	8,300
Saugatuck, Mich.	3,500
Arcadia, Mich.	3,000
Holland, Mich.	3,600
Grand Haven, Mich.	30,000
Grand River, Mich.	4,200
Muskegon, Mich.	9,500
Ludington, Mich.	9,300
Frankfort, Mich.	3,400
Charlevoix, Mich.	2,700
Ship channel connecting waters of Great Lakes between Chicago, Duluth and Buffalo	20,000
Black River, Mich., at Port Huron	5,000
Alpena, Mich.	5,000
Harbor Refuge, Harbor Beach, Mich.	200,000
St. Marys River, Mich. (fourth lock)	1,006,000
Toledo, O.	35,000
Sandusky, O.	5,000
Huron, O.	3,000
Cleveland, O	92,000
Conneaut, O.	195,000
Erie, Pa.	30,000
Buffalo, N. Y.	187,373
Charlotte, N. Y.	12,000
Lake Erie entrance to Black Rock Harbor and Erie Basin, N. Y.	10,000
Oswego, N. Y.	100,000

PACIFIC COAST.

Los Angeles, Cal.	$ 75,000
San Francisco, Cal.	12,000
Oakland, Cal.	80,000
San Pablo Bay, Cal.	15,000
Humboldt Harbor and Bay, Cal.	300,000
Petaluma Creek and Napa River, Cal.	15,000
Sacramento and Feather Rivers, Cal.	60,000
Coquille River, Ore.	76,000
Coos Bay, Ore.	70,000
Coos River, Ore.	3,000
Suislaw River, Ore.	117,500
Yaquina River, Ore.	3,000
Nehalem Bay, Ore.	116,175
Snake River, Ore., Wash. and Ida.	20,000
Upper Columbia River above Celilo Falls to mouth of Snake River, Ore. and Wash.	37,000
Mouth of Columbia River, Ore. and Wash.	1,500,000
Columbia and Lower Wilamette Rivers, below Portland, Ore.	450,000
Willamette and Yamhill Rivers, above Portland, Ore.	25,000
Cowlitz and Lewis Rivers, Wash.	15,000
Clatskanie River, Ore.	1,000
Grays Harbor and Bar, Wash.	460,000
Waterway connecting Port Townsend Bay and Oak Bay, Wash.	17,500
Kahului, Hawaii	10,000
Honolulu, Hawaii	25,000
San Juan Harbor, P. R.	8,000

An $891,000 Irrigation Undertaking.

A large irrigation development is proposed by the Teel Irrigation District of Umatilla County, Oregon. A bond issue was authorized some time ago for carrying out this work, and it is expected that these securities will be offered for sale shortly. The estimated cost of the complete system is $891,000. The main features of the undertaking are a reservoir having a capacity of 31,000 acre ft. of water when filled to 5 ft. of the top of the dam, and a tunnel 12,341 ft. long and 7 by 8 ft. in size. The dam will be 105 ft. high, will have a bottom width of 200 ft. and will be 650 ft. long on the top. The open ditch work will be of comparatively easy excavation. The district contains about 20,000 acres of land and has water supply rights of double its requirements. J. Frank Spinning, Echo, Ore., is Secretary of the District and W. B. Hinkle, Echo, is Engineer in Chief.

THE GOVERNMENT RAILWAY OF ALASKA.

Route Selected and Construction to Start at Once.

509 Miles of Line to Be Built by Contract at Cost of $26,800,000.

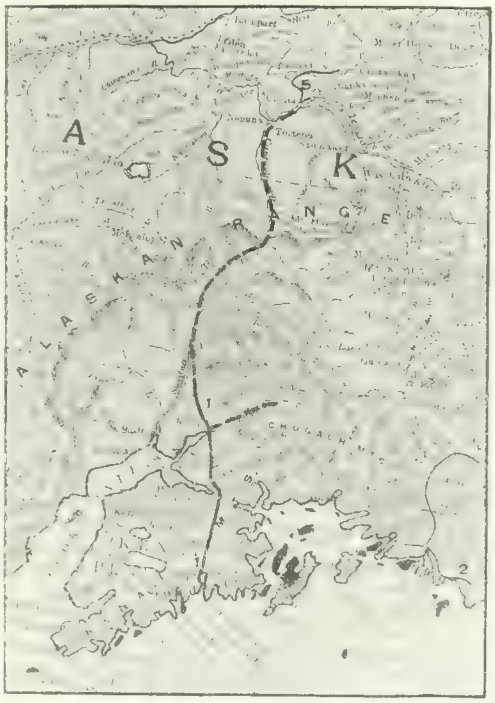
The Federal Government has selected the route for its railway in Alaska and construction work will be started at once. The Susitna route has been adopted. This extends from Seward on Resurrection Bay to Fairbanks on the Tanana River, a distance of 471 miles. This route includes the existing Alaska Northern R. R., which runs from Seward through the Kenai Peninsula for a distance of 71 miles to Turnagain Arm. The Alaska Northern R. R. has been purchased by the government for $1,150,000 and will form the first link of the Federal railway. From Turnagain Arm the route is to be extended through the Susitna Valley and across Broad Pass to the Tanana River, and from there to Fairbanks. A branch is to be constructed from Matanuska Junction into the Matanuska coal field, a distance of 38 miles. The road is to be built with its present base at Ships Creek on Cook's Inlet, and this location will serve as a shipping point for the Matanuska coal.

The estimated cost of the entire system from Seward to Fairbanks, including the Matanuska branch, is $26,800,000. In the bill passed by Congress contemplating the construction of the Alaska Railway provision was made that the expenditure should not exceed $35,000,000. The sum of $1,000,000 was authorized last year for the work of the Alaska Engineering Commission. Of this amount about $500,000 remains unexpended and will be used for the first payment on the purchase of the Alaska Northern R. R. For the present year a $2,000,000 appropriation has been made.

The first construction will be the building of a wharf at Ship Creek and the dredging of a more adequate channel. It is probable that about 40 miles of the railroad will be constructed this season. This work will be done in large part by station men, who will make direct contracts with the commission for building distinct units of the road. At the end of this season the work done in this way will form a basis from which it may be determined whether it is wise to have the road constructed as a whole or in part by contract. It is expected that the commission will employ a very small force composed chiefly of engineers to supervise the construction. Men to fill these few places will be selected exclusively on the ground of merit and experience. In the official announcement of the Secretary of the Interior made public last Saturday it is stated the work to be undertaken by the government does not justify any rush to Alaska. The government itself will employ but few men, and these men of a high order of railway engineering experience. The Secretary advises those contemplating going to Alaska that there is little opportunity for employment in that country at this time, and they must be prepared in advance for their return in the fall.

The route as approved by the President is as follows:

Commencing at the town of Seward on the westerly shore of Resurrection Bay, Alaska; thence following along said westerly shore in a northerly direction to the head of said bay; thence following up the drainage of Salmon Creek to a summit between said drainage and the drainage of Snow River, thence following the drainage of Snow River to Kenai Lake; thence continuing northerly along the eastern shore of Kenai Lake, along Falls Creek, along the shores of Lower and Upper Trail Lake, and up Trail Creek to a summit in the Kenai Mountains near Mile 45 from Seward; thence descending along the drainage of Placer River to the head of Turnagain Arm of Cook Inlet; thence following the northeasterly shore of said Turnagain Arm and crossing Portage Creek and Twenty-mile River to the mouth of Kern Creek near Mile 71 from Seward; thence in a northwesterly direction along the shore of Turnagain Arm to near the mouth of Big Rabbit Creek; thence leaving Turnagain Arm and running northerly to a summit in section 26, township 14 north, range 3 west, Seward meridian; thence running northeasterly to near the head of Knik Arm of Cook Inlet; thence running northerly across the flats at the head of said arm and crossing Knik and Matanuska Rivers, to a point about two miles north of the Matanuska River; thence running in a westerly and northwesterly direction, crossing the little Susitna River and following along the southwesterly slopes of Bald Mountain to Willow Creek, a tributary of the Susitna River; then in a northerly direction following the drainage of the Susitna and Chulitna Rivers to Broad Pass, situated in the main Alaska range of mountains; thence crossing Broad Pass and entering the drainage of the Nenana River; thence continuing northward following the drainage of the Nenana River to the Tanana River, the total distance from Seward being 416 miles, more or less.



Route of Government Alaska Railway.

Also starting from a point on the above described line, situated two miles more or less northerly from where said line crosses the Matanuska River, and thence running in an easterly direction following the drainage of said Matanuska River and its tributaries, a distance of 38 miles, more or less, to the Matanuska coal fields.

The Alaska Engineering Commission, which has been in charge of the preliminary work, will have charge of the construction. The commission is charged with the general duty of preparing and adopting plans for construction, the employment of force, and the purchasing of supplies for the work. W. C. Edes, the present chairman of the Commission, will have immediate charge of the work. He will have his headquarters at Seward, Alaska. Lieutenant Frederic Mears will be stationed at Ship Creek and Thomas Riggs, Jr., will conduct surveys in the Brook Pass region.

$440,000 of Bridge Construction in Philadelphia.

Bridge work to cost about $440,000 has been authorized by the city officials of Philadelphia, Pa., and bids will be invited in the near future. In all nine bridges are provided for. The location and some particulars of the structures are as follows:

Fifth St., over North Pennsylvania R. R.; 70 ft. wide, over four tracks. Skew, steel floor, concrete substructure and encasement. Outside cost, $70,000.

Diamond St., over Connecting Ry.; 60 ft. wide, over six tracks. Skew, steel floor, concrete substructure and encasement. Outside cost, $75,000.

Cambria and A Sts., over Richmond Br., P. & R. Ry.; 52 ft. wide, over 13 tracks. Skew, steel floor, concrete substructure and encasement. Outside cost, $62,000.

Third St., under Phila. and Newtown Conn. R. R.; two tracks, over 50-ft. street. Steel superstructure, concrete abutments. Outside cost, $32,000.

Holme Ave., over Pennypack Creek. Plain concrete arches, two 50-ft. spans, one 80-ft. span. Reinforced concrete wing walls. Outside cost, $80,000.

58th St., over Baltimore Central R. R. Reinforced concrete arch, 60-ft. span, 30 ft. wide. Ornamental balustrade. Outside cost, $18,000.

Fisher Ave., under North Penna. R. R.; two tracks, over 60-ft. street. Steel superstructure. Concrete abutments. Outside cost, $32,000.

Whitby Ave., over Baltimore Central R. R.; 80 ft. wide, over four tracks. Steel floor, concrete substructure and encasement. Outside cost, $42,000.

Sherwood Ave., over Indian Run. Concrete arch, 20-ft. span, 56 ft. wide. Ornamental railings. Outside cost, $30,000.

Contractors desiring notification of when plans and specifications for the above work are ready should address Chief Engineer, Bureau of Surveys, Philadelphia, Pa.

$13,530,000 of Appropriations for U. S. Reclamation Service.

The Government appropriations for the U. S. Reclamation Service for the fiscal year ending June 30, 1916, amounted to $13,530,000. This sum is to be expended for maintenance, operation, continuance of construction and incidental operations. The allotment to the various projects, in accordance with the sundry civil service bill approved March 3 last, is as follows:

Salt Lake Project, Arizona	$ 590,000
Yuma Project, Arizona-California	[illegible]
Orland Project, California	87,000
Grand Valley Project, Colorado	702,000
Uncompahgre Project, Colorado	469,000
Boise Project, Idaho	1,650,000
Minidoka Project, Idaho	410,000
Jackson Lake enlargement work, Idaho-Wyoming	¹476,000
Garden City Project, Kansas	[illegible]
Huntley Project, Montana	150,000
Milk River Project, Montana	1,110,000
Sun River Project, Montana	1,100,000
Lower Yellowstone Project, Montana-North Dakota	70,000
North Platte Project, Nebraska-Wyoming	[illegible]
Truckee-Carson Project, Nevada	236,000
Carlsbad Project, New Mexico	128,000
Hondo Project, New Mexico	6,000
Rio Grande Project, New Mexico-Texas	[illegible]
North Dakota pumping project, North Dakota	25,000
Lawton Project, Oklahoma	50,000
Umatilla Project, Oregon	366,000
Klamath Project, Oregon-California	317,000
Belle Fourche Project, South Dakota	144,000
Strawberry Valley Project, Utah	[illegible]
Okanogan Project, Washington	[illegible]
Yakima Project, Washington	[illegible]
Shoshone Project, Wyoming	478,000
Surveys and investigations of secondary projects	50,000

[1] Conditioned upon deposit of this amount by Kuhn Irrigation & Canal Co. and the Twin Falls Canal Co. to credit of reclamation fund.
[2] Includes $800,000 for Fort Laramie unit.

Engineering and Commerce Efficiency Society of America.—This organization was incorporated in Columbus, Ohio, April 2, 1915, for the purpose of promoting and giving publicity to questions of administrative and productive efficiency in the technical industries and commercial pursuits in this country and abroad. Temporary headquarters are taken in Cleveland and Pittsburgh and over 2,000 consulting civil, chemical, electrical and mechanical engineers are on the list of members. The society will maintain a free employment bureau, and information exchange and a confidential bureau of technical records, etc.

Care of Fire Hose.—The *Boston City Record* gives some hints as to the care of fire hose; the most noteworthy of which are as follows:

After each time of use the hose covering should be thoroughly scrubbed and dried. If the hose is put away without drying out all surface moisture, the sand and grit wear into the surface, or mildew results, and then rotting. Avoid friction of the surface, especially at the point of contact with the ground nearest the fire plug. Keep hose out of the sun rays and out of hot, dry air as much as possible. Oil of any kind is ruinous to the rubber lining. In oiling couplings be sure not to allow any of the lubricant to get into the hose. Keep the hose soft and pliable, not allowing it to remain in its cart or on the reel indefinitely. Avoid short bends in storing.

NEWS LETTERS

St. Louis Items.

Mulvill Bros. of Alton, Ill., have two miles of a coal mine spur near Kirksville, Mo., to sublet. There is between 30,000 and 40,000 yards of grading in this job. Part of it is grader and part of it wheeler work. Want an outfit in the neighborhood of 25 teams.

Announcement was made at Jefferson City, Mo., on April 2, by State Highway Commissioner F. M. Buffum, of the resignation of Col. W. S. Hawkins as Assistant Commissioner. He resigns to practice civil engineering in Kansas City. E. E. Sheets of Palmyra, former County Engineer of Marion County, selected to fill the vacancy assumed his duties the same day. Commissioner Buffum will soon begin the preliminary work on some cross state highways from the north to the south.

S. J. Grimes died at Danville, Va., on April 1. Grimes is well known in this part of the country, having been associated with some of the best contractors in this neighborhood for the past twenty-five years, and right previous to his death was with Costello Bros.

The Board of Local Improvements of Swansea, a village on the outskirts of Bellville, Ill., met last week and awarded a contract for brick paving 2,200 feet of 25-foot roadway on Caseyville Ave. to the Struble-Helmich Company of Alton, on its bid of $14,545.50. The board also awarded a contract for a 25-foot concrete bridge on Gilbert St. to the Parham Construction Company of East St. Louis on its bid of $419.

W. F. Woodruff of Bedford, Ind., has a small team outfit that he wants to place on railroad work or any kind of grading

Sixteen thousand acres of now worthless bottom land in Marion and Lewis Counties, Missouri, will be reclaimed with the construction of a huge levee around the Fabius River drainage district. The machinery has been unloaded and the work will be started at once. The drainage district is about 15 miles north of Hannibal. The work will cost $396,000 and require a year for completion. The levee will be the second in this vicinity. The South River drainage district was completed last fall, 15,000 acres being reclaimed. A meeting of the commissioners was held recently in Quincy and it was voted that $300,000 bonds be sold to pay for the improvements, while $96,000 is already at the disposal of the Commissioners. The northern line of the district is 3½ miles north of West Quincy, Mo., and extends into Lewis County 2½ miles, but is chiefly in Marion County. The J. H. Harmon Engineering Company of Peoria, Ill., has the contract.

Keating Bros. will finish their work at Kincaid, Ill., in three weeks and will be in the market at that time for work for their 20-team outfit.

The following were the successful bidders on the 20-mile cut-off which the Norfolk & Western R. R. Co. are going to build near Roanoke, Va.: Patterson, Moran & Co., New York; Robert Grace Construction Co., Pittsburgh, Rhinehart & Dennis, Charlottsville, Va., and J. J. Sheehan, Doanoke, Va. There were in the neighborhood of 50 contractors bidding on this work.

Harrington Bros. have been piling up some big estimates on their grading job in the southwestern part of the city during the nice weather that we have been having here the past two weeks.

J. E. Nelson, Scott Tippy and M. L. Windham were awarded contracts by the Illinois Central R. R. Co. for constructing a new coal road into the recently opened coal fields surrounding West Frankfort, Ill. This line will be between 5 and 6 miles long. A. B. Koenig

PERSONALS

Mr. J. P. Beck has resigned as publicity manager of the Universal Portland Cement Co. of Chicago. He will be succeeded by Mr. Robert F. Hall.

Dr. Ernest Lester Jones, Deputy Commissioner of Fisheries, has been appointed by the President as superintendent of the Coast and Geodetic Survey, vice Mr. O. H. Tittman, resigned, and will enter on his new duties April 16. Other changes in Survey service are announced as follows: Mr. F. Walley Perkins, assistant superintendent of the Survey, has resigned after 51 years' service. Mr. Robert L. Faris succeeds him. Mr. Charles C. Yates has been appointed assistant inspector of hydrography and topography.

Mr. George S. Iredell, civil and electrical engineer, who was formerly city engineer of Austin, Tex., has entered private practice with offices at 521 Littleford building, Austin. Mr. Iredell will make a specialty of municipal work, including reinforced concrete construction, paving sewers, water and light plants and road building. Mr. Iredell has been connected with the engineering department of the city of Austin for nearly eight years, six years as city engineer and for two years as first assistant. For about two years previous he was wireless telegraph engineer, constructing and putting in operation wireless telegraph stations, some of them high power stations for the U. S. Government. Prior to that he was for 16 years in executive and technical positions with telegraph and telephone companies, and was at one time assistant superintendent of the Chicago Telephone Co.

Mr. L. W. Rundlett, consulting engineer, and Mr. C. G. Moore, municipal engineer, have formed an organization under the name of "General Engineering Bureau," and are prepared to undertake civil, mechanical, electrical and structural engineering of all kinds. The headquarters of the firm are at 696 Endicott building, St. Paul, Minn. Mr. Rundlett is a member of the American Society of Civil Engineers and has served as city engineer and commissioner of public works of St. Paul for twenty years, and for several years in a similar capacity in Moose Jaw, Sask. He has also had an extensive practice as a consulting engineer in the design of municipal work and making valuations. Mr. Moore received his technical education at the University of Wisconsin, and has had nine years of practical experience as a railroad engineer, as city engineer of Eau Claire, Wis., and as a municipal contractor.

Mr. Otto H. Tittmann has resigned as superintendent of the U. S. Coast & Geodetic Survey after 48 years of service. In 1874 he was sent as assistant astronomer with the Transit of Venus Expedition to Japan, and in 1890 was sent to Paris to bring to the United States the National standard meter and to inspect weights and measures offices at London, Paris and Berlin. In 1895 he was delegate from this country to the International Geodetic Conference at Berlin, and in 1900 was made a member of the permanent commission of the International Geodetic Association. He has been superintendent of the U. S. Survey since 1900. In 1899 he represented the United States in the Alaska-Canadian boundary dispute, and in 1904 became United States Commissioner of the Alaska boundary. Mr. Tittmann is a member of the American Society of Civil Engineers, and of several scientific societies. He is also the author of numerous geodetic and metrological articles.

Mr. J. F. Ziglar and Mr. G. F. Hinshaw have organized the firm of Hinshaw & Ziglar, civil engineers, with offices at Winston-Salem, N. C. Mr. Ziglar has been connected with the Southern Railway since May, 1911, filling in order the positions of building inspector, concrete inspector, draftsman, assistant engineer and assistant roadmaster. In 1908 and 1909 he was employed on street railway and municipal engineering work at Winston-Salem, and during the following year was draftsman in the office of the chief engineer of the Winston-Salem Southbound Railway. Later, for a time he was draftsman for a locating party on the Elkhorn Extension of the C. C. & O., and for several months was instrument man on the W. S. S. Railway and the G. S. & S. Interurban. Mr. Hinshaw has just resigned the position of city engineer of Winston-Salem, having been connected with the department since 1907.

OBITUARIES

William Hunter, chief engineer of the Pennsylvania & Reading Railway Co., died in a Philadelphia hospital April 2 from a stroke of paralysis. He was 60 years of age and had been in the service of the Reading since 1878. He graduated from the Polytechnic College of Pennsylvania in 1872. He at once entered railway service as a rodman, and worked up through the positions of division engineer, assistant engineer, assistant roadmaster and assistant chief engineer. He was made chief engineer of the Reading in August, 1900.

F. Hopkinson Smith, noted author, artist and engineer, died in New York, April 7, aged 77. Although best known as an author, and having in his earlier days a wide reputation as an artist, Mr. Smith's engineering work has been noteworthy. A native of Baltimore, he entered a manufacturing plant of that city in his boyhood and at the age of 21 was superintendent of the Calvert Iron Co. At the close of the civil war he removed to New York City and established himself as constructing engineer and contractor, and entered upon the work of constructing under contract with the U. S. Government a number of lighthouses and breakwaters on Long Island Sound. In 1871 Mr. Smith began the construction of the Race Rock lighthouse off the harbor of New London, the building of which occupied him for nearly five years. The building of this lighthouse included the construction of an artificial island, the subsequent excavation of its interior and the filling in of this with a mass of concrete laid by divers working under water. Readers of Mr. Smith's novels will recall the thrilling account of some of the difficulties of this work in "Caleb West, Diver."

Mr. Smith also executed the contract for the construction of the foundation for the statute of Liberty in New York harbor, which forms the first 52 ft. of the structure. Among other works which he handled may be mentioned the sea walls around Governor's and North Brother's Islands, the water works at Mount Vernon and Fishkill, N. Y., the lighthouse at Cold Spring Harbor, L. I., and the sea wall at Tompkinsville, Staten Island.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examinations:

Marine engine draftsman for submarines; $5.04 per diem; May 12-13.

Electrical expert aid-ship; $4 per diem; May 12.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

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The Civilian Builders of the Panama Canal: Gen. George W. Goethals.

A notable kind of appreciation of the services of assistants is recorded in a recent public speech of Gen. George W. Goethals. It follows:

> Mr. Taft in his message of 1912 recommended that I be promoted to the position of major-general in the army. Two friends of mine in Congress, one in the Senate and one in the House, immediately introduced bills for that purpose. I wrote and told them service men should have no promotion unless promotions could be given to all alike. That attitude I have consistently maintained. It is a source of regret to me that the bill ever passed. Civilians built the canal, not the Army. When the Army people leave here they are retired and looked after by the government, whereas the civilian must get out and hustle to make a living for the rest of his days. The completion of the canal is due to the brain and brawn of the men who are gathered here.

The reward that General Goethals received for his work at Panama seems now more than ever before, to have been well bestowed.

Inviting and Avoiding Direct Competition Between Consulting Engineers.

A growing number of agencies of a public character perform functions akin to the activities of the consulting engineer in private practice. Thus advice of an engineering nature is being given by such agencies as Municipal Reference Bureaus of Leagues of Municipalities, Public Service Commissions, and Extension Divisions of State Universities. In general, we believe, these agencies in the long run provide much more work for the consulting engineer than they take from him. Particularly is this true in rural communities where the local official has an initial lack of confidence in the consulting engineer and unlimited confidence in an engineer representing some public institution. In such cases the latter worker creates opportunities for the former by carrying projects through the preliminary stage and then stepping aside in favor of the consultant.

Thus, the municipal engineering work carried on in villages by the Extension Division of one of our State Universities has been described in these columns. Under this plan the representative of the institution points out the need of a water system, for example, and shows that it is feasible. He then advises the town to get a consulting engineer to go on with the work.

Again, a League of Municipalities, acting through its Municipal Reference Bureau tries to impress upon city officials the fact that it is always expensive to do public work without engineering advice, and that it is always cheaper, ultimately, to pay an engineer an adequate fee for doing the work in a proper manner than to attempt to dispense with an engineer's services.

Also, Public Service Commission staffs often do considerable in the way of preliminary advice in connection with plant operation and betterments, ultimately giving way to the engineer in private practice.

There are, of course, other agencies of a public nature doing work which logically leads up to the engagement of a consulting engineer. In all these cases we believe the point is soon reached where the agent of the public institution in effect says to the city official: "Now go and get a consulting engineer." It is then only natural that the official should ask for advice in choosing a consultant. A list of names of successful practitioners is sometimes submitted with the explanation that all are good men and one chosen therefrom will surely be satisfactory.

Up to this point we think the far-seeing consultant will be in full accord with the procedure but the list of names should be submitted with some general advice. Any impulse of the official to write a form letter to every man on this list asking him to name a fee for a given service should be discouraged. Such "bidding" is harmful to engineers and engineering. Much better is it to select a man for his qualifications to perform the desired service than solely by the amount of his fee. The agencies we have mentioned are urged to discourage any tendency, arising from their good offices, toward bringing about wholesale competitive bidding between consulting engineers. Obviously this matter requires tactful as well as impartial handling.

Cost of Quantity Surveys of Buildings and a Proposed Survey Guarantee.

The writer, in the course of appraisal work, has had quantity surveys made of many buildings. Given the ordinary architect's plans, the cost of such a survey averages about $3 to $4 per $1,000 of total cost of the building, or 0.3 to 0.4 per cent. Often, of course, this expense can be avoided in making an appraisal, either by using cubic foot or square foot prices where the cost of a considerable number of quite similar buildings is known, or by adding a percentage to the known original cost to get the present day cost.

Careful building contractors make quantity surveys of all important buildings upon which they submit bids. If, as is often claimed, "ten jobs are figured for every one landed," and if every contractor makes a separate quantity survey, the total cost of all the quantity surveys is 3 to 4 per cent of the building cost.

We have at hand an advertising circular issued by a quantity survey company in New York, and it appeals to us as being a most rational argument for the making of quantity surveys of every important building prior to the call for bids. The company says of its work:

> It furnishes itemized lists of all the different classes of work required to complete a building. It guarantees that the totals of the lists are correct within 3 per cent. It gives an acceptable surety bond for an amount equal to 10 per cent of the estimated value of the work listed, agreeing to indemnify any interested party against extra cost due to an error in excess of 3 per cent in the totals of the lists.
>
> It is an axiom that a reduction in the amount of work bid on lowers the price. Quantities guaranteed to be correct within 3 per cent justify their purchase at the Survey Co.'s fee, which is approximately 1½ per cent of the value of the work listed. Such quantities have only to be 1½ per cent lower than the usual contractor's quantities to offset the fee. Everyone familiar with quantity estimating admits that the fee will be saved. We claim a saving of at least twice that amount, taking into consideration the close quantities and the other indirect benefits tending toward the elimination of claims for extras and allowances after the contract is let.

To civil engineers it has long been a matter of wonder that architects furnish no list of quantities upon which contractors may estimate. Doubtless the practice of charging a fee for architect's services is partially responsible for throwing the burden of making the quantity estimates upon the contractors. Now comes a company that proposes not only to make but to guarantee quantity estimates. We are inclined to doubt, however, their ability to induce many architects to favor their plan, if the charge is to be 1.5 per cent. But if the charge were somewhat less than 1 per cent, there might be a different story.

We feel that there is sufficient merit in the scheme, in general, to suggest that engineers might well try to secure business of this sort. It may be that the guarantee feature of the plan will not prove as attractive as might be expected. On the other hand, it may be that many architects could be induced to recommend to their clients the making of quantity surveys without guarantees were the fee made sufficiently low, say 0.6 to 1 per cent, the rate depending upon the size and character of the building.

Will High European Taxes Drive Money and Men to America?

The per capita debt of European nations was already vastly greater than that of America before the war. Europe's public debt at the close of the war will be the most colossal in the history of nations. The effect of the consequent high taxes upon industries has been much discussed, but we have seen no mention of one result that seems inevitable. We refer to the immigration of workmen as well as capital from Europe to America after the war.

Almost every European nation collects a very large part of its revenue by taxation of incomes. The tax falls heavily upon "unfunded" as well as upon "funded" incomes, upon the small as well upon the large. Whether an income be from an investment or from a wage, a substantial part of it goes to the government. Hence the European worker as well as the European capitalist now faces a situation of the gravest economic aspect.

Many financial experts have been astonished because European investors have not hastened to sell their American securities. It was fear of such "liquidation" that led the New York Stock Exchange to close its doors eight months ago, and the same fear led also to the adoption of a "minimum price schedule" when the exchange opened again in December. The other day the restriction as to "minimums" was removed without causing the slightest flurry. It now seems that the fears of American stock brokers and bankers were without foundation.

Instead of seeking to withdraw capital from investments in America there is reason for a flow of investment capital to America. The pressure that will first cause this flow will be the greatly increased taxes resulting from the war.

Where money goes there go men, but even if money does not go in advance of men, still men will leave Europe in greater numbers than ever before. America has always been the land of promise, the world's El Dorado. When, in addition to this lure, there comes before European workmen a full realization that the tax gatherer is about to reduce their already meager wage, can it be doubted that America will look more attractive than ever? May we not anticipate an exodus from the old countries such as has never been witnessed before?

Let us consider another factor that will have its influence in causing the exodus. If that shoestring of land between North and South America had been broken by nature a thousand years ago instead of by man a few months ago, the Pacific Coast of this continent would probably have been as densely settled as the Atlantic Coast now is. Indeed, there are reasons for thinking that New York might have been located at the Golden Gate or on Puget Sound. Climatically the Pacific Coast is more attractive than the Atlantic. Of natural resources there is wealth enough on the Pacific to support fiftyfold the present population.

The coal of the Atlantic seaboard finds its equal in the fuel oil and waterpower of the Pacific. In fact, the latent power in the snow summits of the Sierras and the Cascades is vastly greater than that in all the "fossil sunshine" of Pennsylvania. An acre of bean land in Los Angeles County sells for $1,000, and the price it brings is only the capitalized annual income from several crops of beans. Citrus lands at $5,000 an acre make it evident that the Golden State holds its title, not merely because of its baptismal name of '49.

In seeking to find some fault with the natural resources of the Pacific, a New Yorker remarked to his Seattle cousin:

"But you have no lobsters indigenous to your coast."

"We have Dungeness crabs, however, that make a taste for lobsters seem like the perverted appetite of a Digger Indian for clay."

There is a quid for every quo, and the quids seem, on the whole, to have the best of the quos, in comparing our Western with our Eastern Coast. But whether this be the general verdict matters little. The fact that deserves particular notice is that the undeveloped resources of the West are now made fully available through the use of the Panama Canal. A stream of immigrants will soon begin to flow through this new channel, for war taxes will furnish a "velocity head" more than enough to overcome the frictional resistance of custom and the ties of home.

Engineering Education, Engineering Success and Leadership Among Men.

Our engineering schools have been criticised at various times both for what they have included in their courses and for what has been omitted from them. It is natural and proper that such schools should take cognizance of the changes constantly being made in the engineering field, and should make an attempt to meet certain of these changes. There is, however, need for great caution and insight on the part of educators if they are to keep the essential and discard the non-essential. In the past there has been a decided tendency in some of our engineering schools to give undue emphasis to certain kinds of engineering work only to find (or rather it remains for their graduates to discover) that the special training received is no longer demanded by employers. It is now being recognized that a thorough grounding in the fundamentals of engineering is essential, and it is gratifying to note that many of our engineering schools have recently revised their courses to insure a better training in basic subjects.

During the past year a considerable number of addresses have been made by prominent engineers, in which the "status of the engineer" has been the key-note. Such discussion reflects the reaction which is taking place against present conditions, for which our engineering schools are partly responsible, although such schools in a measure reflect the demands made upon them by engineers and by employers of engineers. It is now generally conceded that some changes are needed, and constructive criticism should be encouraged. Much of what has recently been written on this subject, however, is somewhat radical, and indicates that, unless caution is exercised, we are apt to turn about face so sharply as to jeopardize the standing of engineers in the future. In order that discussion of this subject be pertinent and constructive we must keep in mind that the basis of such discussion should primarily be the *making of better engineers*—men who not only are deserving of greater benefits, but who are able to contribute more to the comfort and happiness of men in other lines of work. We must remember that efficient engineers will always be needed, just as are efficient business men, lawyers and doctors. Efficiency, in a measure, requires specialization, and we do not believe that engineers will exert a greater influence by becoming engineer-lawyers, engineer-business men, etc. The profession of engineering is broad enough to occupy the entire energy of those men who are able and willing to meet its requirements. If the engineer will give the proper time and thought to state and national affairs which every citizen should, then he will best serve all interests, including his own, by devoting the rest of his energy to engineering. Much of the present dissatisfaction is voiced by men who call themselves engineers, but who are trying to do work for which they are not fitted.

Engineers must face the reality that the very nature of their work imposes certain restrictions as to other activities, and men will never attain highest prominence, as engineers, until they recognize these restrictions. For example, mathematics and mechanics are engineering subjects of such importance that no engineer can attain much prominence, as an engineer, without a basic knowledge of their principles. Such a knowledge involves long study and close application, which means less time for other subjects. In a recent address a well-known engineering professor expressed himself as follows:

> In my opinion there is scarcely anything that tends more to narrowness of view than dealing all the time with problems that can be solved only by right mathematical processes, because the great questions which confront us are not mathematical; the data are shifting, variable, and the human element comes in. Therefore, the man who is accustomed to solve his problems by mathematics, and can only do the solving in that way, finds himself at a loss in the practical affairs of life—mathematics do not apply.

If it is true that mathematics has a narrowing tendency—and in the main we believe it does—then engineers must face the facts as they exist. We believe our engineering schools must give such thorough training in mathematics and mechanics that the average student will be thoroughly grounded in their principles. If they do not, their graduates will be failures, as engineers, although an occasional man may achieve success in some other line of work. We believe that any engineering school which points with *greatest* pride to those few of its graduates who have attained success—not as engineers but as business men, or promoters, or as industrial managers—is a partial failure, because it is placing emphasis on principles which some other school is better fitted to teach. The greatest men in every kind of human activity are those who master their particular subjects—although appreciation by their fellowmen may be exceedingly tardy, and such men may not be what we call "well-rounded."

To offset the narrowing influence of mathematics the educator, from whose address we have already quoted, offers this solution:

> We should seek to broaden the minds of our engineering students by study in history, literature, psychology and other subjects which give a broad outlook upon life.
>
> I urge, therefore, that in these ways we help to give the engineer of the future the personal qualities for leadership. We may rest assured that if he is possessed of these qualities, leadership will come to him.

The author evidently intends us to infer that the engineer will be able to assume leadership over men in other lines of work. Is this assumption logical? Can we reasonably expect that the engineer—as such—will ever be a leader of lawyers, or business men—men who have made a special study of their profession and its requirements? As a general proposition we doubt it, as too much of the engineer's time must necessarily be devoted to subjects in which such men are only incidentally interested. Engineers can accomplish more by doing their engineering work well, and by proper co-operation to secure recognition of it, than by incidental study of subjects taken with the *object* of making them capable of exercising leadership over other men.

We do not wish to be understood as advocating engineering courses which do not include subjects having broad educational value—such subjects are essential if the engineer is to be the best type of citizen. We do, however, believe that the main purpose of engineering schools is to turn out efficient engineers. Certainly enough literature, or history, or psychology, cannot be crowded into an engineering course to enable the graduate ever to exercise leadership in lines of work in which his engineering knowledge is not absolutely essential. In general, engineers may rightly be expected to exercise leadership along those lines of work requiring specific engineering knowledge. Students of engineering should not be misled by believing that incidental study of general subjects will ultimately insure leadership in other lines of work requiring special training. Such courses as those mentioned should be taken for their broad educational value, in the hope that students who take them will be better and broader men; they should not replace basic engineering subjects.

We do, however, believe a thorough training in English will do more to increase the prestige of engineers, and to secure recognition of their work, than any subject which is properly a part of an engineering course. A poor command of English prevents many engineers from taking an active interest in public affairs; it also prevents many engineers from being recognized by those engaged in the same kind of work.

From time to time some man who has been trained as an engineer will, after practicing engineering for several years, begin seriously to question his fitness for such work. If he is honest, and does not try to deceive himself, he will turn his efforts toward that line of work which promises greatest contentment. After such a man "finds" himself he may achieve great success, but both he and his engineering friends should squarely face the fact that this new success is gained—not as an engineer, but as a specialist in some other line of work. Unquestionably, a considerable part of his engineering training will prove of value to him in his new work—some of it must be placed in the "loss" column. There is nothing which will cause greater discontent in the minds of real engineers than the erroneous belief that engineering principles are primarily the cause for the success of the man who changes to some other line of work. There will always be a place for efficient engineers, and the status of such men will be satisfactory; likewise some men will still continue to take engineering courses who should receive special training in other lines. Those in charge of engineering schools must not be swayed too much by the present discussion concerning the status of the engineer—provided they are now offering efficient engineering courses. They must remember that their function is to train engineers.

Service Tests at Philadelphia of Bituminous Carpets for Concrete Roads.

A test of the efficacy of bituminous carpets for concrete roads was, as many of our road engineer readers will recall, one of the purposes of the Byberry and Bensalem Service Test Road constructed by the Philadelphia Department of Highways. The results of about two years service on ten areas of this carpeted concrete are recorded in the annual report of the department for 1914. Summarized very briefly the bituminous covering on five of these areas has practically disappeared, on two it is in fair condition and on three it is in good condition. No very definite analysis in detail is practicable from the published records; but it is plain that all carpetings are not a success, nor are all carpetings a failure. This is information of at least corrective value. There has been observable a rather strong tendency of road engineers to group themselves into two parties, one seeing no value in bituminous carpets and one advocating their use always. Obviously from the Philadelphia tests the value of carpeting a concrete road depends upon the carpet. The immediate duty of road builders is then to determine as far as may be practicable the kinds of bituminous surfacings that are most effective and the degree of their efficiency. Until these facts are available it is hardly logical to assume a partisan stand either of approval or of disapproval.

WATER WORKS

Superintendents' Day at the Coming Meeting of the American Water Works Association.

The annual convention of the American Water Works Association will be held at Cincinnati on May 10-14. All day Thursday, of the convention week, including an evening session, has been set apart as Superintendents' Day. The question box will be taken up and general water works topics will be discussed. There will also be some short papers presented on practical water works subjects, every day experiences, new devices and methods. This is the kind of information that will be useful to superintendents.

This plan was inaugurated a year ago at the Philadelphia convention and was successful. For the greatest measure of success at such sessions the active interest of the superintendent himself is, of course, essential. The Association officials have done their part in introducing this innovation in the arrangement of the program of the convention, and superintendents should respond promptly and whole-heartedly. With this character of response the usefulness of the Association to its members who are interested in water works operation will be vastly increased.

The American Water Works Association is a thoroughly democratic institution. Both the superintendent from the small town and the superintendent of short experience in the water works business may rest assured that any statement of their problems and perplexities will receive respectful consideration.

The Ransome Drifting-Sand Water Filter—Results of Tests on Demonstration Unit at Toronto.

(Staff Abstract.)

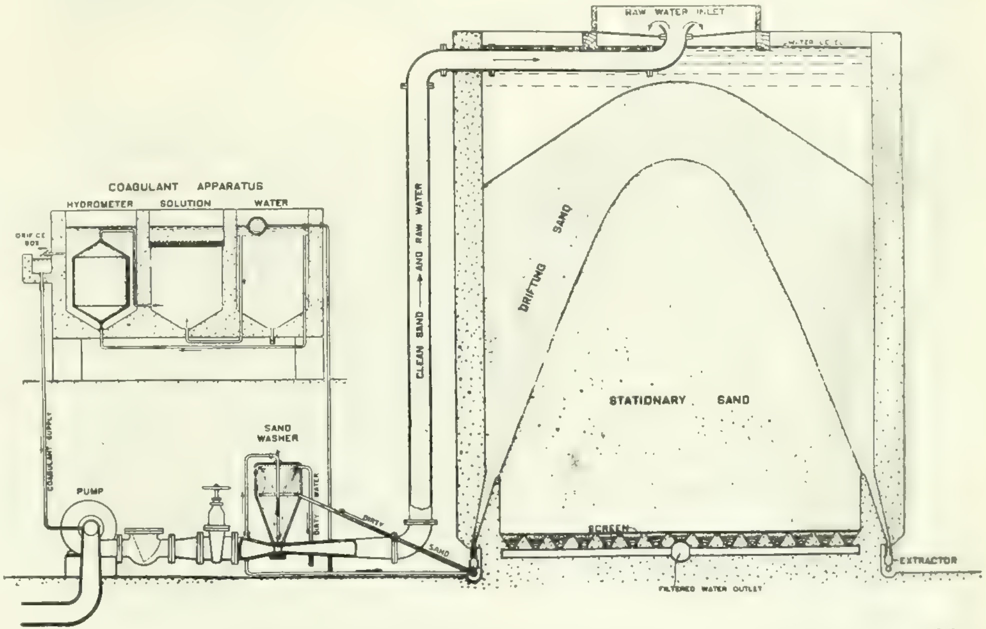
On Feb. 3, 1914, bids were opened at Toronto, Ontario, for the construction of a water filtration plant of 60,000,000 Imp. gallons capacity. On June 8 of the same year a contract was awarded to the John ver Mehr Engineering Co., Ltd., of Toronto, to install a mechanical filtration plant of the Ransome drifting-sand type. This type of filter was designed and developed by William Gore of Toronto, who is consulting engineer for the firm named. The system is comparatively new and only relatively small plants are in operation. The contract for this large plant at Toronto was awarded after a 30 day test on a small filter of this type. The results of this test, here described, have just been made public. The essential features of the experimental plant are shown in Fig. 1.

THE DRIFTING-SAND PRINCIPLE.

The following description of the theories and principles underlying the design and operation of the drifting-sand filter are as given by the John ver Mehr Engineering Co. in submitting its bid on the large plant at Toronto, which is now under construction.

The filters to be installed will be that type known as the Ransome drifting-sand filter, the distinctive feature of which is the employment of a gradually moving body of sand as the primary or roughing filtration medium, which eliminates as a continuous process the main impurities from the water prior to its passage through the final filtration medium or stationary sand. Governed by its natural angle of settlement, the moving sand almost imperceptibly gravitates, grain by grain, toward a system of collecting or extracting points at the bottom of the filter arranged in a system so as to divide the filter into 30 equal sections. The sand with added water then passes to a central collecting point and is elevated to a sand washer placed centrally at the top of the filter, where, after being thoroughly and automatically cleansed of its impurities, it will be continuously caught up by the incoming water and deposited again on the moving sand surface at the top of the filter. The stationary sand forms naturally into pyramidal shapes with rounded tops, offering a large surface to the passage of the filtering water. This surface is more than twice the plan area of the filter. The stationary sand rests upon gravel from which it is separated by perforated brass screens and the water is collected from a number of brass and cast iron collecting pipes from the bottom of each of the 30 sections.

The elimination of the main impurities by the moving sand will enable this filter to carry on a continuous filtration process without washing back, for a period of about one week, thus assuring continuous and practically uniform results.



Sectional Elevation, Showing the Essential Features of the Demonstration Filter Plant of the Ransome Drifting-Sand Type, Toronto, Ont.

The loss of head in the filter gradually increases from a minimum of 5 ft. at the commencement of a run to a maximum of 12 ft., when it becomes necessary to wash back the filter with a high rate wash of 15 gals. per square foot per minute, using filtered water, for which an overhead tank with duplicate pumps to fill it with, will be provided. The slow rate at which the filters clog, removes the desirability of providing rate controllers, as all that is necessary is that the attendant should adjust the main outlet valve once or twice a day to the desired requirement.

The operation of the sand extractors is such that they are controlled by the raw wash water, which if shut off, causes the extractors to cease operating and when the water is applied again to start working as before.

With this type of filter the need for coagulating and sedimentation basins is avoided; indeed, as proved by the slowness of the clogging of the stationary sand, and the efficiency of filtration, the drifting sand is much more effective in removing the impurities than sedimentation basins. Thus it is not proposed to provide mixing, coagulating or sedimentation basins, but to apply the coagulant to the main raw water pipe opposite the chemical house. The mixing of this coagulant with the water will be perfect, in that it will first of all have to pass through the suction well, where it will receive considerable natural mixing, and afterward through the pumps where the mixing with the raw water will be complete. Further intimate mixture between the sulphate of alumina and the raw water takes place at the sand washer and the distribution pipes so that by the time the water reaches the filter a thorough mixture is absolutely assured.

THE TESTS.

The water tested in the demonstration plant was pumped from Humber Bay. This water is always sewage polluted and frequently muddy. The raw water mixed with a continuous supply of washed drifting sand from the sand washer entered the filter at the top, as shown in Fig. 1.

The Test Filter.—The filter consists of a vertical cylinder of reinforced concrete deeper than usual in filter design, and usually filled with sand. The filtered water collecting system is at the bottom, divided into a number of small units consisting of a number of hoppers filled with graded gravel held in place by a brass screen fastened down to the concrete. At a distance of 2 ft. 6 in. above the underdrain system and all round the filter are a series of hopped-shaped ports down which the drifting sand passes. These ports converge downwards to extractor outlets, with glass inspection tubes so that the operation of the drifting sand can be watched. The extractors are controlled by cocks, which can be adjusted to suit the character of the water being filtered.

The drifting sand from the inspection outlets is collected by a ring main system, along which is a current of wash water which conveys the sand to the sand washer or sand separator. The sand washer consists of a flat-sided, hopper-like vessel with glass windows at the flat sides through which the action can be observed. The sand washer is attached to the filter supply pipe immediately over a constriction in it something like the form of a Venturi meter tube. An opening in the bottom of the sand washer lets through the clean sand into the water passing, which conveys it to the filter and maintains the conical heap of sand in it. By the well known hydraulic principle the pressure in the pipe at the constriction is very much less than on the filter.

This difference is sufficient to draw the loose or drifting sand charged with dirt out of the filter into and through the sand washer and into the supply pipe, and so maintains the continuous motion of the sand while the filter is in operation. The sand, which by this time has become freed but not separated from the dirt, is led into the sand washer at about midheight. The weight of the sand carries it to the bottom of the washer and the dirty water escapes at the top. Near the bottom of the washers is a jet of water which carries the sand downwards into the supply pipe, displacing the dirty water upwards in so doing. The water used for washing the drifting sand is unfiltered. The plan area of this filter is 143 sq. ft., or 0.0033 of an acre. The estimated surface of the stationary cone is 306 sq. ft., or more than twice the plan area. The average depth of the sand in the filter is about 13 ft., of which about 54 per cent is drifting. The minimum thickness of drifting sand is about 2 ft. 6 ins. and the maximum 10 ft. The minimum thickness of the stationary sand is 2 ft. 2 ins. and the maximum 13 ft.

The physical analysis of the sand shows its effective size to be .4 millimeters, and its uniform coefficient 2.7. In the drifting sand the coarser particles tend to collect in the planes of maximum travel and the finer materials to drop through the coarser, thereby offering the coarser materials to the water first and the finer materials later.

Coagulating Plant.—A novel feature of the coagulating plant for the supply of a solution of aluminum sulphate to the raw water is the employment of a large float or hydrometer-like arrangement for maintaining a solution of constant strength of about 1½ per cent, which is fed through an orifice under a constant head, the orifice being changeable. The arrangement is shown diagrammatically in Fig. 1, and consists principally of rectangular reinforced concrete tanks in series, coated with solid paraffin.

The first tank contains water supplied from the pumping main and maintaining at a constant level by a ballcock. The water from this tank may pass either direct to the bottom of the solution tank or through the needle valve at the bottom of the hydrometer tank.

Solid crystals of aluminum hydrate are fed into the upper compartment of the solution tank in sufficient quantity to maintain the solution at any convenient amount in excess of 1½ per cent. The solution passes from this tank into the hydrometer tank through a needle valve at the top of the hydrometer. Thus the hydrometer tank is supplied either with solution at the top or water at the bottom, depending whether the hydrometer is up or down. The hydrometer, which consists of an oak barrel with conical ends of concrete and provided with brass adjustable needle valve points, is weighted so as to just float in a solution containing 1½ per cent of aluminum sulphate. The mixing of the two liquids takes place quite readily, owing to variations in density. The heavier solution coming in at the top commences to travel downwards, producing circulation; conversely, the lighter coming in to the bottom commences to travel upwards, again producing circulation, with the result that stratification at the orifice cannot be detected. The solution, before passing to the pump suction pipe, was further diluted about 200 per cent, so that when entering the raw water the solution was of about ½ per cent. The alkalinity of the raw water was about 100 p.p.m.

After the completion of the official test a culture of bacillus prodigiosus was added to the raw water in such quantities that from 204 to 600 colonies of the bacilli were present. No colonies appeared on the filtered water plates.

The turbidity of the raw water ranged from 3 to 45. The effluent was perfectly clear at all times. By the addition of clay the turbidity was increased from 375 to 650 p.p.m. Again the effluent was perfectly clear, using 1½ grains per gallon of alum.

With this type of filter there are two kinds of wash water. That which carries the drifting sand out to the washers amounts to about 2 per cent of the total water filtered. This is raw water. That used to wash back the filter about every eight days was somewhat less than 1 per cent of the total filtered. This is filtered water. The loss of head in the filter immediately after washing back was about 7 ft. when filtering at the rate of 500,000 Imp. gallons per day. This commonly increased to 14 ft. in eight days.

BACTERIOLOGICAL RESULTS.

The average bacteriological results over the whole test were as follows:

Average raw water count per cubic centimeter or standard agar at 37° C. was 1,420.

Corresponding average filtered water count, 14.8.

Efficiency of removal, per cent 99.

ACKNOWLEDGMENT.

The information here given relative to the test is from a report made for the city of Toronto by Dr. George G. Nasmith and Fred Adams, both of the Toronto Department of Public Health.

Construction Plant and Methods Employed on New Water Works Intake Tunnel at Milwaukee, Wis.

(Staff Abstract.)

I

INTRODUCTORY.

The entire water supply of the city of Milwaukee is at present drawn from Lake Michigan through the North Point intake tunnel shown in plan in Fig. 1. This tunnel, placed in service in 1895, is of 7½ ft. internal diameter and is brick lined. Its length from shore shaft to lake crib is 3,146 ft. Two parallel lines of 60 in. cast iron pipe, laid in a trench 8 ft. deep, run out 5,000 ft. into the lake beyond the crib. These pipes end at a point where the depth of water is 60 ft., and they terminate in riser pipes secured in position by submerged cribs. The maximum daily capacity of this intake system is 95,000,000 gals.

Since it was evident that this North Point intake system would not long continue adequate, it was decided to construct an additional tunnel known as the Linwood Avenue intake tunnel. This construction was authorized Dec. 23, 1912.

NEW COMPREHENSIVE PLAN.

It was decided to adopt a comprehensive water collection system as follows (all as shown in Fig. 1):

(1) To construct a 12 ft. internal diameter tunnel, from a shore shaft to a lake crib 4,000 ft. distant and to extend four parallel 72-in. cast iron pipes from the lake crib to a submerged crib 2,500 ft. farther out in the lake, terminating in approximately 65 ft. of water; (2) To construct a 9 ft. internal diameter concrete tunnel from the North Point intake tunnel shore end, this being the location of the North Point pumping station, to the shore shaft of the Linwood Avenue intake tunnel, 5,700 ft. farther north. (Bids were received on April 19, 1915 for this tunnel construction). (3) To construct a 9 ft. internal diameter concrete tunnel, from the shore shaft of the Linwood Avenue intake tunnel to the site of the proposed new pumping station 7,000 ft. west of the shaft. This proposed new pumping station site is located where it is closer to the center of distribution, which will make pumping less expensive. This project when completed will care for the water consumption of the city for the next 30 or 40 years. The total estimated cost is $2,500,000.

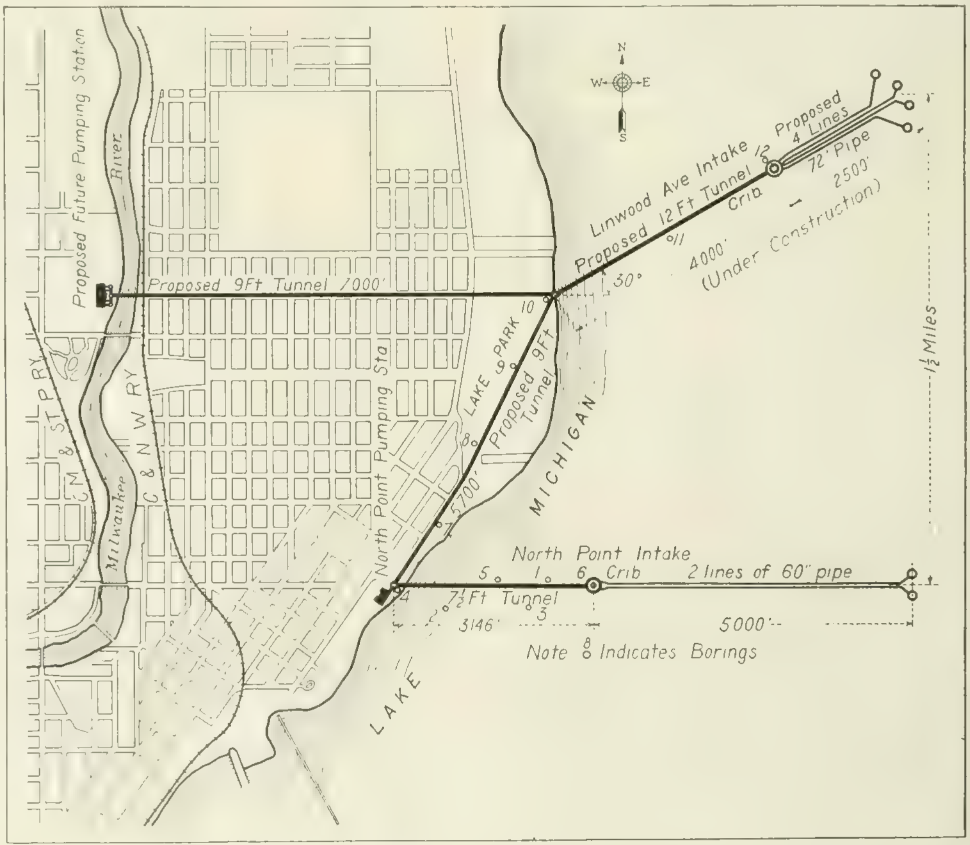


Fig. 1. General Plan, Showing Present and Proposed Water Supply Collecting Works at Milwaukee, Wis.

The project, because of its inter-relations and magnitude, was divided into two sections, as follows:

The first section consists of the Linwood Avenue intake tunnel, beneath the lake, and the connecting tunnel from the shore shaft of the Linwood Avenue tunnel to the North

Point pumping station. This section will provide an additional water supply to the present pumping station, giving approximately 220,000,000 gals. of water at a velocity of 3 ft. per second in 24 hours. The estimated cost was $450,000 for the lake tunnel alone. The present article relates to the construction of the lake tunnel.

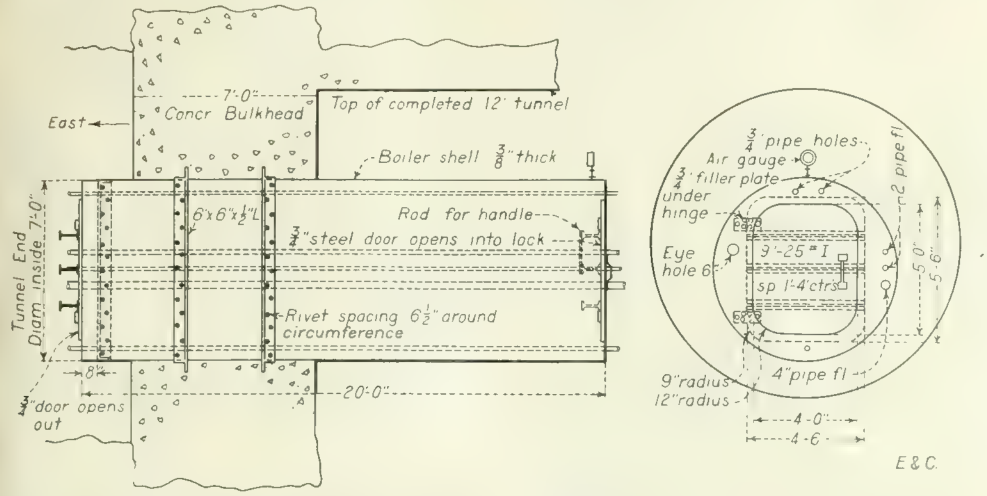


Fig. 2. Detail of Steel Air Lock for Materials, Linwood Avenue Water Supply Intake Tunnel, Milwaukee.

Lake Tunnel.—The original surveys for the first section of the new project were made in October, 1911. Twelve test borings were made as shown in Fig. 1. Based upon the surveys and these borings, the plans were completed in 1912.

The Linwood Avenue intake tunnel is 12 ft. in internal diameter. The lining is a reinforced concrete shell with a minimum thickness of 18 ins. The reinforcement consists of ¾ in. rods bent in vertical rings spaced 12 ins. on centers, and longitudinal rods spaced on 15 in. centers. At the shore the tunnel terminates in a 15 ft. internal diameter shaft with a concrete lining of a minimum thickness of 18 ins. The depth of the shaft is 86 ft. below datum.

Lake Crib.—The lake end of the tunnel consists of a steel and concrete circular crib, 60 ft. in diameter, with an internal water chamber 39 ft. in diameter. The concrete walls are 10½ ft. thick. This crib is 59 ft. high, and rests in 43 ft. of water. Through this lake crib, it is planned to drive a shaft, 15 ft. internal diameter, to meet the lake end of the tunnel. This shaft, as planned, is to have a depth of 35 ft. from the top of the tunnel to the bottom of the lake. The lake crib contract was awarded to the Wisconsin Dredge & Dock Co. for $90,000. It was placed Sept. 20, 1914.

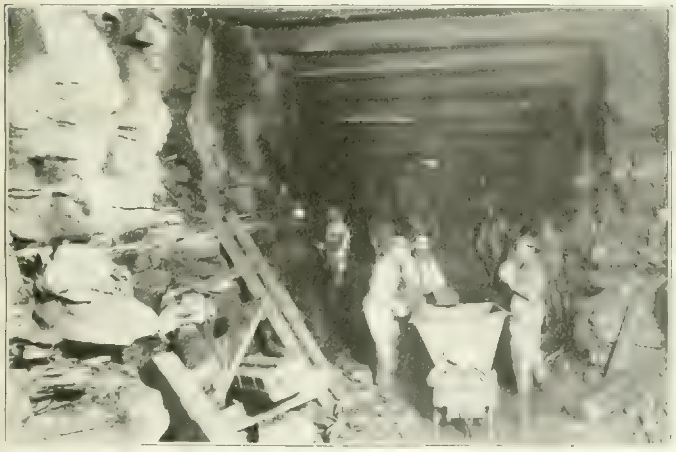


Fig. 4. View of Heading, Showing Roof Timbering, Material Traversed, and Type of Dumping Car Used, Milwaukee Tunnel.

Tunnel Grade.—From the shore shaft, to a point 2,500 ft. distant, the tunnel rises on 1/10 per cent grade from elevation, —81.00 to —83.5. From station 25 + 00, it was planned to have the tunnel fall on a grade of 0.66 per cent to station 40 + 00, terminating there at elevation —88.50.

CONTRACT PRICES.

Bids for the construction of the Linwood Avenue tunnel and shaft were opened on April 29, 1913. There were only two bidders, both from Chicago, Ill. Their itemized bids were as follows:

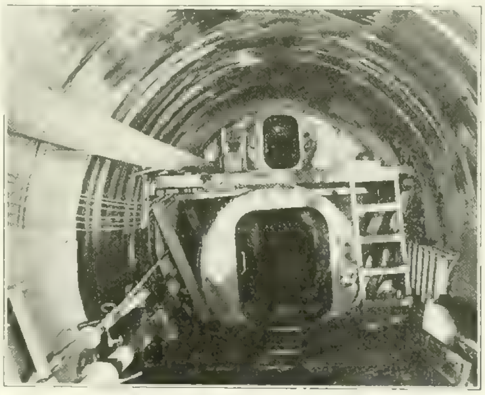


Fig. 3. View Showing Tunnel Lining and Face of Air Locks, New Water Intake Tunnel, Milwaukee.

	Nash Bros.	J. Hanreddy.
Shore shaft	$325 per ft. 27,600.00	$300 per ft. 25,500.00
Lake shaft	575 per ft. 48,900.00	500 per ft. 42,500.00
Lake tunnel (brick)	133 per ft. 532,000.00	87 per ft. 348,000.00
Lake tunnel (concrete)	143 per ft. 572,000.00	93 per ft. 372,000.00
Total bid with brick tunnel	$608,500.00	$416,000.00
Total bid with concrete tunnel	648,500.00	440,000.00

Joseph Hanreddy & Co. were awarded the contract.

CONSTRUCTION PLANT AND METHODS.

The contractor started to erect his plant on June 20, 1913. He decided to install a compressor plant, operated by motors by power derived from the local electric company. The compressor plant consisted of a 2-stage Ingersoll Imperial Type No. 10, capable of delivering 1,000 cu. ft. of air per minute and two single Ingersoll compressors being of the Imperial Type capable of delivering 700 cu. ft. of air per minute. Each compressor is driven by an electric motor which is controlled by pressure system of governing. The first named compressor has been used to furnish air to the drills and pumps in the tunnel. The second named compressors have been used for furnishing air to the tunnel when it was under air pressure and also for furnishing air to the pumps when the first named compressor became in-operative by an accident. The actual work of construction was started at the shore shaft.

SHORE SHAFT.

The driving of sheet piling for the shore shaft was sub-let. The sub-contractor started driving the piling on June 1, 1913. A water-tight cylinder 22 ft. in diameter and 23 ft. deep was formed by driving interlocking steel piling 30 ft. long and ¾ in. thick. All the driving was done with a steam pile driver, which was suspended from a derrick at the foot of the lake shore, 65 ft. below the hoisting engine. The boom was 75 ft. long and was supported by three posts firmly anchored. About 250 ft. of cable was used in the hoisting machine.

Excavating and Lining.—Excavation of the shore shaft required 24 days. It was started July 17, 1913, and completed Aug. 16, 1913. This excavation averaged 3.6 ft. per day, 86 ft. in depth being excavated. The material encountered consisted chiefly of red clay, hard pan and brown shale. The hard pan contained red clay and about 30 per cent gravel. The brown shale, encountered about 30 ft. below the lake bottom, required blasting for removal. All of the excavation was removed with ¾ cu. yd. buckets. The shaft was concreted in September, 1913, in 12 days and averaging 8 ft. of depth per day. The total depth of the shaft from 8 ft. above datum to —88 below datum to the bottom of the sump floor is 96 ft. This concrete lining averaged about 3 cu. yds. of concrete per foot of depth.

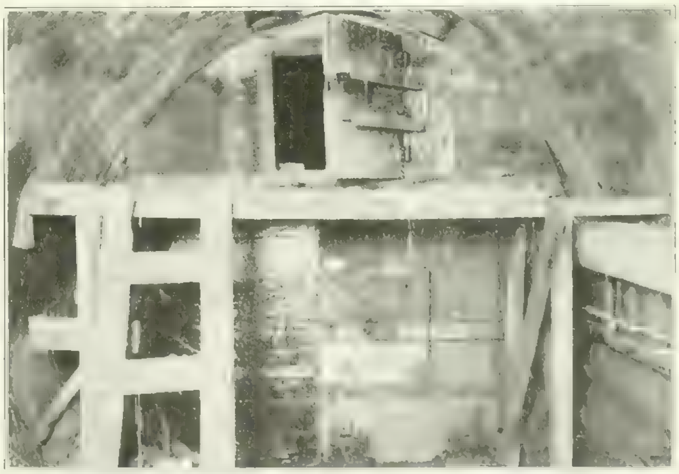


Fig. 5. View of Heading Side of Safety Timber Bulkhead, Linwood Avenue Tunnel Construction, Milwaukee, Wis.

Hoist and Locks.—In the completed shaft the hoist form, consisting of 12 x 12 in. timbers, was then constructed. It is divided into two compartments, each compartment being provided with guides for one cage. Two cages operated on a breast cable by means of an electric hoist have been in constant operation. These cages conveyed both the ingoing and out-going mules and also the laborers. A set of air locks were installed at station 0 + 75. It consisted of one material lock and one man lock. The material lock is composed of ⅜ in. boiler steel, is 7 ft. in diameter and 20 ft. long. The man lock is composed of ⅜ in. boiler steel, is 3½ ft. in diameter and 12 ft. long. It has been necessary to use these locks for one emergency, which will be described later. Figure 2 shows the design of the steel air locks for material. Figure 3 is a view of both locks.

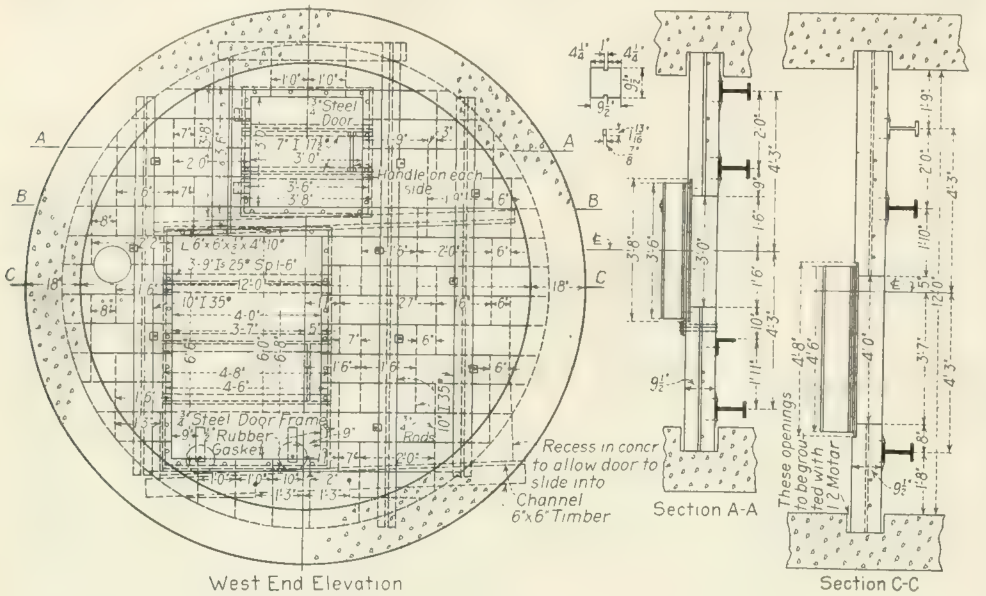


Fig. 6. Plan and Sections of Safety Timber Bulkhead, Showing Arrangement of Structural Steel and Doors.

LAKE TUNNEL.

Excavation.—Excavation in tunnel proper was started Aug. 8, 1913. The material encountered consisted of brown shale, or what is known as Hamilton shale interlaid with thin layers of clay. Drilling was done by means of 2¾ x 24 in. Ingersoll Rand drills in service on every mining shift, there being two shifts in 24 hours. The number of holes drilled per shift averaged 20, as follows: 4 holes, 8 ft. deep, in the bench; 6 holes, 6 ft. deep as cut holes, in the face; 4 holes, 4 to 6 ft. deep, in the roof, and 3 holes, 6 ft. deep in each side. These were loaded with 60 per cent Gelatine dynamite for blasting, the number of rounds varying from three to four. The average amount of dynamite used per hole has varied from 1¼ to 2 lbs. The average daily mining progress varied from 5½ to 10 ft. The weekly progress in excavation varied from a minimum of 33 to a maximum of 68 lin. feet. The maximum volume of shale excavation was 626 cu. yds. per week, the minimum of this excavation being 308 cu. yds. The removal of muck was done by means of steel cars, of ⅔ cu. yd. capacity, drawn by mules. These cars are of the tipping side dump type. A car is shown in Fig. 4 which also shows the nature of the material traversed and the method of timbering the roof.

Difficulties Encountered.—Severe difficulties were encountered in the progress of the excavation at widely separated points. The first roof collapse occurred at station 6 + 60 and extended to station 6 + 90, on Jan. 18, 1914. This extended above the normal timber line for a height of approximately 7 ft. The second roof collapse occurred at station 8 + 25, extending to station 8 + 65. This was one of the most severe roof collapses that occurred in the year, extending 18 ft. above the normal timber line. Following this collapse, great difficulties were encountered in driving the tunnel, on account of severe seaming and the unsolid condition of the roof. This trying condition was met from station 8 + 65 to station 10 + 60. No further serious mishaps were encountered in excavating until station 27 + 95 was reached, where a serious roof collapse occurred on Sept. 27, 1914, carrying down timbers and leaving a hole 15 ft. wide and 9 ft. long at the bottom and 7 ft. by 8 ft. at the top extending 15 ft. above the normal timber line. From this hole came gravel, sand, clay and disintegrated shale. The excavating was then advanced to station 29 + 09, where another roof collapse occurred, extending to station 29 + 19. This hole measured 3 ft. square at the normal timber line, extended 8 ft. above the normal timber line and was 2 ft. square at the top. It brought down glacial drift, disintegrated shale and 2 ft. of hardpan roof.

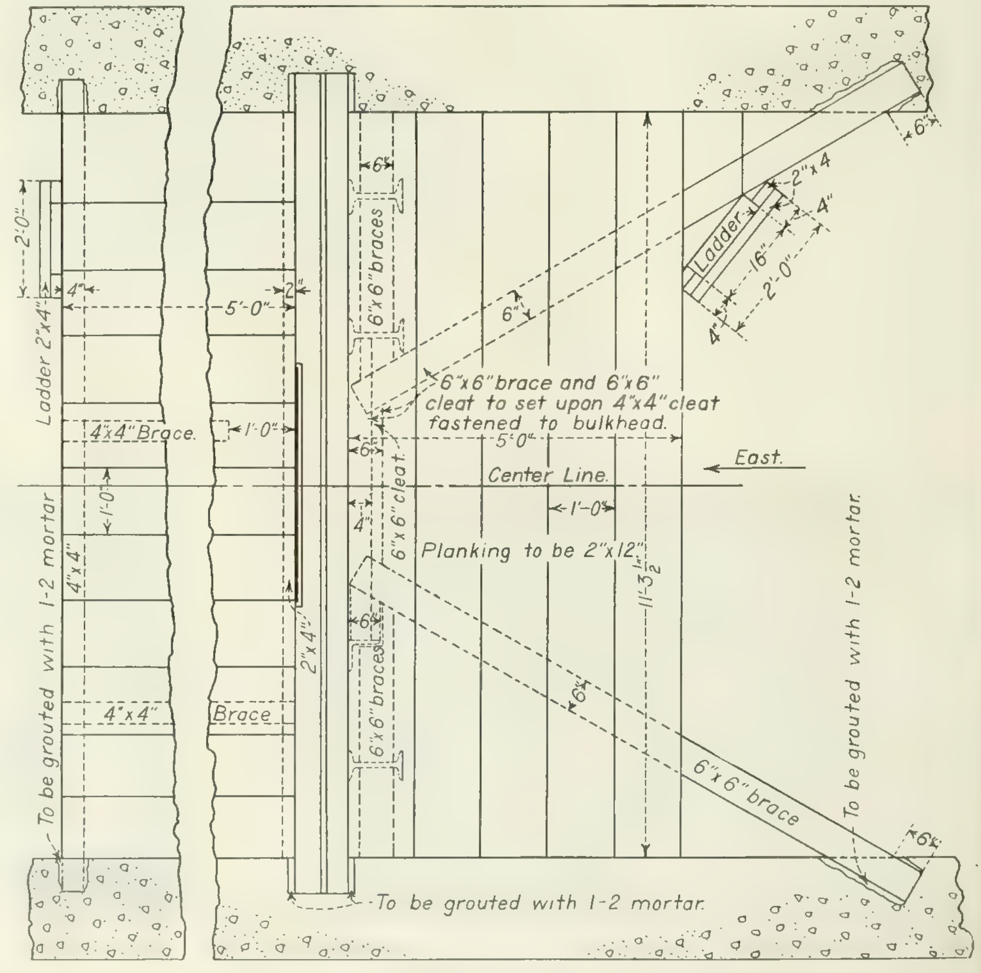


Fig. 7. Section B-B of Safety Timber Bulkhead Shown in Fig. 6.

This accident on October 12, necessitated for the first time the putting of the tunnel under air pressure for 48 hours, the maximum air pressure being 26 lbs. One interesting result which was brought to light by placing the tunnel under air pressure was the fact that the tunnel shell was comparatively air tight. After the cessation of delivering air pressure to the tunnel, the pressure dropped from 26 to 17¼ lbs. in eleven hours. The excavating proceeded without any unusual delay from station 29 + 19 to station 34 + 48. At the latter station, on Dec. 21, 1914, a roof rupture occurred, carrying away one timber and deflecting others. Due to the quickness in timbering the point of rupture, no hole of any size resulted in the roof. Heavy seams and a deflection in the roof stratification, and the breaking of the timbers, were the only evidences of a rupture. Wherever any roof ruptures or collapses occurred, causing holes above the timber lines, these holes were filled and packed securely with timber cribbing so that the pressure of the roofs of the holes was transmitted directly upon the cribbing and then upon the regular timber sets.

Due to the foregoing mentioned difficulties, and to the probability of meeting additional bad sub-ground, it was decided advisable to install a safety bulkhead for the protection of the men, and it was also decided to change the grade, so that an additional 10 ft. of covering would be secured when the tunnel reached the crib. A change of grade from 0.66 per cent to 2.00 per cent was started at station 29 + 50. At station 31 + 41, because of another rupture in the unlined roof, it was found necessary again to depress the grade, changing from 2.00 per cent to 3.73 per cent. This grade was followed to station 31 + 61, where the grade was changed from 3.73 per cent to 2.43 per cent. This was followed to station 31 + 83 where the grade was again changed from 2.43 per cent to 5.41 per cent, due to the fact that the roof timbers, already placed, were found too low, and to the inadvisability of removing them due to the danger of a roof collapse. At station 32 + 06, it was decided to return gradually to the 2.00 per cent. The falling grade was changed from 5.41 per cent to 2.70 per cent. At station 32 + 30, the grade was changed for 2.70 per cent to 2.00 per cent, this rate was continued to station 35 + 90 where the grade was returned to 0.66 per cent, the additional 10 ft. of covering having been secured. These changes in grades are referred to falling grades only. As a commentary upon the maximum grade advisable for hauling with mules, it was found that 2.00 per cent is the maximum advisable grade for the employment of mule hauling.

Safety Bulkhead.—The safety bulkhead was installed at station 28 + 79. The heading side of the safety bulkhead is shown in Fig. 5 and the design is shown in Figs. 6 and 7. It is composed of 10 x 10 in. tongued and grooved timbers, reinforced with 1 20-lb. 6 in. I-beam and 2 35-lb. 10 in. I-beams placed perpendicularly and 1 35-lb. 10 in. I-beam placed horizontally at about the spring line. In the lower half it has a 4 x 6 ft. material door composed of ¾ in. steel plate, and in the upper half, it also has a 3 x 3 ft. man door composed of ¾ in. steel. The former door is supported on two steel wheels, which travel in a steel track, the door being operated by rolling on this track. The upper door is hinged opening toward the heading. A wooden platform, 7 ft. long and extending the entire width of the tunnel, is placed just below the man door, on each side of the bulkhead. The platforms are reached by ladders. The outside perimeter of the bulkhead rests in a 6 in. groove in the concrete lining of the tunnel. The placing of this bulkhead created an additional air chamber in the tunnel because every precaution was taken to assure airtightness in the structure. In case of any emergency arising to require the use of this bulkhead, the material door first would be closed. This would stop the rush of any soft material and would temporarily check the water. The laborers in the meantime would have a chance to escape through the upper exit, or man door. It has not been found necessary to use this bulkhead, but on two occasions everything was prepared to throw it into immediate use.

ACKNOWLEDGMENT.

The second and final article pertaining to the construction of this lake tunnel will be published in the next issue. The information here given is derived chiefly from a paper by Mr. George F. Staal, City Engineer of Milwaukee, before the Wisconsin Engineers' Society. The copy for illustrations was furnished this journal by Mr. Staal. Mr. Lee G. Warren is resident engineer on construction and Mr. Roland E. Stoelting, Assistant Engineer, has been chief designing engineer under the city engineer.

Design and Operation of New Water Filtration Plant at Quincy, Ill.

The new water filtration plant at Quincy, Ill., which replaced an old filter installed in 1891 under the O. H. Jewell patents, was placed in operation on Sept. 1, 1914. The new plant is of fireproof construction with reinforced concrete substructure, brick superstructure and steel doors and windows.

The concrete substructure is 172 ft. by 89 ft. and the highest concrete walls rise 25 ft. above the footings. Of the total area, the six 1,000,000 gal. filter units, with pipe gallery, cover 40 ft. by 89 ft. at the north end. Adjoining the filters on the south, a space 12 ft. by 89 ft. is used for the main entrance and stairways leading down to the pipe gallery and up to the operating floor, and for the steam heating plant and coal bin. Then a space 24 ft. by 89 ft. is occupied by the forebays and mixing chambers. The remaining area, 96 ft. by 89 ft., is used for sedimentation purposes.

Two complete coagulating, mixing, and sedimentation units are provided and connected in such a manner that they can be operated in parallel, in series, or either unit may be operated alone. The No. 1 unit provides for two-thirds of the total capacity and the No. 2 unit one-third. Present indications are that the best results can be obtained by the series method of operating. The plant is therefore being operated as follows:

The low service pumps discharge into an open forebay where the water is treated with the first dose of sulphate of alumina. It then travels about 400 ft. over and under the concrete baffles in the mixing chambers and finally passes through sluice gates into sedimentation basin No. 2. This basin is 27 ft. by 94 ft. by 20 ft. in depth and is provided with a vertical concrete baffle which extends nearly the entire length of the basin on the center line. When the plant is operating at a 6,000,000 gal. rate this basin provides a travel of about 175 ft. and a period of 1½ hours for sedimentation. From the outlet side of this basin the water is drawn from the surface, over a weir, through a large sluice gate, and passes through a concrete flume to the second forebay where it receives its second dose of alum, as it begins its tortuous passage through the mixing chambers connected with basin No. 1. This basin is 55 by 94 ft. by 20 ft. deep with one vertical concrete baffle on the center line around which the water must pass. The sedimentation period in this basin is about 3 hours, making the total for both basins 4½ hours. The water passes from the outlet side of this basin to the filters.

Steel storage tanks, for coagulating solutions, are provided in duplicate for the alum and lime. A small electric motor is used to stir the solutions constantly to keep them of uniform strength.

The coagulant feed is accomplished by means of constant head orifice boxes, the solution flowing by gravity from the orifice boxes to the forebays. A complete hypochlorite sterilizing plant is also installed in duplicate. This solution flows by gravity and is introduced into the filtered water as it passes through a 24-in. pipe line on its way to the high service pumps.

The six filters are grouped, three on each side of the pipe gallery. They have a sand area 12 by 32 ft. and are 10 ft. deep. The regulation New York Continental Jewel Filtration Co. strainer system, as designed for the combined air and water wash, is used. The strainers are covered to a depth of 1 ft. with graded gravel and the sand has a depth of 30 ins. Ottawa sand of .38 mm. effective size is used. Two steel wash water troughs run the entire length of the filters and provide a very uniform flow of water from the entire sand area during the washing process. The filters are equipped with loss of head gages, hydraulic operated valves and the Simplex Venturi Tube type of rate controllers.

The space under the filter beds is used for storage of filtered water. The two basins are 32 by 38 ft. each in area and hold a depth of water of 9 ft. thus providing storage for 160,000 gals. Since water for filter washing is taken from the clear wells the capacity is rather small and it would be entirely inadequate if direct pressure were maintained. Duplicate motor driven centrifugal pumps and one motor driven blower comprise the necessary mechanical equipment for filter washing.

The superstructure is of a buff colored St. Louis hydraulic pressed brick, with a dark red brick for quoins, and Bedford stone trim. The head house, which is 62 by 89 ft. and two stories in height, is located over the forebays, mixing chambers and a part of the sedimentation basins. The second floor is of reinforced concrete supported by concrete columns and beams. This floor provides ample space for the storage and mixing of coagulants. The tops of the solution tanks extend 3 ft. above the second floor and they rest upon concrete platforms which stand 5 ft. above the lower floor. Numerous manhole frames and covers, set in the floor, provide access for cleaning and opportunity for study of the effect of the coagulants on the water as it passes through the mixing chambers. Large rectangular openings, over the inlet and outlet of the sedimentation basins, also provide convenient points for sampling and observation of the operating results.

A well equipped water works laboratory is also located on this floor. It consists of four connecting rooms having a total floor area of 625 sq. ft., with well lighted work benches and sinks, and all of the apparatus and utensils necessary for the preparation of media and for the bacterial and microscopic examination of water.

The filters are covered by a one story brick superstructure which rests upon the outside walls of the filters, leaving the entire area of the filter beds open for inspection. This room is well lighted by means of a monitor roof over the operating floor in addition to the windows in the side walls.

ACKNOWLEDGMENT.

The original designs for this plant were prepared by Messrs. D. W. Mead and C. V. Seastone, Consulting Engineers of Madison, Wis. The contract for the construction of the plant was awarded to the New York Continental Jewel Filtration Co. and this Company sub-let the building construction to the Coddington Engineering Co., of Milwaukee, Wis. Mr. Carl Francis was resident engineer for the Filter Company during the construction period, and Mr. Gilbert Pratt was in charge of its operation during the official efficiency test which was conducted by Mr. W. F. Langelier of the Illinois State Water Survey. Valuable assistance was also rendered by Dr. Bartow and Mr. Paul Hansen, Director and Engineer, respectively, of the State Water Survey, in the preparation of the plans and the final award of the contract. The plant is for the Citizens' Water Works Co. of Quincy of which Mr. W. R. Gelston is Superintendent. The foregoing information is from a paper by Mr. Gelston before the Illinois Section of the American Water Works Association.

Topographic Maps of the Philippine Islands.—A series of topographic maps of the Philippine Islands prepared in the Geographic Division of the Insular Bureau of Surveys under Mr. P. A. Welker, Director of Coast Surveys, and printed at the Coast and Geodetic Survey office at Washington, may be obtained for 50 cents each from the office of the Coast and Geodetic Survey at Washington or the sub-office at Manila. These maps are part of a series which will eventually cover the whole of the Philippine Islands. They are in colors and on a scale of 1:200,000. The sizes within borders are respectively 50 x32, 44x36, 32x30, 38x35, and 43x24 ins. The maps were compiled from surveys by the Coast and Geodetic Survey, the U. S. Army, the Bureaus of the Insular Government, unpublished Spanish maps, information furnished by municipal officials, the Manila Railroad Co., and other sources. Elevations are shown by hachures and the principal heights are given in figures, in meters above mean sea level. There are graphic scales of miles and kilometers, and also border scales on these maps and projection lines are shown. The projection is polyconic.

A map is in preparation which will cover the entire Archipelago on a scale of 1:1,000,000, which will conform to the plan adopted by the International Geographic Congress for an atlas of the world.

The new filtration plant at Miraflores, the largest and most complete purification plant in Central America, was placed in service on Sunday, March 14. All water supplied to the canal villages south of Paraiso, and the city of Panama are now purified at this plant, after being pumped from the Chagres River at Gamboa.

BRIDGES

Design and Construction Work Preliminary to the Actual Shifting of a Double-Track Swing Bridge on the Chicago & Northwestern Ry., at Milwaukee, Wis.

(Staff Article.)

The shifting of a new swing span at Milwaukee, Wis., from the temporary falsework on which it was erected to a bearing on its substructure involved some interesting preliminary work and some difficult shifting operations. The bridge, which is on the line of the Chicago & Northwestern Ry., and spans a part of the channel of the Milwaukee River, is a double-track structure, with a length between end bearings of 237 ft. 6 ins. The new span was placed on the reconstructed pivot pier of an old draw bridge. To permit this reconstruction work, and to interfere as little as possible with traffic, the old span had previously been moved a short distance downstream and placed on a temporary substructure. In this position it formed part of a temporary double-track line which was continued in use until the new span was practically completed. The old span was moved on scows to its temporary location Oct. 25, 1914, and remained in this position until March 14, 1915, when it was moved to afford sufficient space for the shifting to place of the new span. The width of the river at the bridge site is about 350 ft., which required the construction of pile trestle approaches at each end of both the new and temporary structures. The old pin-connected bridge had a length of 237 ft. 6 ins. between end bearings, and weighed about 500 tons, while the new span, which is a riveted latticed structure, has the same length, but weighs about 740 tons. This article will deal mainly with the preliminary work done in connection with the erection of the new span on falsework, the reconstruction of the old substructure, and other work preliminary to the actual shifting operations, the latter being performed on March 14, 1915.

As will be noted by referring to Fig. 1, the new bridge was erected on falsework a short distance upstream from the position it was finally to occupy. Its longitudinal axis was in line with the protection work of the permanent and temporary pivot piers, while its distance from the new location of the old span was such that material entering into its construction could be unloaded from the old span directly onto the falsework of the new span. The new bridge, as erected on its falsework, was about 6 ins. higher than the temporary span.

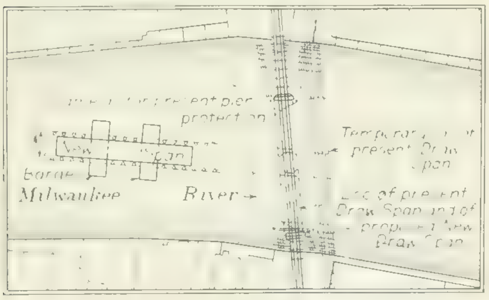

permanent pier protection
Temporary present Draw Span
New Span
Barge
Milwaukee River
Line of present Draw Span in 1915 proposed New Draw Span

Fig. 1. Layout Showing Position in Which New Span Was Erected, Its Final Location, and Temporary Position of Old Span in Diversion Line—C. & N. W. Ry. Bridge, Milwaukee, Wis.

NEW SPAN AND REPAIR WORK REQUIRED.

The trusses of the new span are spaced 31 ft. on centers, and are 32 ft. high between centers of top and bottom chords. The distance from top of masonry to base of rail is 8 ft. 1 in. The bridge has a clear width of 29 ft. and a clear height of 22 ft. 6 ins.

During the time that the new span was being erected on its falsework, repairs were made on the old pivot pier and on the end supports for the span. The repairs for the pivot pier consisted of a reinforced concrete cap placed on the old masonry. This cap is octagonal in plan, with a short diameter of 34 ft. Figures 2 (a) and (b) show a plan and cross section of the top portion of the pivot pier. These drawings show clearly the details of the new concrete cap. The quantity of concrete (1:2:4 mix) required for the repair of the pivot pier was 88 cu. yds.

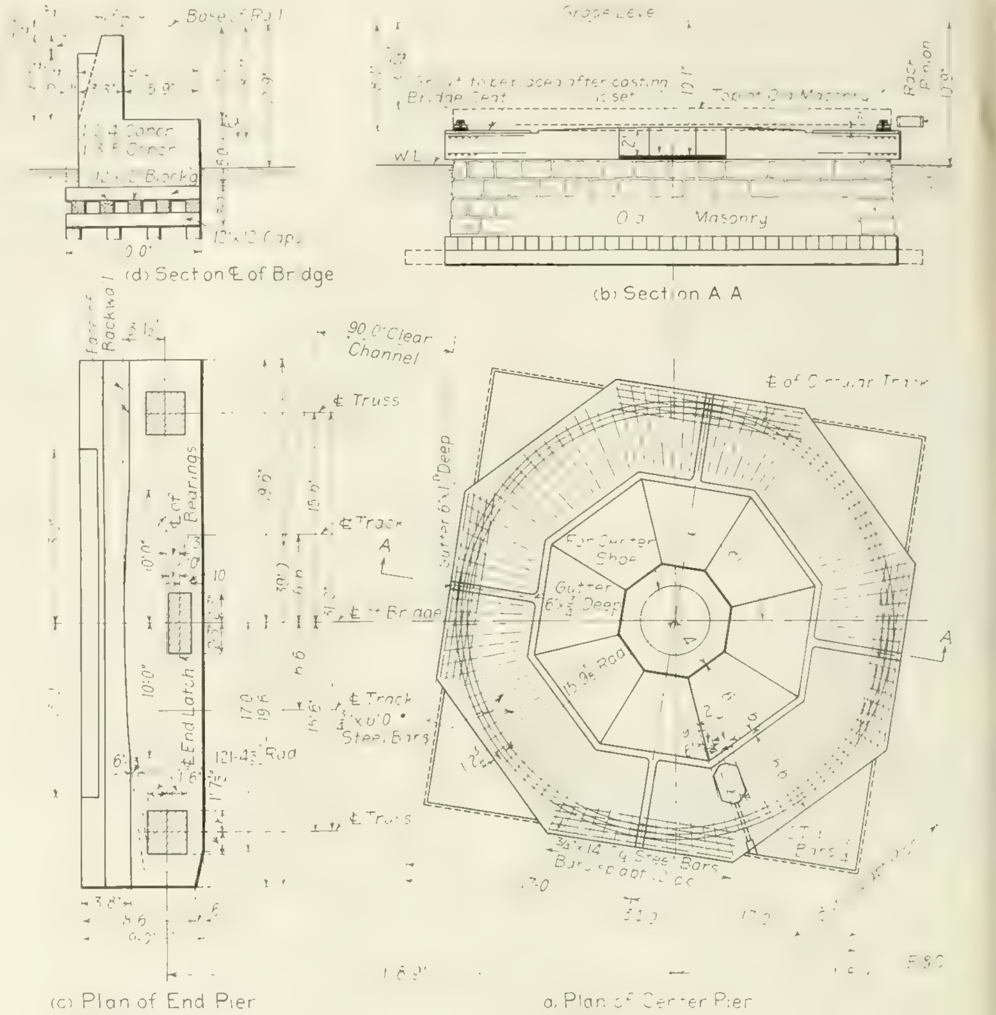


Fig. 2. Plans and Elevations of End Piers and Top Portion of Pivot Pier of C. & N. W. Ry. Bridge, Milwaukee, Wis.

Figures 2 (c) and (d) show a plan and a cross section of the new end piers of the swing span. The distance from the end bearings of these piers to the center of the pivot pier is 118 ft. 9 ins. To construct these two piers required 100 cu. yds. of 1:2:4 concrete and 91 cu. yds. of 1:3:5 concrete.

Figure 3 (a) shows a cross section of the center bearing for the new span. In this drawing the top portion is shown raised above the phosphor bronze disk, to indicate the division line between the portion which was erected with the draw span and the portion erected on the substructure. It will be noted that the top concave bearing was erected with the superstructure. This procedure made it necessary to drill holes through this concave bearing and bolt it to the top portion, the heads of the bolts (not shown in the drawing) being countersunk at the lower plane of the concave bearing. It will be noted that the top concave bearing was beveled, at "B" around the circumference, to make it enter its socket more easily.

The centering band shown in Fig. 3 (a) and (b) was used as a guide during the placing of the superstructure on its bearing. This band was built in three sections. When the bolts connecting these sections were loosened, the inside radius of the band was about 1 ft. 10 ins. The band was placed on the center bearing, as shown in Fig. 3 (a), with the bolts loosened. After the superstructure was floated approximately to its final position, and the top bearing was made to enter this band, it was accurately centered by tightening the three bolts of the band, the radius thus being reduced to 1 ft. 7 13/16 ins.

Fig. 3 (c) is a cross section of the rack circle and bearing at the turntable circumference. The portion above the line B-B was erected with the superstructure. The rack circle was made in section, and during the shifting operations two sections were removed opposite the rack pinions, to avoid interference between pinions and rack while lowering the bridge.

The new span is electrically operated, the operating mechanism being furnished in duplicate, to provide against accidents. A 32-hp. gasoline engine is also installed for emergency use. As a further precaution hand-power machinery is also installed. The specifications for the machinery require that the bridge be turned through an angle of 90° in 50 seconds, against an unbalance wind pressure of 1 lb. per square foot, this movement to consist of: acceleration through 22.5°, 17.25 seconds; constant velocity through 49.5°, 19 seconds; and retardation through 18°, 13.75 seconds. Against the same unbalanced wind pressure it was required that the hand-power equipment be capable of turning the bridge through an angle of 90° in 11 minutes by 8 men (4 at each capstan) walking at the rate of 3 ft. per second and exerting a force of 50 lbs. each.

WEIGHT OF STRUCTURE MOVED.

The following are the itemized weights of the structure moved, the weights of machinery and structural steel being taken from the shipping statement:

	Lbs
Gasoline engine and 4 motors and machinery	18,000
Trusses, laterals and portals	634,000
Floor system except center panels	296,000
Loading girder system	168,000
End lifting and turning machinery and machinery supports	136,000
Stairs, etc., and floor system for engine house	73,000
Engine house, wooden framework	26,000
Ties and rails in place	130,000
Total	1,481,000
Approximate weight of blocking	210,000
Total weight on scows	1,691,000

ERECTION FALSEWORK.

As has been noted the new span was erected on falsework a short distance upstream (see Fig. 1). On account of the size and weight of this double-track swing bridge, an extensive system of falsework was required, special construction being necessary to permit the placing of the scows used in shifting the span. This falsework was designed to give support to the trusses at each panel point, which necessitated the use of 18 timber bents, in addition to the special construction over the scows. To span the scows the following old girders were used, these girders being material from old bridges taken from various points along the line of the C. & N. W. Ry.: One 54-ft. girder; one 53-ft. girder; two 51-ft. 10-in. girders, and four 39-ft. 1¾-in. girders. The weight of these girders was about 183,700 lbs.

Figures 4 (a) and (b) show a general plan of the falsework and a section of it along the center line. Figures 4 (c) and (d) are half elevation of bents Nos. 4, 5, 6 and 7 and bents Nos. 13 and 14, respectively. Figures 4 (e) and (f), are half elevations of bents Nos. 1, 2 and 3, and bents Nos. 8 to 12 and 15 to 18, respectively. These drawings give the essential details of the system of falsework used. To afford protection to the falsework, pile clusters were placed around it, as shown in Fig. 4 (a), these clusters being extended to the protection work of the pivot pier. With the exception of two clusters, near the upstream end of the bridge, these clusters contained seven piles each, wrapped with chains; the two end clusters contained 19 piles each.

To provide for the camber of the lower chord it was necessary to use great care in bringing each panel point to its relative position; this was done by means of oak wedges placed near the ends of the floorbeams, as shown in Fig. 4.

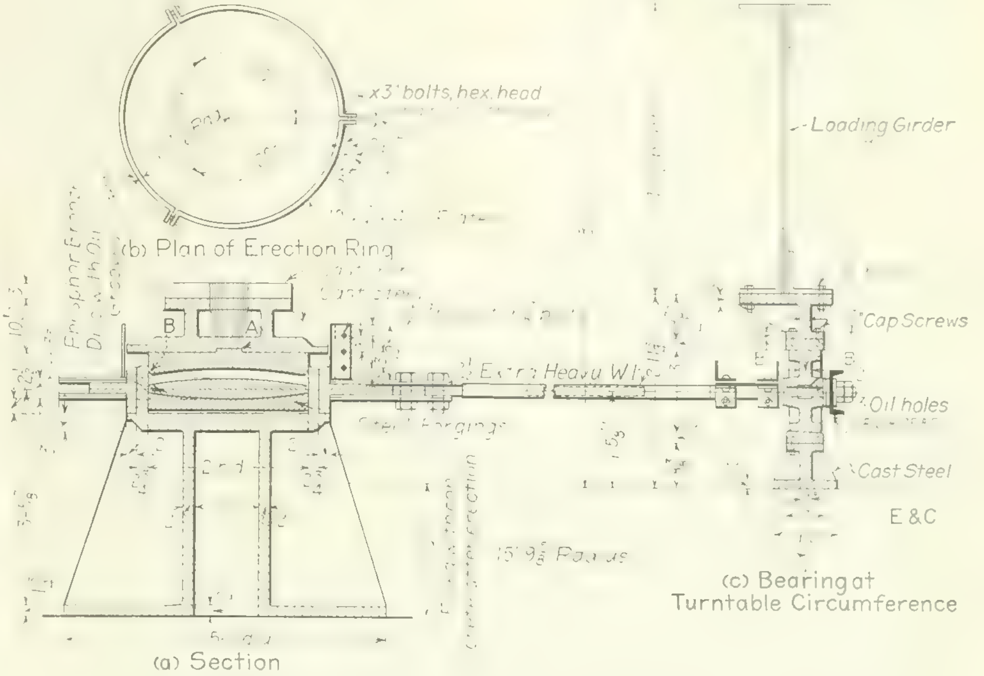


Fig. 3. Cross Sections of Center Bearing and Turntable Circle and Bearing of C. & N. W. Ry. Bridge—Note Erection Ring Used in Setting Span on Center Bearing.

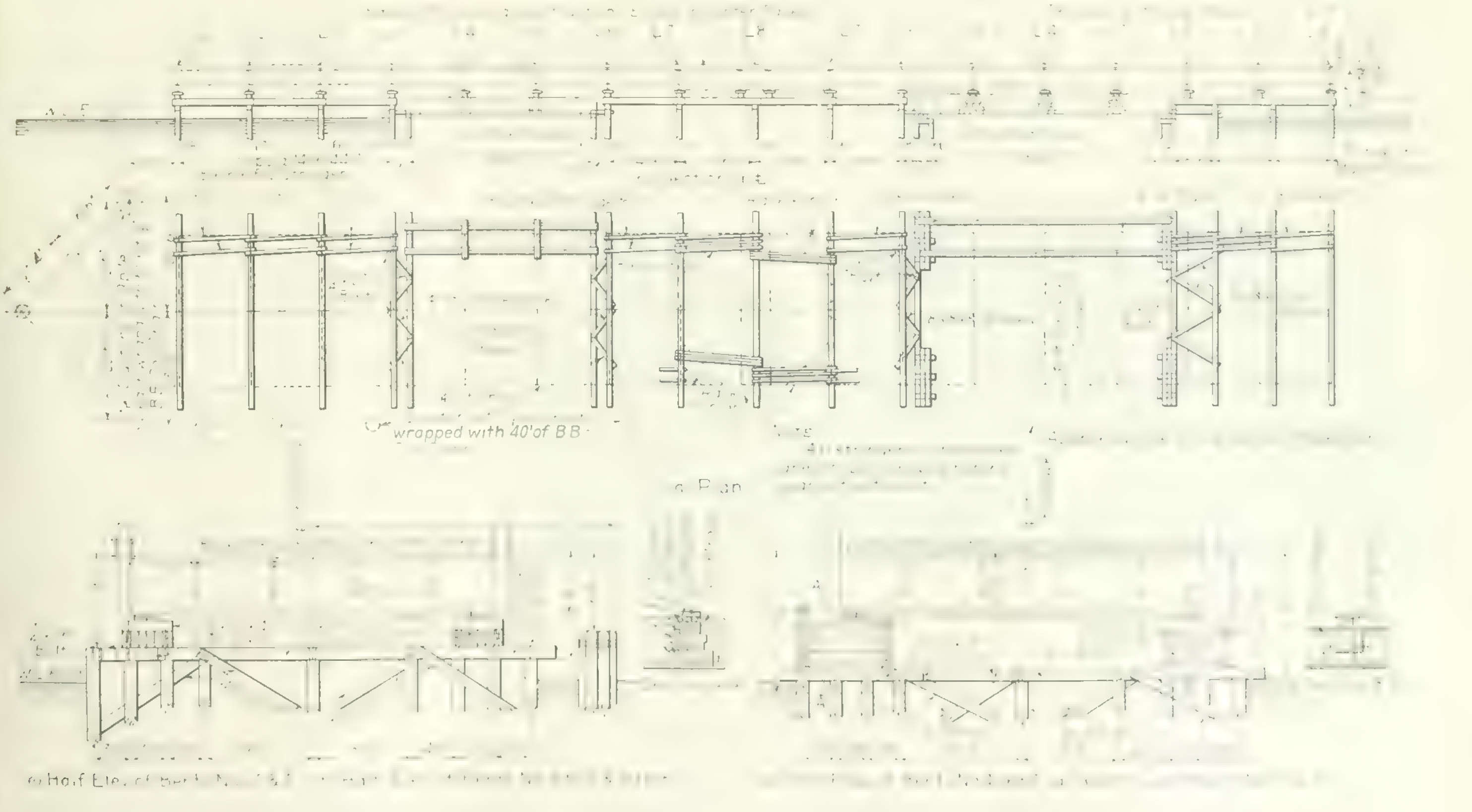


Fig. 4. Plan, Elevation and Cross Sections of Falsework Used in Erecting New Swing Span of C. & N. W. Ry. Bridge.

BLOCKING AND BRACING USED TO SUPPORT SPAN ON SCOWS.

It was originally planned to use only two scows in floating and shifting the spans (see Fig. 4, b). To give greater stability, and to provide against unforeseen conditions, two small auxiliary scows were used, these scows being placed near the ends of the span. They did not enter into any of the calculations, however, as the two large scows, a 35x100x8-ft. steel scow and a 33x110x8-ft. wooden scow, were of sufficient capacity to float the span and raise it to the required height.

After the span was erected and the substructure made ready to receive it, the scows were placed in position, and the span was blocked up on the scows and braced as shown in Fig. 5. The span was brought to a bearing by means of the oak wedges shown in the drawings. The struts shown in Fig. 5 were so placed as to distribute a part of the weight of the swing span to the ends of the scows, and thus give a more even distribution of the loading.

Figure 6 gives computed data in connection with the floating in of the scows, the loading of them, and the landing of the span on its substructure. Figure 6 (a), (b) and (c) apply to the 35x100x8-ft. steel scow, and Figs. (d), (e) and (f) to the 33x110x8-ft. wooden scow. It was specified that, if the elevation of the water was greater or less than that shown on the drawings, the difference was to be subtracted from or added to the height of the blocking. It was further specified that the draft of the scows should be measured after the blocking, pumps, etc., were placed; and that, if this draft plus the calculated draft from the bridge plus 6 ins. of water in the scows exceeded 6 ft. (see Figs. 6, b and e), the height of the blocking should be increased by this excess and the freeboard correspondingly reduced.

SHIFTING PROCEDURE AS OUTLINED BY C. & N. W. RY.

The following data give each step of the work, connected with the shifting of the swing span, as outlined by the Engineering Department of the Chicago & Northwestern Ry.:

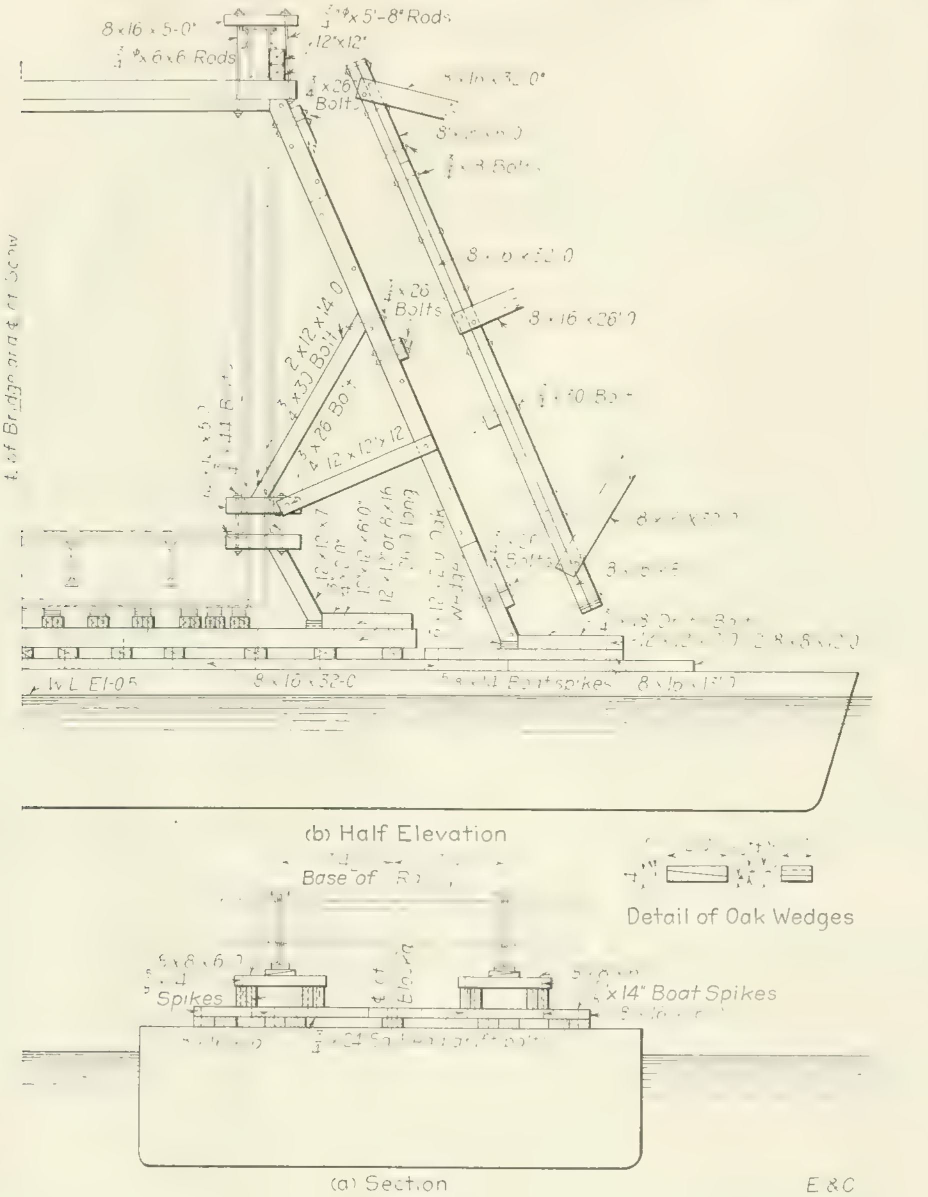


Fig. 5. Elevation and Cross Section, Showing Blocking Used to Support New Swing Span on Scows, and Struts Used to Distribute Loading Over Scows—C. & N. W. Ry. Bridge.

First Period—7:00 *to* 10:15 *a. m., Mch.* 14. 1915.—River traffic will be closed at 7:00 a. m.

Work of the Great Lakes Dredge & Dock Co.:

(a) On new span.

(1) Drive the wedges under the new span, bringing it to bearing on the scows. The scows will have been previously floated into position with all the blocking adjusted to give a free board, when wedges are driven of 10 ins. on the steel scow, and 1 ft. 10 ins. on the wood scow. (Note.—This free board is to top of deck, and does not include the combing.)

(2) Pump out the scows, raising the span 1 ft. (not less) above the elevation at which it was erected.

(3) Remove all the stringers in the falsework span under the west half of the loading girders, to make the way clear for the west pinion in floating out the bridge.

(4) Float the span into the channel north of the falsework, and upstream far enough to turn the span square across the channel beyond the end of the falsework. Make the turn in such a way that the stairway on the span will be on the downstream side when the span is turned.

(5) Remove all the timber in the falsework down to the level of the tops of the caps.

(6) Float the span toward the piers, straddling the falsework piling. Stop about 100 ft. from the new pier, and hold stationary until the old span has been floated out of the way.

(b) On old span:

(1) Float the four scows into position under the old span. (The blocking on these four scows will have been previously adjusted to give the free board indicated on the blocking plans, when scows are in position under the bridge.) Hold the scows in true position with lines and timbers, so that they will be ready for driving the wedges under the span when signal is given.

Work of the Railway Company:

On old span:

Connect up all the parts used in carrying the center castings, wheels, rack and treads. (Span must not be swung after these parts are connected up.)

Second Period—10:15 *a. m. to* 4:00 *p. m.*—Traffic over bridge will be closed at 10:15 a. m. after train No. 119, north bound, has passed:

Work of Great Lakes Dredge & Dock Co.:

(a) On old span:

(1) Drive the wedges under the old span, bringing it to bearing on the scows.

(2) Pump out the scows until the span is raised not less than 1 ft. 0 in. above the present elevation. (The two scows nearest the center of span should be pumped as nearly dry as practicable. The other two scows should be pumped out until the bridge is raised the required amount.)

(3) Float the old span down stream to the place designated by the Railway Company for landing the span, and anchor the scows securely.

(b) On new span:

(1) Float the new span toward the piers, keeping the scows parallel to the protection pier, until the northeast corner of the span is about 1 ft. from the west end of the north pier. Then hold the north end stationary and swing the south end down stream until the bridge is parallel to its final position.

(2) Float the span to position over the piers, keeping it always parallel to its final position, guiding it by the ends, and controlling the scows by ropes running to the drums of hoisting engines on scows or floating pile drivers anchored above and below the bridge, in each channel.

(3) When span has been brought to true alignment, and centered over the center pier, hold it against horizontal displacement by stop timbers at both ends, and by ropes holding it firmly against wedges at the south pier.

(4) Lower the span by sinking the scows until the span is about 6 ins. above its final position. The span must be perfectly level when the lowering is stopped at this stage.

With the span at this elevation, the Railway Company's crew will place the centering ring on the center casting and center the span accurately over the turntable.

(5) Lower the span to permanent position on the turntable, keeping it perfectly level at all stages.

Work of the Railway Company:

(a) On new span:

(1) After the span is lowered to its bearings, and before any more water is pumped into the scows, fit the end rails into place and make all the necessary adjustments at end bearings, so that bridge will be ready for trains.

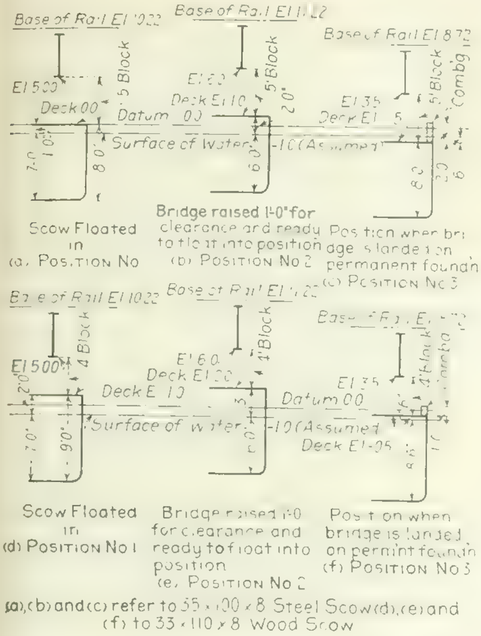
(After all the necessary adjustments have been made, and before any train is allowed to pass, the Great Lakes Dredge & Dock Co. will lower the scows until the wedges can be released and the scows swung free below the bridge.)

(2) Release the bridge for turning, and turn it (moving north and toward the west) with ropes at each end, until the rack pinions have cleared the open spaces in the rack circle where rack sections have been omitted. (During this movement one man must be stationed at each pinion to give the pinion the proper angular position for meshing with the rack, and prevent it from

locking against the first rack tooth encountered.)

Replace the two sections of the rack, and the two sections of the spacing ring. Use bolts for splices in the spacing ring.

Close the bridge and make it ready for trains. (Note: The above operation will require about one-half hour. It may be deferred to the third period if there is not sufficient time for it in the second period.)



(a), (b) and (c) refer to 35 × 100 × 8 Steel Scow (d), (e) and (f) to 33 × 110 × 8 Wood Scow

Fig. 6. Computed Elevations of Base of Rail of New Swing Span and Draft of Scows During Various Floating, Shifting and Setting Operations—C. & N. W. Ry. Bridge, Milwaukee, Wis.

(3) Make all the connections in the power-transmission system, completing the circuit up to the switchboard in the operator's house.

(4) Remove the top course of timber on the temporary center pier, and all drift bolts or other obstructions above the level of the second course of timbers. Also remove all the timbers of the old center pier protection that project above this level, over all that portion within 120 ft. of the center of the new bridge.

(5) Remove from the north temporary pier the end bearings of the old span, the pony bent, and the first course of timbers forming the bridge seat. Also remove the west railing, the deck, and the stringers under the west track on the first span back of the north temporary pier.

Third Period—4:00 *p. m. to* 6:00 *p. m.*

Work of the Great Lakes Dredge & Dock Co.:

(1) Remove the scows from across the channel, out of the way of the river traffic.

Work of the Railway Company:

(1) Make all connections of the power-transmission system and other parts of the electrical installation that may not have been completed in "Second Period."

Test the operation of the bridge with electric power by turning 90° in each direction from closed position.

Have bridge ready for operation so that traffic on river can be resumed at 6:00 P. M.

General:

In order that there may be no misconception of authority and responsibility, and no conflict of orders, it must be understood that all work of lifting and moving the bridges on the scows, and of lowering the new span into place, will be done under the direction of the Great Lakes Dredge & Dock Co., whose superintendent and foremen will give all orders and signals for the movements of the spans while on the scows.

(The actual shifting operations are covered in the following article.)

PERSONNEL.

The work described in this article was in charge of the Engineering Department of the Chicago & Northwestern Ry.: W. H. Finley, chief engineer; W. C. Armstrong, engineer of bridges, and H. M. Spahr, resident engineer, in charge of field work. The Cleary-White Construction Co. built the new end piers and reconstructed the pivot pier; the American Bridge Co. fabricated the steelwork; the Bernhisel Construction Co. erected it; and Geo. P. Nichols & Brother installed the power equipment. The actual shifting operations were in charge of the Great Lakes Dredge & Dock Co.

Actual Operations in Connection With the Shifting of Double-Track Swing Spans on the Chicago & Northwestern Ry. at Milwaukee, Wis.

(Staff Article.)

In the preceding article data are given on the design of the substructure, falsework and bracing for the new swing span of the Chicago & Northwestern Ry., at Milwaukee, Wis., together with a description of the construction features preliminary to the actual shifting of the new span and the removal of the old one from its temporary position, the article being based on data furnished by the engineers of the railway company. This article treats mainly of the work done in connection with the actual loading, shifting and setting of the new span, the data being furnished by the Great Lakes Dredge & Dock Co. The work here described was done on Sunday, March 14, 1915. A study of the drawings and data given in the preceding article will make clear the following operations.

FLOATING, SHIFTING AND SETTING OPERATIONS.

As Saturday preceding the shifting of the span was a day of favorable weather, with little surge in the river at the bridge site, the new bridge was wedged up against the blocking on the water-filled scows. It remained in this position until Sunday morning, being watched all night by crews and warning tugs to protect it from damage from passing boats, and to enable the wedges to be knocked out should any considerable change in the river level occur, due to shifting winds. As conditions were favorable during the night, and as the fair weather prevailing early Sunday morning gave promise of continuing throughout the day, the pumping out of the scows with eight pumps, using leads of steam hose from tugs, was started at daybreak; and at 7:30 a. m. the bridge had been lifted about 17 ins. off of its falsework. At 8:30 it had been shifted sideways out of the falsework, towed upstream far enough to turn around in the river, and brought down across the falsework, the upper timbers of which had been removed in the meantime to give clearance to the large operating pinions projecting below the bridge. The floating span was tied up within 100 ft. of its permanent location, with men on it to give attention to the scows, and work was then directed toward floating the old span from its temporary location, by placing under it four water-filled scows, two on each side of its transverse axis. Figure 1 is a view of the new span, the view being taken at 9:00 a. m. This view shows the type of superstructure used, and gives the position of the struts used to assist in distributing the weight of the span more evenly over the scows. It will be noted that no struts are provided for the end scows (one of which is shown), as the two center scows are intended to carry the greater part of the load.

At 10:00 a. m. the old bridge was wedged against the blocking on the scows, and at 10:15, after the last train had passed over this structure, the eight pumps on this set of scows were started. At 11:15 a. m. the old bridge had been lifted about 16 ins. off of its pier. It was then moved downstream a sufficient distance to permit the new span to be set over the permanent pier.

The new span was then moved toward its final location. At 11:40 it had reached the upstream ends of the end piers, and was being shifted to place over the pivot pier. At 12:00 noon the span was in line with its approaches, and the work of lowering it was started, by pumping water into the supporting scows. At 12:45 the adjustment of the center bearing was pronounced correct; the wedges were at once knocked out, and the scows released soon afterward. This placed the new bridge in position for railroad traffic by about 2 p. m. Further work was required, however, to complete the adjustments necessary to permit the bridge to be swung for navigation purposes, as a section of the turntable rack had been taken from each side of the bridge, to give clearance to the two large rack pinions. These pinions were quickly meshed by partially swinging the span by tugs, after which the missing sections were placed and the operating machinery tested for both kinds of power. The first train to pass over the new bridge was the regular 4:00 train.

Figure 2 is a view of the bridge in its final location, the view being taken at 1:30 p. m. The view also shows the old span and a part of the temporary diversion track.

The old bridge was towed to a slip, about a mile from the bridge site, where it was landed and dismantled.

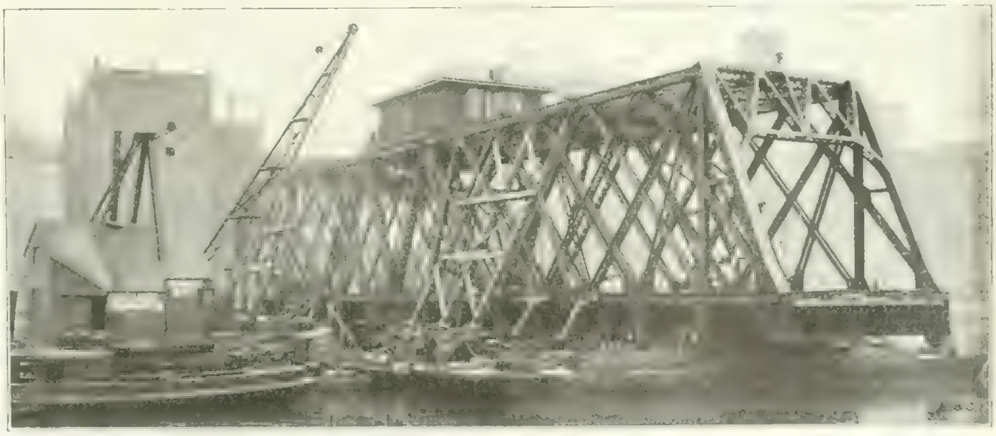


Fig. 1. View Showing New Double-Track Swing Span on Scows—Note Struts Used to Distribute Loading—C. & N. W. Ry. Bridge, Milwaukee, Wis.

COMMENTS ON PROCEDURE AND EQUIPMENT USED.

The work was complicated, and the equipment required was extensive, as it was necessary to float both the new and old spans at the same time. This was due to the fact that the new span could not be swung for navigation until the old span was removed from its position in the temporary line. Considering the weight of the structures moved, and the difficulties encountered, the time required to complete this double operation is noteworthy. The last train passed over the old bridge on the temporary line at 10:15 a. m., and the first one over the new span passed at 4:00, an interval of 5¾ hours.

Although it was planned to float the new span on two scows, and the falsework was designed to provide for only two scows, four were actually used, which made it necessary to tear out some of the falsework before the auxiliary scows could be floated into position. Four scows were also used under the old span. Each scow for both spans was fitted with two comparatively large wrecking pumps, making sixteen such pumps in use, in addition to twelve large syphons, which were used to blow out the water near the bottom of the scows where the pumps could no longer operate efficiently. Four steam tugs were used to furnish steam with which to operate the pumps and to assist in moving the spans. Two pile drivers, two floating derricks, and an air compressor plant were also employed, to furnish power and steam at various stages of the operations and to stand by, to provide against emergencies.

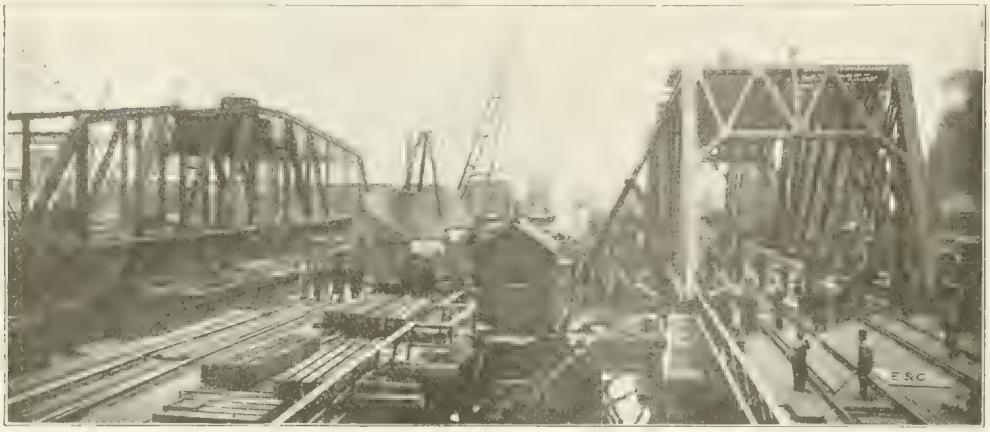


Fig. 2. View Showing New Swing Span in Final Position on Reconstructed Piers—View Also Shows Old Span and Part of Temporary Diversion Track—C. & N. W. Bridge, Milwaukee, Wis.

The use of the auxiliary scows, which actually carried only about 100 tons of load each, was due mainly to the fact that the range in the elevation of the bridge during the various operations was about 18 ins. greater than that originally considered. The critical feature therefore was, not the lifting capacity of the scows, but their ability, when at the permanent center pier, to be sunk this additional 18 ins. and still possess sufficient buoyancy to maintain the entire bridge load absolutely level while the structure was being accurately located upon, and lowered to, its center bearing. Moreover, one of the two large scows, which were originally intended to carry the entire load of the new span, was of steel construction, and as it is very difficult to control such a craft when well filled with water there would be danger of serious accident should this scow list quickly or sink entirely. This danger was augmented by the fact that the bridge site is near the mouth of the river, where storms on the lake create a heavy surge in the river. Even though wooden combings were constructed above the decks of the scows it was thought expedient to use the auxiliary scows, mainly to give stability to the bridge, which projected about 45 ft. above the water surface.

The system of struts used to distribute the load over the two main scows is worthy of comment. The use of these struts was considered advisable as the lengths of these scows (100 and 110 ft.), and the relative narrow width of the bridge (which was placed crosswise at the center of them), would cause large stresses for which the scows were not designed. As the usual loadings of such scows —sand, gravel or stone—give a fairly uniform loading the struts were intended to approximate such a loading. By means of the long struts from the top chords, and the inclined posts and A-frames from the bottom chords, it was estimated that about 60 per cent of the total load would be carried away from the center of the scows and counter-moments would be avoided near the ends. The use of steel girders and I-beams to distribute the loading was considered, but their use was thought to be impracticable, due mainly to excessive deflections.

The use of the long struts necessitated a very careful adjustment of the wedges at their lower ends, in order to distribute a proper proportion of the loading to the ends of the scows as the pumping operations progressed. In the case of the wooden scow, the deflection of the scow trusses was compensated by the compression of the 40-ft. struts. There was little deflection in the steel scow, however, due to its stiffness, and the proper proportion of the loading could be brought to the ends of the struts only by wedging the struts tightly before the pumping was started and by "slacking off" the jacks under the bridge at the center of the scows as the load came on.

The care with which the preliminary work and calculations were conducted is evidenced by the fact that all conditions of buoyancy, displacement, deflection, etc., as computed, were very closely approximated during actual operations.

PERSONNEL.

All work in connection with the shifting of the spans for the bridge was in charge of the Great Lakes Dredge & Dock Co., of Chicago.

Novel Method Used in Supporting a Pratt-Truss Span During the Reconstruction of Its Abutments.

(Staff Article.)

To insure maintenance of traffic during the reconstruction of the abutments of a bridge on the Rochester & Eastern R. R., an interesting and unusual construction procedure was adopted. The bridge, which carries the traffic of this interurban freight and trolley line, spans the State barge canal at Bushnells Basin, near Rochester, N. Y. It is a through pin-connected Pratt-truss bridge of 150 ft. span, the original foundations of which were very shallow, being only about 3 ft. below the surface of the ground.

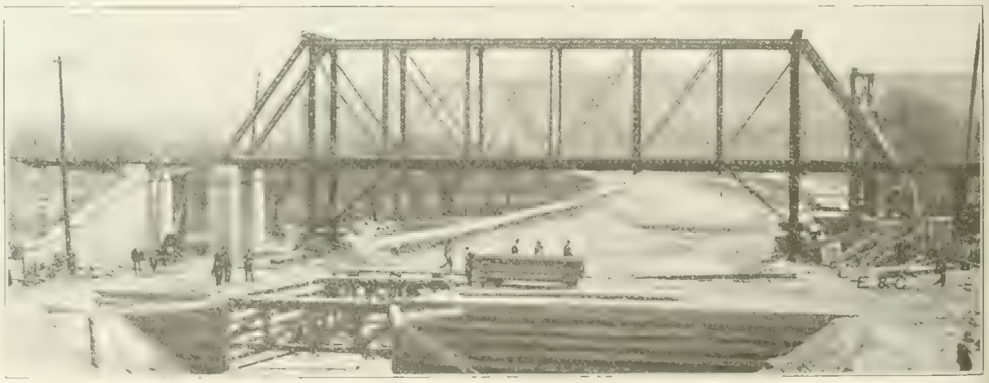


Fig. 1. View of Pratt-Truss Span During Reconstruction of Abutments—Note Manner of Supporting Span.

As the contemplated barge canal improvements involved the widening and deepening of the canal prism, it was decided that new abutments would be required by such improvements. The subsoil at the site is a very light sandy material, which, coupled with the fact that the foundations of an old highway bridge located about 200 ft. west of this structure had washed out during a break in the canal embarkment, emphasized the need of new abutments. As the contractor for this section of the canal desired to carry on work adjacent to the bridge site, it was impracticable to erect and maintain a temporary wooden trestle; hence it was necessary to maintain traffic over the bridge itself. The plans for reconstruction involved the replacement of the old abuments with two new abutments and one pier, the north end of the bridge resting on a pier. The use of an auxiliary abutment at the north end was due to the requirement that a driveway be maintained at this end. It was specified that the footings of the new abutments and piers be lowered to the bottom of the new canal prism and founded on piles.

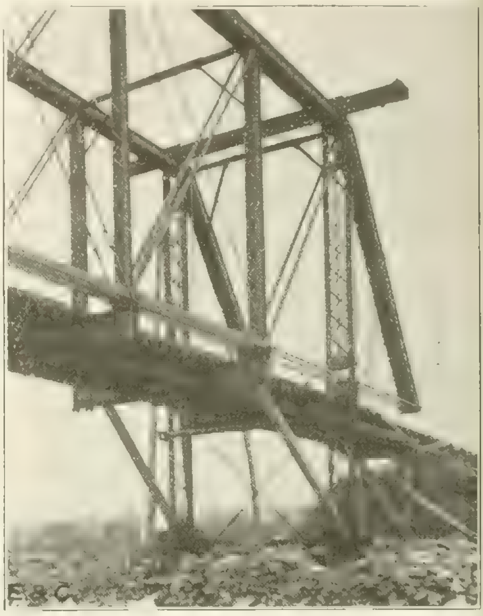


Fig. 2. View of End of Span, Showing Details of Construction Used to Support Span During Reconstruction of Abutments.

CONSTRUCTION METHOD USED.

The construction method adopted by the engineers of the Rochester and Eastern R. R. was to support the bridge by placing steel columns at the hips, or ends of the top chords, thus taking the load off the abutments and transferring it to blocking inside of the lines of the new and old substructure.

Figure 1 shows the manner of supporting the bridge on the temporary blocking during the construction of the foundations. It will be noted by referring to this view that the new pier and abutment at the north end are completed, although the load is still carried on the temporary supports. The shoring and the equipment used for concreting is shown in place at the site of the south abutment. The bridge was completely blocked up at both ends before any substructure work was started.

The columns used at the hips were special fabrications of latticed steel channels, so arranged that their center lines coincided with the center lines of the trusses (see Fig. 2). The two columns at each end of the bridge were joined together at their bases, at points directly under the floor system, and at their tops by rigid braces and by tie rods, which prevented the displacement of one truss relative to the other. Wooden braces, extending diagonally from the supporting column bases to the adjacent intermediate panel joint in the lower chord, provided for the horizontal tractive forces, while cables, anchored at the sides, prevented lateral displacements of the bridge as a whole (see Fig. 2).

The end panels of the floor and the track over the adjacent spaces at the ends of the bridge were carried on I-beams, which rested on wooden bents and blocking. The excavation for the lower part of the foundation was done in sheeted pits. An interesting construction detail consisted of the use of electric power for operating the concrete mixer and for driving the piles, the current being taken from the trolley line.

The method used proved entirely satisfactory, and, except for the slow order of car movements, the work was completed without interference with traffic.

ACKNOWLEDGMENT.

We are indebted to Chas. R. Waters, assistant engineer, Department State Engineer and Surveyor, Albany, N. Y., for the data upon which this article is based.

SEWERAGE AND SANITATION

Construction Plant and Methods Employed in Building a System of Tunnel Sewers at Edmonton, Alberta.

(Staff Abstract.)

The Saskatchewan River at Edmonton varies in width from about 400 ft. at low water to 650 ft. at flood. The corresponding variation in depth is 15 ft. though this figure has reached 30 ft. at time of extreme flood. Low water elevation is 54. The greater part of the city, 8,500 acres, lies on a plateau at elevation 200 to 260, that is from 146 to 206 ft. above low water level. A small 1,100 acres, river-flat area is about 34 ft. above low water level. In 1909 the existing sewerage systems were rapidly becoming inadequate, and field work for the collection of data upon which to base the design of a comprehensive sewage collection scheme was carried on in that year. In 1910 Mr. Alexander Potter of New York City was engaged as consulting engineer and the system here discussed was designed under his direction.

ADOPTION OF TUNNEL SYSTEM.

The considerations which led Mr. Potter to adopt a tunnel system of sewers were: (1) The height of the plateau above the river; (2) favorable ground for tunneling; (3) that steeper grades and consequently smaller sewers could be adopted in tunnel system than in open cut system; (4) the greater flexibility in the resulting system.

CHOICE OF MATERIALS.

The choice of a tunnel lining material was of first importance. The materials considered were brick, plain concrete in place, reinforced concrete in place, reinforced concrete blocks, and vitrified clay blocks.

Plain concrete was rejected owing to the difficulty of making it of sufficient strength to withstand internal pressure, and to the difficulty of construction, especially in the smaller sizes.

Brick, although very desirable as regards facility of construction, is open to the same objection as plain concrete in its inability to withstand internal pressure.

Reinforced concrete in place would be able to withstand internal pressure if constructed properly, but it was thought that the difficulties of construction would prevent it from being the most efficient or economical material to adopt. To satisfy public opinion, and to verify the above judgment, alternative bids using reinforced concrete blocks, and reinforced concrete built in place, were invited. For the larger sized sewers the prices were practically the same, but for all other sizes the reinforced concrete blocks were the cheaper. The cross-sections of the reinforced concrete built in place, on which tenders were received, were designed for the same external loads and internal pressure as the reinforced concrete blocks.

Reinforced concrete blocks were adopted, and fulfilled all the necessary requirements. Being essentially a unit form of construction each unit can be inspected carefully before being assembled in the work and, if defective, can be rejected at a minimum loss. There is thus no hesitation about rejecting a unit of doubtful fitness. In the case of reinforced concrete built in place, defects are not always easy to observe, and many which are not considered bad enough to justify the tearing down and replacing of the work, are patched and repaired.

The form of reinforced block type adopted is shown in Fig. 1. The sewer is made of blocks manufactured specially for the purpose, and for that particular sewer. Surrounding the blocks, and lying between them and the earthen walls of the tunnel, is a layer of about 4 ins. of mass concrete.

The reinforcement consists of circumferential square twisted bars within the concrete or mortar which forms the circumferential joints of the sewer, and of longitudinal straps tying the blocks together in a solid unit. This reinforcement is designed to resist the external pressure on the sewer.

As these sewers are at depths below the surface varying from 50 to 100 ft., they may be subjected to considerable internal pressure when the area is fully built up. Steel reinforcement, in the form of flat bands around the outside of the blocks, is added to resist this pressure. Each circumferential band is made in two pieces joined by coupling shoes of special design. The Textonius lug shown in Fig. 2, superseded these on the greater part of the work. Thorough test showed that this lug was equally reliable, and cheaper than the original design. The coupling shoes or lugs served to join the halves of the bands and to draw them up tight. The bands are designed to withstand the maximum hydrostatic or internal pressure, using a unit stress not exceeding the elastic limit of the steel. The provision of this reinforcement for internal pressure ignores the resistance of the clay walls around the sewer, which in most of the ground through which the tunnels pass would be sufficient provision against any probable internal pressure. The bands are also efficient under normal conditions, and enable less steel to be used in the concrete blocks than would be required if the bands were absent.

The design of the cross-section of the various sizes of sewer is shown in Fig. 1. Two alternative cross-sections were designed for use in bad ground, the choice being left to the city engineer. These alternatives for the 4-ft., 4-ft. 6-in., 5-ft. and 6-ft. sewers, as prepared for the letting of contract No. 6, are shown in Fig. 1, and those for other sizes are similar. The one with the flat base was used in wet sand or soft ground.

In addition to the above types, tenders were also invited on a vitrified block type of sewer, shown in Fig. 3. This is identical in many ways with the reinforced block type, the same enveloping concrete backing, and circumferential reinforcement against internal pressure being used. The blocks themselves were de-

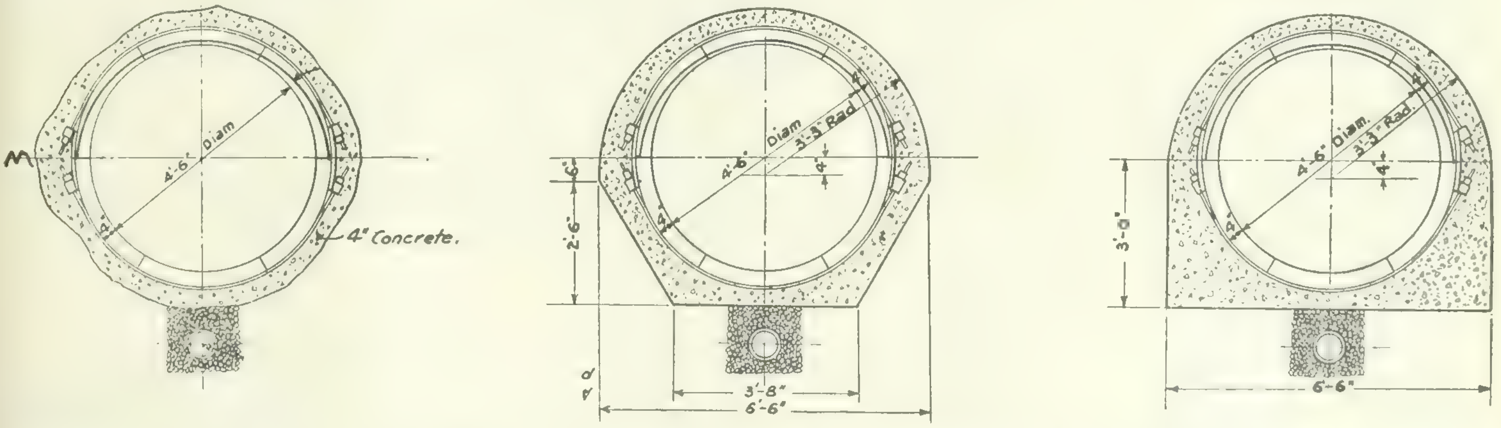


Fig. 1. Typical Sections of Reinforced Concrete Block Sewer Tunnel at Edmonton, Alberta.

Left hand section for firm ground; other two sections are alternates for use in soft ground, as directed. Crown bars are 7/16-in. square twisted, 12 ins. on centers. The subdrain is a 6-in. vitrified tile. On top and on each side 6 ins. of 2-in. screened gravel; on bottom [illegible] of same size gravel.

pended on to resist external pressure, no steel reinforcement being used. The blocks were to be made by the American Sewer Pipe Company, and although no such sewers were built at that time, some excellent 30, 36, and 42-in. sewers have been built of this material in Edmonton during the past two years.

The bids received on the vitrified block construction were slightly the lowest in each case for the tunnel sewers here under discussion. However, as it was then a new material, especially in sewers of this size, it was not thought advisable to substitute it for the reinforced concrete block, since at that time the latter had been well tried out in two contracts, let some time previously, which were then well under way.

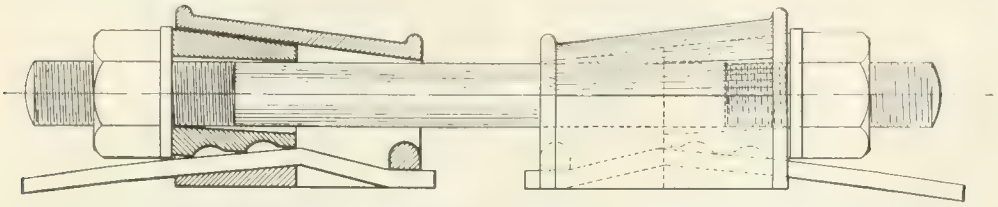


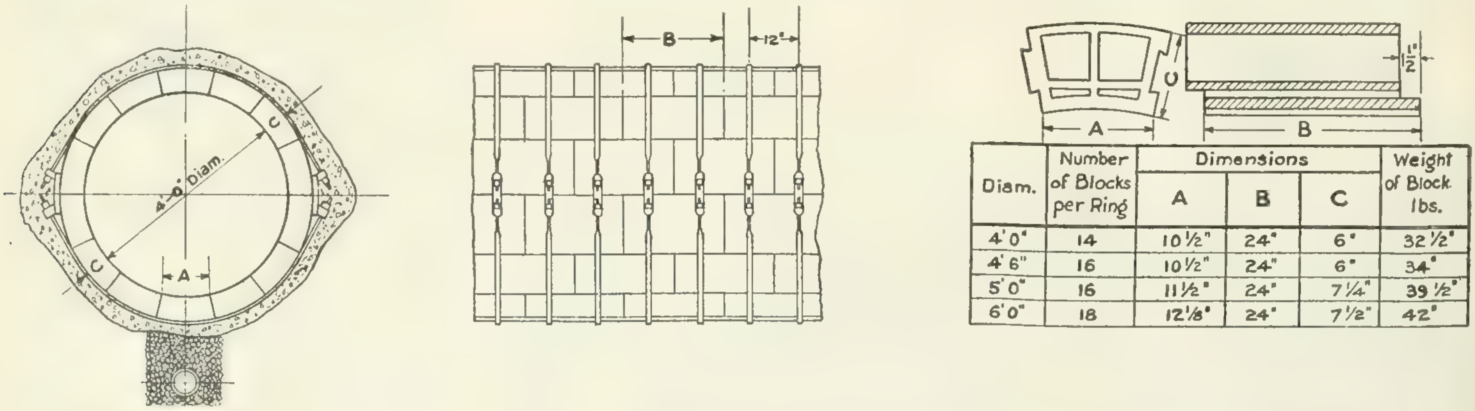
Fig. 2. Sectional and Outside Elevations of Tecktonius Lugs, Used on Tension Bands of Edmonton Tunnel Sewers.

TEST BORINGS.

Before calling for bids borings were made at intervals of 1,500 ft. apart along the line of the sewer. The records of these borings were furnished the contractors as a guide in bidding. As the bad spots occurred in pockets many of these were missed by the borings.

CONSTRUCTION OF SEWER.

The concrete blocks used consist of 1 part of Portland cement, 2 parts of sand, and 3 parts of gravel or broken stone passing a 1-in. screen. On contract No. 1 (Messrs. Manders & Gregory, contractors), the blocks were first made at a gravel pit about 7 miles east of the city, and transported in cars on the steam railway. Only a small number of blocks was made there, as the gravel supply failed to meet expectations. The plant was moved to a location on the Saskatchewan River, not far from the outlet of the sewer under construction. A large shed heated by steam pipes was built so that operations could be carried on during the winter. Most of the gravel used was washed river gravel. When contract No. 2 was awarded to the same company, another block-making plant was started. This plant was more advantageously situated as regards obtaining material (other than river gravel) and by far the greater part of the blocks made by Manders & Gregory themselves were made at this plant, which also supplied blocks for a later contract awarded to McGarry & Co.



Diam.	Number of Blocks per Ring	Dimensions A	Dimensions B	Dimensions C	Weight of Block lbs.
4'0"	14	10½"	24"	6"	32½"
4'6"	16	10½"	24"	6"	34"
5'0"	16	11½"	24"	7¼"	39½"
6'0"	18	12⅛"	24"	7½"	42"

Fig. 3. Tunnel Sewer Section, Showing Detail of Vitrified Clay Sewer Blocks Considered as Alternative to Concrete Blocks, Edmonton, Alberta.

The largest block-making plant was located immediately north of the Canadian Northern Railway yards, a spur being laid to the plant to supply materials. Here were manufactured all the blocks used in the sewers constructed by Ulen & Co. The manufacture was carried on by the Midland Construction Co., who held a sub-contract from Ulen & Co. A light railway connected the plant with all points where blocks were used.

The wooden forms used by Manders & Gregory were metal lined so as to give a smooth finish to the inner surface of the block, a roughness on the other faces being more desirable than otherwise. The forms were made in gangs, with the metal lined face at the bottom, and as soon as the blocks had set sufficiently, the sides and divisions were removed, leaving the blocks standing on the metal face. After about 48 hours the blocks were carefully removed from the forms so as to prevent breaking off the sharp corners.

The forms used by the Midland Construction Co. were also of wood, lined with sheet metal. They are shown in Fig. 4 and differed somewhat from the above. The blocks were cast on their sides, those requiring the rabbet for holding the reinforcing rods in position being made by placing the necessary strips along the bottom of the form. All the smaller-sized blocks were made by this company in these forms.

All concrete was mixed wet and well spaded in the forms. The blocks were marked with the date of manufacture, and rejected blocks were broken up after being marked by the inspector. Of Manders & Gregory's blocks there were few rejections due to poor concrete, but many were rejected at the start of operations on account of damage done by rough handling before the blocks were seasoned sufficiently. The number rejected was less as the work progressed. The blocks made by the Midland Construction Co. were frequently rejected in the earlier stages, owing to insufficient thickness near the center. The trouble was due to the forms, and after being remedied, rejections were due principally to breakage in handling. City inspectors were employed in the inspection and manufacture of the blocks. The plant used consisted of concrete mixers (used chiefly in block making), electric hoists, and one motor-driven conveyance of the Ulen Co. Forty-one electric hoists were used in the shafts. They varied in size from 5 to 11 HP.

Excavation.—Shafts from which tunnelling proceeded were located at intervals of 200 to 1,150 ft. Except in a few cases on Ulen & Co.'s work where auxiliary shafts were sunk to expedite operations, the shafts were built up to form the manholes after completion of the sewer. The shafts were generally sunk as a rectangular excavation, and timbered in the usual manner, tunnel excavation proceeding in both directions from the level of the invert. The material encountered was mainly a stiff gray clay with occasional pockets of sand. Except where sand occurred, practically no timbering was necessary, the ground holding perfectly. The cross sections were trimmed true to shape, and no cavities existed between the sewer and the earth walls. This is also true of the sections in bad ground, but in many cases the nature of the material required some of the timber to be left in.

On a portion of Ulen & Co.'s work, the shafts were sunk as circular excavations, timbered by means of sets of vertical lagging about 4 ft. long, held in place by steel bands. These bands were in two parts, the ends being bent over to form a flange. They were made heavy enough to resist distortion from the pressure of the walls of the shaft. In sinking the shaft, the excavation was made for about 4 ft., care being taken to have it trimmed truly circular and the right size. The first set of lagging and bands were then put in place, the bands being wedged out at their junctions to tighten them up against the lagging. Another 4 ft. was then excavated, and the lagging put in directly below it and the bands then inserted. By placing one of the bands in position before putting in all the lagging, this latter operation was made easier. This type of shaft worked very well where the ground was good, and was somewhat cheaper than the rectangular.

Small charges of dynamite (½ to 1 stick) were used to loosen up the clay after which the excavators took it out, using a mattock instead of a pick. These tools were also used in trimming the cross-section to shape. The material as it existed in the face possessed a rubbery elastic property, and a pick simply sank into it without loosening it. However, the material when excavated and exposed to the air changed its character, drying and breaking up similarly to the disintegration of lignite coal when exposed to air. The material was not a shale but a boulder clay having a number of stones scattered through it ranging in size from half an inch to small boulders.

The excavated material was transported on a small car to the foot of the shaft, where it was hoisted to an elevated track and dumped into wagons. The completed sewer followed the excavation closely, except where it was thought necessary to hold back to prevent injury from blasting. The shock was never serious, however, owing to the small charge used, and the completed work was never more than 15 ft. from the face of the excavation.

The tunnel was electrically lighted, and the absence of forms facilitated the laying of a small track for the cars carrying the excavated material, and the blocks, etc., used in the sewer.

Most of the sand pockets encountered were comparatively short, but one fairly long stretch, not detected in the preliminary borings made before the contracts were let, was met. In this case a tongue of wet sand stretched across the sewer, and it chanced that a test hole had been bored on each side of the tongue in good ground. The progress in sinking one shaft was so slow, that knowing the variable occurrence of bad places, borings were made in the vicinity with the object of changing the line to avoid the bad ground. This was found to be possible without affecting the utility of the sewer, and with practically no additional cost. The contractor was agreeable to the change, and abandoned the work already done on the shaft. A safer and better sewer was constructed, and the contractor on his part escaped a rather difficult piece of work.

Block Laying.—After the excavation in a length was completed the subdrain was laid. Then the concrete was laid in the bottom, to the level of the bottom of the blocks. The lower half of the hooping band was then placed on the concrete, and the invert block on top of the band. The remaining blocks up to the springing line were added, the backing concrete being placed as the block laying proceeded until the lower half of the ring was complete. A short wooden form extending partly into the finished sewer was then used to complete the upper part of the ring. The reinforcing crown bar, previously bent to the proper shape, was first placed in position against the face of the previous ring, so as to rest on the projection on these blocks. Block laying was then continued, care being taken to fill the joints between the blocks thoroughly, so that the reinforcing bar and the jointing irons would be surrounded by and bedded in the mortar. After the last block was placed at the top, the upper half of the hooping band was put on, the halves being connected by coupling shoes, and drawn up tight by wrenches. This point was watched carefully by the inspectors. After tightening the band the concrete backing was placed so as to fill the space between the blocks and the earth. The lower half of the ring having been extended meanwhile, the form was moved ahead and the process repeated.

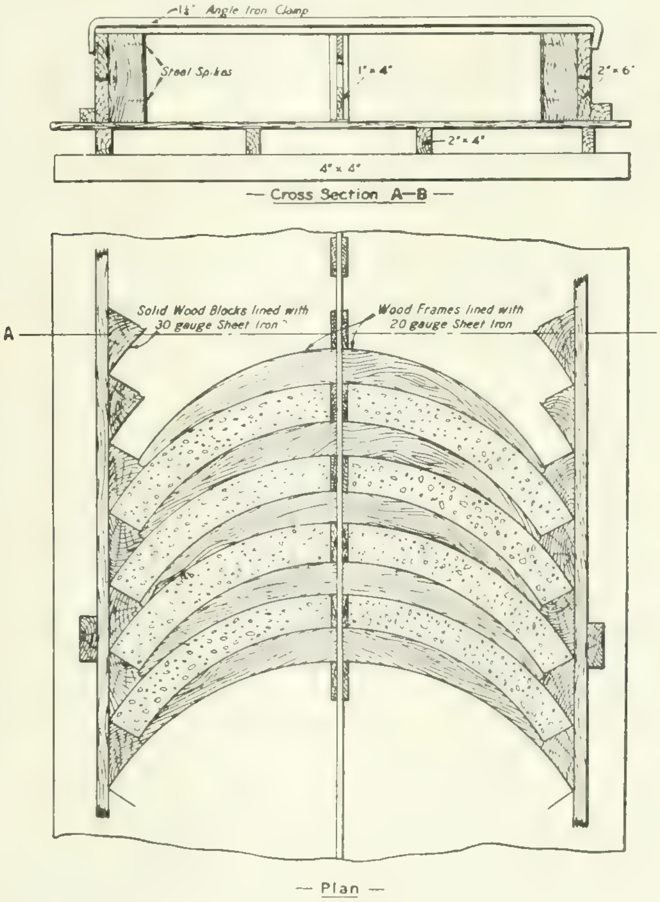

1¼" Angle Iron Clamp
Steel Spikes
1" × 4"
2" × 6"
2" × 4"
4" × 4"
— Cross Section A—B —
Solid Wood Blocks lined with 30 gauge Sheet Iron
Wood Frames lined with 20 gauge Sheet Iron
A
— Plan —

Fig. 4. Plan and Cross Section of Forms for Casting Concrete Lining Blocks for 5-ft. Sewer Tunnel, Edmonton, Alberta.

In completing a junction of the sewer between any two shafts, the operation is very simple. After the excavation work on any two faces has been completed, the work of constructing the sewer on each side of the junction is carried on in the usual manner. A measurement is made of the gap between the two sections of sewer, before these approach too close, in order to ascertain how many tiers of blocks will be required to fill the gap. In this way it is often possible, by slightly increasing the width of the joints, to have the final tier of blocks just nicely close the final gap. At other times it is seen by the measurements that the final gap cannot be adjusted to a block in width except by too great a change in the width of the joint. In such cases, the final gap is closed by cutting the blocks to the required width. The lower portion of the sewer is thus completed with blocks without difficulty. The final gap in the upper half is made with mass concrete, working from each side up towards the crown, lagging being used to hold the concrete in place; these being added from time to time as the work progresses towards the crown. The last small portion at the crown is lifted or shoved into place. After the concrete has set sufficiently, the forms are removed and the work smoothed off, leaving the junction with the appearance of a very wide joint. These junctions were so well made that the ordinary observer walking through the sewer would not notice them, unless he were looking specially for them, or had his attention directed to them.

Rate of Progress.—The rate of progress was 30 to 36 ft. of completed sewer in each face per week. Progress varied somewhat in the different sizes of sewers, but not so greatly as might be expected, as the extra work entailed in the larger sizes was in a measure made up by the greater number of men in the shafts. In the 4-ft. 6-in. and 5-ft. sewers, two men worked at the face, one as car pusher, and two or three men on top, exclusive of hoistmen and foreman. The former served the two faces worked from his shaft, and the latter looked after several faces. In the 6-ft., 6-ft. 6-in. and 8-ft. sewers three men worked at the face, and there were two car pushers.

Work was carried on in two 10-hour shifts. At first the block laying was done by special men, but during most of the work, excavation and block laying were done by the same men. The results were equally good, but the latter method gave less trouble, as the continuous nature of the employment attracted plenty of men to select from, and provided a good class of labor in the shifts. The men doing the block laying were taught by the inspectors to pay special care to the particular points necessary to ensure satisfactory results.

ACKNOWLEDGMENT.

The information given herewith is based upon a paper before the Canadian Society of Civil Engineers by Mr. A. J. Latornell.

Processes Available for the Treatment of Industrial Wastes.

The problem presented in the treatment of industrial wastes is rapidly gaining in importance, both to manufacturers and cities. The sanitary engineer thus finds his field rapidly widening in this direction and a study of the treatment processes available is profitable at this time.

Industrial wastes containing putrescible matter create a nuisance when discharged into water courses. Such wastes entering sewers also add to the load on plants treating domestic sewage. The latter possibility must now be kept in mind in designing new municipal sewage treatment plants. Industrial wastes may also cause deposits in streams or an oily scum on the stream's surface. Some such wastes give a bad taste to water and badly taint the flesh of fish. Thus petroleum refinery wastes give a kerosene taste to water and gas and tar works wastes taint fish.

Sometimes, but by no means always, the treatment of industrial wastes leads to the recovery of valuable by-products and is carried on at a profit. Thus fine screens in pulp mills save much finely divided pulp. In general it is unsafe to assume that a direct profit can be made in the treatment of industrial wastes. However, an indirect return is received by removing the cause, and subsequent cost, of litigation.

In some small plants the facilities of the large plant for making by-products are lacking. However, careful inspection by an outside engineer will frequently show leaks which can be stopped at small expense with comparative profit to the manufacturer. In the tanning industry pieces of skin and even whole hides have been lost to the sewer by lack of proper floor screens and catchbasins. In one wool scouring plant so much wool went down the sewer that the owners refused their operating engineer the privilege of keeping the catchbasin clean for the wool recovered.

In the location of new plants a manufacturer should bear carefully in mind the almost certain probability of regulation of the discharge of waste. Hence it would seem wise to locate plants producing large amounts of waste difficult of treatment on the largest bodies of running water available. Unfortunately, in many cases this is not done, and a plant is built on a stream which furnishes hardly enough water for an adequate water supply, and then a nuisance results.

CLASSIFICATION OF WASTES

From the physical and chemical standpoint the various wastes can be classified as follows:

1. Wastes carrying sediment or suspended matter. (a) Heavy mineral matter, such as marble dust, ashes, etc., usually inert. (b) Heavy matter, such as the product of chemical reactions as tarry waste from gas works, residues from ammonia works, etc. (c) Heavy organic matter—which may be highly putrescible, or comparatively inert.

2. Wastes carrying little or no sediment. (a) Containing soluble organic matter, which may be highly putrescible. (b) Containing chemicals. 1. Eager to absorb oxygen. 2. Inhibiting bacterial action.

3. Wastes carrying both suspended and soluble matter.

4. Wastes carrying floating materials. (a) Volatile and inflammable, as for instance gasoline or kerosene. (b) Fats and oils. (c) Light organic matter. (d) Light matter the product of chemical reaction, as floating material from gas wastes, etc.

These classifications are of service to indicate simply the general types of material which may be present. The wastes to be handled vary considerably with the industry, and even among plants of the same industry, according to the processes used and the material produced. The prevalent waste differs in the various states. In Indiana, for instance, strawboard wastes are very common, whereas in Ohio creamery and wire mill wastes occur, in Maine the pulp and sulfite waste and in Illinois the wastes from the packing houses, tanneries, starch works and distilleries are most common. At times canneries give trouble. These are usually found near the agricultural districts.

PROCEDURE IN TAKING UP A PROBLEM.

In studying an industry from the standpoint of treatment of the waste, the first essential is to learn the processes carried on and the probable sources and amounts of waste. Seldom does the manufacturer know just how much sewage he is discharging. A thorough inspection of the plant in all its details is of value, for frequently the study of the inside workings reveals many points at which waste can be reduced with comparatively small expenditure of material and labor. No general method of procedure can be stated, as each plant is usually a law unto itself. At times separation of the wastes may be desirable, whereas in other cases, as for instance in tannery work, the effluent from one part of the plant contains chemicals that may be of material value in precipitating material held in suspension in the effluent from another part of the plant. Under those conditions mixing of the wastes is of service. Rain and surface water drains generally should be kept out of the sewer systems receiving waste, in order to avoid at times of rain serious overloading and scouring out of the material which should be retained.

TREATMENT METHODS AVAILABLE.

The methods of treatment available are somewhat more varied than for domestic sewage, although for the most part the same general principles apply. The difficulty is, of course, to find the proper constants and loading which can be used to produce results. Owing to the diversity of practice in many plants the sure way is to try out what can be done with the individual case in question.

Dilution.—With wastes containing no suspended matter, ample dilution frequently suffices. Sometimes this dilution can be furnished artificially from storage reservoirs. Again it is available in large streams, such as the Mississippi or other rivers with sufficient flow. Where the dilution is not adequate, and velocities are low, the suspended matter in wastes containing such must be reduced in order to avoid deposits in the stream. Screening and sedimentation are available for this purpose.

Screening.—Screening seems eminently suitable for the coarser wastes, such as come from the stock-yards, slaughter-houses, beet sugar works, pulp mills, etc., where material slow to digest can be readily removed by a fine mesh screen. The disposal of the screenings when putrescible may, however, be complicated with the problem of avoiding nuisance. Sometimes the material can be dried and burnt. Occasionally it can be turned back into the processes. Directly comparative results available in the packing industry would indicate that considerable material is left over after fine screening, which can be removed by settling. However, the screening removes much which is slow to settle and is a source of scum in sedimentation tanks.

Settling.—Settling should remove practically all the settling suspended matter, the actual per cent depending on the waste, the period of settling, the type of tank and the velocities used. A doubledeck tank is frequently most suitable where much scum producing material is present. In extreme cases, fine screening has been proposed as a preliminary treatment to reduce the scum forming material. With comparatively inert material, the Dortmund type of tank with sloping bottom may prove successful if properly and frequently cleaned. On tannery waste, particularly from the limes, heavy material is present which will quickly settle. In wool pulleries or wool scouring shops much heavy grit is produced which also drops quickly. For such gritty waste a grit chamber design readily cleanable is desirable. Unfortunately, many of the tanks now in operation in tanneries and elsewhere are expensive to clean, as the entire work has to be done by hand on days when the plant is shut down.

Chemical Precipitation.—Chemical precipitation may materially increase the removal of suspended matter by settling, and in some rare cases may be produced by the combination of chemicals already in solution in wastes from the various processes in the plant, particularly in tanneries.

Septic Tanks.—Septic tanks were once widely used in the past, and are used occasionally today, despite their limitations, on creamery, canning and tannery wastes where organic matter slow to decompose needs breaking down. As a rule, however, the septic tank is not regarded favorably on account of liability of nuisance and the larger storage required to hold liquid for many days.

Filtration.—Very frequently further treatment is required to produce an effluent needing but slight if any dilution. In Massachusetts intermittent sand filters have been used freely in experimental work, as well as in actual practice, but of late sprinkling filters have been found helpful, particularly as a preliminary to intermittent sand filtration, in connection with tannery or other wastes high in organic matter, thereby permitting much higher rates of application to the sand filters. In Chicago, on the mixed waste from Packingtown, a sprinkling filter has proved adaptable in handling mixed stock-yards and domestic sewage thoroughly settled. Owing to the possibility of deposits of grease in such a filter, its history is being watched over several years.

Evaporation.—Occasionally a waste is so difficult to handle and contains so much material in solution that evaporation appears to be the only remedy. Although the economy of evaporation is markedly increased by the use of several effects, the process is expensive, particularly for dilute wastes. It has, however, proved practicable in the packing industry for evaporating "tank" water from the rendering tanks which contains matter of value as a fertilizer, and has also been applied in evaporating distillery wastes, as well as in recovering chemicals from industrial processes where they can be used over again to advantage and profit.

SLUDGE.

Amount.—As in the treatment of domestic sewage, a sludge problem soon arises, for the quantity of sludge found in industrial waste is frequently much greater than in domestic sewage. The amount varies widely. In the mixed waste tested at the Center Ave. testing station of the Sanitary District of Chicago the amount of sludge in an Emscher tank was approximately 10 cu. yds. per million gals., as compared with about 1 cu. yd. found at the 39th St. station on domestic sewage. In the tannery tanks with plain sedimentation from 10 to 100 cu. yds. per million gals. are found. However, in the tannery industry the flows are not usually great, so that the total volume of sludge produced in a day is not quite so appalling as the figures might indicate, although large enough.

Treatment.—The treatment of the sludge depends largely on the waste itself. Where there is a large mass of material to be disposed of with little value except for filling, the expense is for transportation to the nearest dump. Frequently with proper treatment on organic wastes, a quick drying sludge may be produced, as for instance by the use of the double-deck type of tank on the mixed packing-house waste. Such sludge may contain some nitrogen, but is not commonly regarded at present as a valuable material. Sludge pressing may reduce the water content. Under certain conditions the sludge itself may prove of value for the recovery of fat, and once the fat is extracted, the dried sludge may serve as a filler for fertilizer. The basic value as a fertilizer from the laboratory standpoint may be doubtful on account of what the chemists call the difficulty of the assimilation of the nitrogen by the soil. A sure test is the actual trial of the sludge in the field.

OXYGEN DEMAND.

In testing the strength of industrial waste the sanitary engineer is primarily interested in the oxygen demand, particularly where the stream flow available is limited. This can best be determined by the use of a dilution test or the nitrate test devised by Dr. Lederer. The comparison of strength of sewage by this method is of value, and is impressive even to the layman. In the Sanitary District the domestic sewage at 39th St. has been found to have a bio-chemical oxygen demand averaging 100 to 125 p.p.m., with a consumption of approximately 25 to 30 per cent in the first 24 hours at 20° C. The mixed stock-yards and packing-house wastes average 900 to 1,300 p.p.m., with a consumption of about 20 per cent in the first 24 hours. Tannery wastes vary considerably, ranging from 400 to 1,000 p.p.m., with consumption averaging around 7 per cent in the first 24 hours. The consumption in the first 24 hours at 20° C. has a direct bearing on the conditions to be met in a stream if 24 hours is the interval of time to the critical point. Other time periods may be taken for study, if desired, to meet local conditions.

DESIGN OF WORKS.

In the design of works to handle industrial waste, the manufacturer is usually anxious to cut the cost of installation to a minimum, and consequently the most careful designing is required. Where a plant is located in a city in the midst of a built-up region, lack of space is a great handicap. Although willing to employ legal talent, the manufacturer is frequently averse to engaging competent engineering advice. Consequently it sometimes happens that more funds are frittered away in ill-considered experiments than would produce a practical working plant for service, and this phase is occasionally complicated by the eager salesman who urges devices which from their very principle could be ruled out as impractical or insufficient from the start.

Inside any industrial plant, self cleansing sewers are a necessity, with plenty of manholes for ready inspection. In the tanning industry provision should be made on the floors at all inlets to the sewers to hold back large pieces of material, such as skin and the like, by suitable screens of perforated plates set in the floor over the outlet drains. Some of the most up-to-date factories are equipped with catchbasins under every inlet. The exact efficiency of this is, however, unknown. On lines of sewer the use of fine screens may be desirable to separate out material that is hard to handle and material which might interfere with the proper working of pumps or other machinery.

Settling tanks should be designed for ready cleaning, as hand cleaning is expensive, although still practiced in most tanneries. The experience in the Chicago District would indicate that a tank with bottom slopes over 45° and near 30° from the vertical will feed the sludge to the center of the tank. However, the sludge may become so caked, if cleaning is infrequent, as to be difficult to pump. Compressed air, water or steam introduced at the bottom of the tank just before pumping will break up the sludge and render it easily handled. Wool, leather strips or other foreign material which will tend to clog a small centrifugal should be screened out. Ample sludge drying beds and sludge storage should be provided.

Skimming basins are also useful to hold back grease, or light oils. Grease may occur either in a form which tends to float, or to be held in suspension or to sink. In hot liquids, basins of large surface area are used.

These are the reverse of settling basins, in that scum retaining baffles are provided with scant sludge retaining features. Among these are found the skimming basins built to catch oils from the locomotive shops or roundhouses, as well as to catch tar and refuse escaping through the sewers from gas works, and works for the utilization of tar and gas works waste. In many cities there are now municipal requirements in force which require traps to retain gasoline and oils escaping from garages. In Chicago a triple basin is used suitably trapped and baffled for this purpose.

The sanitary engineer today realizes that sewage can be treated either by aerobic or anaerobic methods to arrive eventually at the same stage, the breaking down and transformation of putrescible organic matter. The anaerobic methods attack organic matter vigorously, but are difficult to control and liable to produce serious nuisance. Consequently, the sanitary engineer has endeavored in the treatment of domestic sewage to keep the sewage as fresh as possible throughout the sewers and treatment. In the height of the septic tank vogue the anaerobic decomposition applied too generously disgusted many manufacturers and proved to their minds at least, from the foul liquids and odors produced, that their wastes were incapable of any treatment. However, other methods available today of screening, settling and aerobic treatment should be tried before final opinion is pronounced. It is rather curious that the septic tank should have been discovered in England and there patented, when for years the Chicago River and Bubbly Creek had been operating as a septic tank, probably the largest in the world, yet censured by all who passed by. Consequently, with Bubbly Creek as an example, it is now difficult to see why the same method was followed in the hope of securing results free from nuisance. In any sewage treatment, either industrial or domestic, the greatest possible freedom from odors is desirable, as well as absence of ill-smelling liquids. Hence the suspended matter should be removed as quickly as possible. There may, however, be some wastes in which the use of septic processes is still of service.

In approaching the manufacturer it is unwise to arouse any false hopes as to the possibility of recovering values from the wastes. As a rule the manufacturer feels that little escapes to the sewers of value to him, and promptly forgets that much may escape which is troublesome to the sanitarian.

The municipality has a basic interest in the wastes discharged by industries, even though the domestic sewage be not treated, from the standpoint of sewer maintenance. Consequently, in most cities ordinances will be found regulating the methods of entrance to the sewers, and prescribing catchbasins and other devices suitable to retain settling material which may cause deposits. Oil is also undesirable. Gasoline and other volatile fluids should rigorously be kept out of the sewers. The intelligent interpretation of these ordinances by an engineer familiar with industrial processes and the application of engineering principles materially helps in holding back a great deal of material at its source, and by so doing relieves expensive maintenance of the sewers. Recently in another city paunch manure from packing-houses completely stopped a 24-in. outfall sewer for a distance of 120 ft., flooding the adjoining back yards. This necessitated the removal and rebuilding of the sewer.

SEPARATE VS. MIXED TREATMENT.

The question of treatment and whether it is best to treat industrial wastes separately or mixed with domestic sewage is a problem which must be solved for each case. However, the principle seems clear that many wastes which are difficult of treatment alone can be more readily handled when diluted with domestic sewage. In this classification, particularly, are wastes which are sterile at their source and which by dilution with domestic sewage are thoroughly seeded with bacterial life required for self-purification. Wastes slightly acid may be neutralized by the alkalinity of the sewage and seeded thereby. The problem is largely one of economy and expediency for each locality. Occasionally hints can be gained by comparison of methods employed in different industries. For instance, in the mining field a great deal has been accomplished on special devices for the classification and concentration of fine slimes to secure economy in cost and operation. To some other industries these same devices may be applicable.

ACKNOWLEDGMENT.

The foregoing discussion of the engineering features of industrial waste treatment is from a paper by Mr. Langdon Pearse, Division Engineer, in charge of the sewage disposal investigation for the Sanitary District of Chicago, delivered at the latest annual meeting of the Indiana Sanitary and Water Supply Association.

ROADS AND STREETS

Treated Wood Block Pavement in the United States.

The history of the development of treated wood block pavements in the United States was discussed in the report of the Committee on Wood Block Paving presented at the last annual meeting of the American Wood Preservers' Association. Modern methods of construction were also discussed. The committee acknowledges the assistance of J. D. McLean of the U. S. Forest Products Laboratory in compiling information and writing the report a portion of which is given here.

The first use of untreated wood blocks as a paving material in the United States is said to have been in a pavement laid in New York City about 1835. Before 1840 Boston and Philadelphia laid pavements of spruce and hemlock blocks which cost from $2.00 to $2.50 per square yard. The use of untreated wood blocks for pavements was soon taken up by other cities and a large variety of species were employed, such as white pine, hemlock, oak, osage orange, cypress, mesquite, cottonwood, tamarack, Douglas fir, and redwood. Large amounts of round blocks, mostly cedar, were also used, especially throughout the Middle West.

In the early use of wood blocks considerable attention was given to the form of the blocks and a number of these were patented. The Nicholson block, patented in 1848, was extensively used between 1860 and 1870. These blocks were rectangular in shape and gave a much more even surface than many of the other forms used.

During the 60 years preceding the use of treated wood blocks many cities laid large quantities of wood pavements at great expense. These were satisfactory at first, but they soon decayed, and in a comparatively short time after laying they had to be removed. Subsequent to 1871 over 1,000,000 sq. yds. of untreated wood block pavement were laid in the city of Washington, D. C., costing from $2 to $4.20 per square yard. Nearly 30 per cent of this was removed six or seven years after it was laid, and by 1889 the last of the blocks had been removed. Similar trouble was experienced by other cities using untreated wood as a paving material.

In most of the early wood block pavements little care was taken in the selection of the wood used, or in protecting it from decay. Often the blocks were laid on a plank foundation, placed directly on the ground, or upon a sand base, thereby creating a favorable condition for decay. While both wear and decay are the principal causes of the failure of wood block pavements, decay is by far the most destructive agency. After years of repeated failures attention was directed to the use of wood preservatives.

In 1882 to 1885, wood blocks treated by the Wellhouse process were laid in St. Louis on Pine and Oliver streets, and are said to have remained there until worn out by traffic. The blocks were treated by the St. Louis Wood Preserving Company and were guaranteed by the contractor for 9 years.

EARLY USE OF TREATED WOOD BLOCK PAVEMENT IN THE UNITED STATES.

One of the first treated wood block pavements was laid in Galveston, Texas, about 1874. A pavement of about 75,000 sq. yds. of longleaf pine blocks was laid at this time and was in service until 1903, when it was removed. It is not thought that these blocks were given the same kind of treatment that is usually given at the present time. They were laid on a sand foundation, no concrete being used. Details of the treatment of these blocks are lacking.

In 1896 Indianapolis laid a few streets with blocks on Washington red cedar. These blocks were thoroughly dried and then placed for six hours in a bath of creosote, which was heated to a temperature of over 210° F. The absorption was estimated to be about three pounds per cubic foot. No expansion joints were used and considerable trouble was experienced on account of swelling. These blocks are still in use and are said to be in a good state of preservation.

It was realized that the best results could not be obtained by dipping the blocks, and in 1898 the first pavement was laid in Indianapolis of blocks treated with creosote under pressure. Longleaf pine was used and was given a treatment of from 10 to 12 pounds per cubic foot. At this time no particular attention was given to the character of the oil. This pavement, although now reported to be in bad condition, gave such good results that city engineers began to appreciate the possibilities of treated wood blocks.

The first wood block pavement used in the East was laid on Tremont street, Boston, in 1900. The blocks were treated by the creoresinate process, in which a mixture composed of one-half creosote oil and one-half resin was used. The object of adding the resin was to render the blocks more resistant to the absorption of water and to assist in retaining the creosote oil in the wood. This pavement is still in good condition. A sample pavement of this kind was also laid on State Street, Brooklyn, N. Y., in 1902.

In 1899 one of the two roadways on the Rush Street bridge in Chicago was paved with creosoted longleaf yellow pine blocks and the other roadway with untreated blocks. This afforded a good test of wood pavement as the traffic on this bridge was probably heavier than on any other street in Chicago. It was necessary to remove the untreated wood blocks at the end of three years, whereas the creosoted section was in good condition at the end of seven years and gave indications of good service for several years more. They were then taken up on account of the untreated plank foundation being decayed.

One of the first creosoted wood pavements in Chicago was a section of longleaf pine blocks laid in front of the Auditorium Hotel in 1900.

The excellent satisfaction given by these treated pavements, which were largely experimental, resulted in a very rapid increase in the use of wood blocks throughout the country, as shown in the tabulated data presented in this report. The larger cities in particular recognized the merits of wood blocks for streets subjected to heavy traffic as well as for residence streets. Wood pavements in Boston, New York, Chicago, and other cities were installed under severe traffic conditions, where the relative durability could be compared with pavements of other materials on the same street. Many of the other types of pavements which were under similar traffic conditions failed, while wood block remained in good condition. The durability, noiselessness, and other desirable features of treated wood blocks have been realized more particularly within the last five or six years.

At present nearly 30 miles of the most heavily traveled streets in Manhattan Borough, New York, are paved with treated wood blocks. In 1912 New York laid about 225,000 sq. yds. and over 180,000 sq. yds. in 1913. Chicago had over 600,000 sq. yds. in 1912 and laid over 165,000 sq. yds. more in 1913.

Minneapolis was one of the pioneer cities in the use of treated wood pavements, and has probably laid as much as any city in the country. This city already has over 1,000,000 sq. yds. and expects to add about 175,000 sq. yds. in 1914. St. Paul, Minn., has planned to lay more than 266,000 sq. yds. during 1914. By January 1, 1914, Detroit had over 458,000 sq. yds. of treated wood pavement, having laid over 166,000 sq. yds. of this in 1913. A number of other cities are also laying large amounts of wood block pavement each year.

DEVELOPMENT OF THE MODERN TREATED WOOD PAVEMENT.

Species of Wood.—Southern longleaf yellow pine was most used in the earlier treated wood pavements. This wood has been found by experience to give excellent satisfaction and is most largely used at the present time. Other species that have been used are tamarack, Douglas fir, hemlock, Norway pine, maple, and black gum. The species most generally admitted by various specifications comprise longleaf yellow pine, Norway pine, and tamarack. Black gum has been used to some extent in the East, but it is claimed that this species has not been entirely satisfactory. Douglas fir is used to a considerable extent in the far West.

Tamarack has been used in several cities and has given good satisfaction. In order to obtain more complete knowledge on the relative value of the various species of wood for paving purposes, the United States Forest Service laid an experimental pavement in cooperation with the city of Minneapolis in 1906. The woods used in the experiment were creosoted longleaf pine, tamarack, Norway pine, western larch, white birch and hemlock. Longleaf pine was used as a basis of comparison for the other species. The last inspection was made July 15, 1914, eight years after the pavement was laid. From the results of this inspection the species may be classified in the order of their efficiency in this pavement in the following order: (1) Longleaf pine. (2) White birch. (3) Eastern hemlock, tamarack. (4) Norway pine. (5) Western larch.

Undoubtedly, there are a number of species of wood that would make satisfactory paving material, but on account of the incomplete knowledge of their value city engineers prefer a wood that has been tried and proved satisfactory. It seems probable that other species will in time be used more extensively than at present. The proper selection of the species of wood used for paving purposes is most important as it determines, to a large extent, the wearing qualities of the pavement.

Depth of Blocks.—Recently there has been a tendency to reduce the depths of the blocks and at the present time 3½-in. blocks are frequently specified, and even 3-in. blocks.

New York City has adopted a 4¼-in. deep block as standard in Manhattan where it has been demonstrated that a 3½-in. block is not strong enough to withstand the heavy traffic. The Borough of Richmond (Staten Island) uses 3-in. block as standard. The Borough of Queens has some of the best wood-lock pavement in this country and after nearly ten years' service 3-in. deep blocks show practically no wear. The traffic is plentiful, but the vehicles not very heavy.

The blocks used in the early pavements were generally 4 ins. wide. In more recent practice the width has often been reduced to 3 ins. This prevents the blocks being laid on their sides. The permissible length varies from 5 to 6 ins. to 10 ins.

Specifications generally require that the blocks shall be sound, free from large or loose knots, shakes and other defects of that nature. There are differences in the number of rings per inch specified and in the amount of sapwood that is permissible. Some engineers allow the use of blocks having five or six rings per inch and others specify not less than eight or nine.

The amount of sapwood allowed usually varies from 10 to 40 per cent. In the early use of treated wood blocks, specifications were more rigid in the requirement of a larger percentage of heartwood. Experience seems to indicate, however, that treated blocks having both sapwood and heartwood show no noticeable differences in wearing qualities from those without sapwood.

Preservatives.—The earlier wood paving blocks were treated with a light grade of creosote oil. Later, due largely to expansion difficulties, varying amounts of tar were added. The bleeding trouble has recently led some cities, notably Chicago, to specify a very high-boiling creosote free from tar. This oil has the disadvantage of being high in cost.

Most of the cities in the United States are now using an oil having a specific gravity of 1.10 to 1.14, and containing a large proportion of tar, usually required to be nearly free from carbon. Such an oil is also permitted in the specifications for paving oils of the representative societies interested in this subject.

There is little difference of opinion as to whether oil from water-gas tar should be used. It is claimed that this cheaper product might be mixed with coal-tar oils without lessening the value of the pavement. Several experimental pavements have been laid using this product, and until the results of these experiments become available most engineers prefer to exclude water-gas creosote from their specifications.

Method of Treatment.—The earlier pavements were treated usually with from 10 to 12 pounds per cubic foot of oil. Engineers then went to the opposite extreme, until it was the general practice to inject 20, and in some cases even 24 pounds per cubic foot, resulting in a greatly increased cost and excessive bleeding of the oil. Recently the tendency has been to reduce absorption, and at present 16 lbs. per cubic foot is about the average used.

The method of treatment first used was, in general, to subject the blocks to a dry heat of 250-280° F., or to steam them at pressures varying from 25 to 50 pounds per square inch for periods varying from 3 to 4 hours, or more, depending upon the condition of the wood. A vacuum of 24 to 26 ins. was then drawn to remove the moisture, after which the preservative was admitted without breaking the vacuum, and pressure applied until the desired absorption was obtained.

At present the method of treating the blocks is often left to the treating plant operators, the specifications merely requiring a given absorption. Some cities, however, outline the method of treatment in detail as to preliminary steaming, vacuum, and pressure periods, giving the time, temperature, pressure, etc., for each operation.

Methods of Laying.—The old type of untreated block was generally laid either on a sand or a plank foundation, neither of which was satisfactory. Treated blocks were usually on a concrete fondation covered with a sand cushion, a method of laying which is still in quite general use. Much trouble has been experienced from the sand shifting or being washed from under the blocks, and thus producing an uneven surface in the pavement. Expansion troubles were also caused by water penetrating the spaces between the blocks and saturating the sand. A bituminous coating is now sometimes laid directly on the concrete base instead of the sand cushion.

While the sand cushion is still quite generally employed, there is a well marked tendency toward the use of a sand and cement mortar. This usually consists of a mixture of one part cement to three or four parts of sand and is spread from ½ to 1 in. thick. This results in a more satisfactory pavement, especially under heavy traffic. The foundation now generally adopted consists of a concrete base from 5 to 7 ins. deep, depending upon traffic conditions, the mixtures commonly used being 1, 3, 5, or 1, 3, 6.

Joints.—In some of the early pavements laid no expansion joints were used, and in many cases no trouble has been experienced on account of swelling. In many other cases, however, much trouble has been caused through failure to properly provide for swelling of the blocks. Streets on which the traffic is heavy do not require as much provision for expansion as do streets of medium or light traffic. In the Brooklyn and Manhattan pavements no provision is made for expansion. For a street 30 or 40 ft. wide the expansion joints are usually ¾ to 1 in. wide and filled with a bituminous filler. In most cities no joints are employed to take care of expansion lengthwise with the street.

The angle of courses is a point upon which engineers are not agreed. The most common method of laying has been at 90° with the curb, but many of the streets are now paved with the courses at an oblique angle. In the Minneapolis experimental pavement the blocks laid at oblique angle did not wear as fast as those laid at 90°, since traffic was not directly across the joints of the pavement. Another advantage of the oblique angle of laying is that longitudinal expansion joints at the curb will take care of expansion in both transverse and longitudinal directions.

Fillers and Top Dressing.—A bituminous or pitch filler was commonly used in the early treated wood block pavements. Bituminous or asphaltic fillers and also sand and cement fillers are the materials generally used at the present time for filling the joints. The advocates of the sand filter maintain that the sand fills the joints completely and that the surface of the pavement becomes practically homogeneous. It is claimed that a waterproof joint is formed by the sand absorbing the oil which exudes from the blocks. Others argue that the sand packs into the joints, thereby making an unyielding filler which does not allow expansion, but permits water to enter between the blocks, causing expansion of the pavement.

Advocates of the cement grout filler claim that the use of this material insures the joints being completely filled and waterproof. The mixture is usually made of one part cement and one or two parts sand, which, after mixing to the proper consistency, is swept into the joints.

Opponents of the cement grout filler claim that unless the pavement is kept free from traffic for a sufficient time to allow the grout to set thoroughly the bond of the mortar will be broken. Even when the mortar is thoroughly set it is claimed that its strength is not sufficient for traffic conditions, and the filler, therefore, serves the purpose no better than sand, while at the same time it is more expensive.

Those favoring the bituminous filler argue that the joints filled with a tar or asphaltic preparation constitute individual expansion joints between each block, thereby allowing for expansion throughout the pavement. Moreover, it is claimed that the pavement is made waterproof and that no moisture can enter between or under the blocks. On the other hand, advocates of the other fillers argue that a bituminous material becomes soft and sticky from the oils that exude from the blocks and may add to the bleeding trouble. In practice, the bituminous fillers are most largely used and are giving the best satisfaction.

The top dressing most commonly employed is a layer of sand spread about ½ in. deep over the completed pavement. This sand fills up any small pockets that may be present and is more or less ground into the wood, making the pavement less slippery.

Concrete Roads and Frost Action.

It is held by many engineers that the action of frost is a primary cause of many of the cracks that occur in old concrete pavements. In a paper before the last annual convention of the American Concrete Institute held in Chicago, Mr. Lovis discussed the subject of frost action on Massachusetts roads and his paper is given here.

IMPORTANCE OF PROPER FOUNDATIONS.

There are four distinct features to be considered in road construction: the alignment, the grade, the foundations and the surface. We sometimes hear comparisons made of the relative value of these factors, but in the consideration of what is sometimes called "a perfectly good road" we will find that all are necessary and equally important. In the order of their construction, the value of each depends upon the integrity of the preceding work. Almost an infinite variety of surfaces may be used on roads, and some variations may be made in the locations and grades, but whatever may be the alignment, grade or surface we must try and make permanent the foundations.

There has been a belief that the foundations under a concrete road may be neglected, and in fact it has been believed that concrete may be laid with perfect safety on almost any kind of soil without danger of bad effects from frost action. There have, however, been many experiences which prove that such is not the truth, and most concrete road builders are now of the opinion that the subgrade is to be constructed quite as carefully for concrete as for a macadam or gravel surface, and this is substantially the opinion of the Committee on Subgrades as expressed in their report at the National Conference in Chicago last year.

It will be found very difficult to make any standard specifications for subgrading which will not be a source of danger, rather than of safety, in practice, the danger being that the inexperienced engineer may follow literally the rule given, even though the physical conditions require special treatment. The construction of the subgrade for a macadam or gravel road has always required more special experience on the part of the engineer than any other subject connected with the work, after the location and grade lines have been determined. In Massachusetts we have learned something of this subject only after having made many mistakes, especially as a result of not having enough volume and depth of good material in the subgrade. It is doubtful if, later, in the full knowledge of the case, we can cite a place where too much material was used. Economically wiser construction, during the past eighteen years, would have involved a different type and a greater amount of material in the subgrade than was practiced, especially in the earlier years.

SIDE DRAINS ABANDONED IN MASSACHUSETTS.

The side drain type of construction was used for about ten years, and was abandoned, and what was called a V-drain was adopted. This drain consists of a stone fill of cobbles, in sizes of 8 ins. and less, in their longest dimensions, and in bad soils was constructed 18 ins. in depth in the center and 6 ins. at the sides, under the full width of the macadam, giving for a 15-ft. road about ½ cu. yd. of stone fill per lineal foot. Good gravel, instead of cobbles, has been used in the same way, with satisfactory results. This type of drain has been changed, of recent years, so that at present the stone fill or gravel is often placed on a level base. The important end to be attained is to overcome a tendency to irregular frost action and resultant disintegration of the surface. Our experience in Massachusetts on the greater value of this method of construction over the old system of side drains is a positive one, and there need be no further basis of argument on this question. Disintegration from frost action has been overcome by this method more effectively than by the side drain method, and at a very much less cost. In connection with this matter it is important that the water be drained from under the road at intervals by means of blind drains.

The following is a copy, in part, of specifications for stone filling:

> At such places as the engineer may direct stone filling shall be placed. Excavations shall be made to the lines shown on the cross-sections. The stones to be furnished by the contractor may be either wall stones or cobbles ranging in size from the smallest obtainable to those not exceeding 8 ins. in their longest dimension, and the larger stones shall be placed at the bottom. . . . The stone filling shall be rolled with steam road roller to the satisfaction of the engineer.

EXPERIMENT ON NORTH ANDOVER ROAD.

In 1913, in the town of North Andover, the Massachusetts Highway Commission built a concrete road for a length of about two miles. The concrete was put on an old turnpike between Salem and Lawrence. In our preliminary consideration of the type of road to be used for this section we proposed a macadam road with a 2-in. bituminous upper course of Bermudez asphalt. As the sub-soil was exceedingly bad, it was proposed to put in about 8 ins. of gravel under the macadam. When the preliminary estimate was made it was found that the cost of subgrading was considerable, and made the total estimate for this construction high, and on that account it was decided to adopt a concrete road, as the estimate showed that the concrete road would cost less than the Bermudez road.

The cross-section for the road was such as would be used for a macadam road, with the same crown for subgrade and for surface section. This, however, was changed to a level cross-section for the subgrade before the work was finished. The road was 19½ ft. in width. The concrete was 8 ins. deep in the center and 6 ins. deep at the sides. The mixtures of concrete were 1-2-4 and 1-1½-3. The stone used in the concrete varied in size from ¼ in. to 1½ ins. The concrete was laid in one course, and a number of different brands of cement were used.

LONGITUDINAL CRACKS DUE TO FROST.

After the road was finished, cross-sections were taken at intervals of 50 ft. and marks were painted where the rod had been held for levels at the center and sides. In the winter, after a continuous cold spell, these levels were taken again at the same places that the originals were taken, and again in the spring, when the frost was entirely out of the ground. By this means it was possible to know exactly how much the surface was raised by the action of the frost, and to observe carefully the raising up of the road, and its relation to the cracking of the surface. A diagram of the road was plotted and notes were made which indicated, in tenths of a foot, the amount of the lifting of the surface. Also, on the same diagram, the cracks on the road were shown. These cracks were, as a rule, longitudinal, and were a little to the right or left of the center. In nearly every instance the evidence of this diagram is that where no gravel was placed beneath the concrete or where the concrete was not reinforced, the cracks developed on the road proportionately to the amount of the frost action. This seemed to be invariably the condition, as in no instance did we find these longitudinal cracks well developed except where the frost had affected the road considerably, and it also appeared that in no instance was the frost action severe without the accompanying cracks, except on certain sections of the road where gravel had been placed in the subgrade under the concrete. We found also that the reinforcement of the road with steel rods had a considerable but not complete effect in offsetting the development of cracks, even where the frost action had been severe.

It may be inferred from our experience on this road that it is an immensely important matter to see to it that the subgrading is ample, and as permanent for this sort of structure as if we were constructing either a macadam or a gravel road.

In reference to the question of whether we may assume that it is possible to reduce the amount of material under a concrete road and use less than we would if we were constructing a macadam road I have endeavored to get the opinion of several men who have had considerable experience on concrete construction. The opinion of one was that it was impossible at the present time to determine how much may be saved in subgrading, but he writes:

> I should be inclined to say on an average the cost of subgrading under concrete roads might be reduced from 25 to 50 per cent.

If this were adopted in theory it would be safe in making a preliminary estimate for a road of this character to reduce the amount of the loose stone or gravel under the concrete by one-third.

Mr. Austin B. Fletcher, state highway engineer of California in reply to this question, says:

> With the thin work, mostly not over 4 ins., which is being done so generally on California state highways, there is no saving in cost in the subgrade, and in my opinion the cost is considerably increased because of the extraordinary care it is necessary to take in getting a firm, hard, subgrade. I hardly know how this would work out in the case of a thick concrete base, but I would hesitate to scrimp on the character of the subgrade even if 6 or 7 ins. of concrete were used. It is true that the concrete bridges over small inequalities in the subgrade, but I do not think that one should place too much reliance on this property of the concrete.

STONE OR GRAVEL BASE FOR CONCRETE.

It was stated that the old side drain type of construction was abandoned in Massachusetts over 10 years ago, and a rough stone fill was deposited directly under the macadam, and the results were much more satisfactory than those we had obtained with the side drain type of construction. It seems evident that this experience with macadam roads should be applied to the construction of concrete roads as well, and the road engineer should not place too much confidence in the side drains to provide against any disintegration of the surface of the road. It is not meant by this statement to imply that the side drains have no value, but the point is that the stone or gravel filling under the macadam or concrete will be more efficacious and less expensive, and the virtue of it will become apparent after a number of years have elapsed, because it has been found in this state that only after a term of years was it realized that the side drains were becoming failures.

In conclusion, it is plain that it is not wise to neglect the foundations under a concrete road. If the engineer has had experience in determining the proper amount of material to be placed under a macadam road he may assume that somewhat less will suffice under a concrete surface, but with our present knowledge of this subject he will be careful not to invite a failure by using too little material. It is not always possible to obtain good gravel or cobbles for making a foundation in the immediate neighborhood, but it will be best to import them rather than to take a chance with inferior material. The sand or stone should be placed for the full width of the concrete slab.

Tests of Adhesion and Resistance to Sliding of Concrete Joints.

Adhesion in shear of concrete joints under conditions of actual construction were made, Jan. 3, 1914, under direction of the U. S. Engineer Office, Colonel Shuuk, at Pittsburgh, Pa. Two pairs of blocks were molded in place on the top of the land wall of the lock about 3½ months before the test. In one test the land wall was clean and smooth when the blocks were molded on it. In the second test the land wall had been somewhat roughened by picking with an ordinary pick. The blocks were pushed apart by the hydraulic jack.

Omitting all question of moment and unusual stresses, and assuming that the resistance was due only to adhesion and to friction of the two surfaces, which gives the maximum possible value to these two, the required force to rupture the bond amounted to about 50 lbs. per square inch in each case.

On Feb. 5, 1914, further tests were made at Pittsburgh to determine adhesive tension between concrete joints. The apparatus consisted of eight hydraulic jacks which lifted blocks of concrete having joints 3x3 ft. adhering to the land wall at Lock No. 1, Monongahela River. These concrete blocks were molded about 4½ months before the test. The joint was examined after each experiment, and in no case was there any evidence at all of poor bond or weakness in the joint. After making the test reductions, etc., the following are the final results obtained from adhesion:

Experiment No. 1. Surface of land wall washed with water; ultimate strength of adhesion 41 lbs. per square inch.

Experiment No. 2. Surface of land wall washed with acid; ultimate strength of adhesion 2.4 lbs. per square inch.

Experiment No. 3. Surface of land wall washed with water; joint cemented with mortar; ultimate strength of adhesion 7 lbs. per square inch.

Experiment No. 4. Surface of land wall picked and washed with water; ultimate strength of adhesion 47 lbs. per square inch.

These two sets of experiments were as near to field conditions as could be arranged. The concrete was the usual field mix, was thrown into the forms in the usual way and no more or no less care was given than is usually given in the field. These results are given by Capt. W. A. Mitchell in "Professional Memoirs," Jan.-Feb., 1915, and on their showing the Ohio River Board decided in dam design coming under its direction to place no reliance on adhesion of concrete to concrete or to rock.

Wide Streets and Narrow Walks and Roadways in Residential Districts.

(Staff Article.)

In his latest annual report Mr. Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment of the City of New York, calls attention to some interesting arguments in favor of narrow sidewalks and roadways in residence districts. What Mr. Lewis has to say on this point is largely applicable to all cities, regardless of size. It touches upon the rights of the small home owner in a spirit which is perhaps too infrequently exercised in cities of much over 20,000 population.

The subject is brought up in connection with a discussion of the regulation of the height of buildings. The board has always insisted upon a minimum street width of 60 ft, not because such a width will be required in all cases, but because no one can predict which streets will ultimately become traffic thoroughfares. Also with good transportation facilities, an intensive use of land in certain districts may occur, when 60 ft. as a minimum street width will be required to insure adequate light, air and access. We quote from Mr. Lewis's statement as follows:

> The acquisition of 60 ft. as a minimum street width and the paving of such a street in the standard manner, with a roadway 30 ft. wide, will, if the abutting property is to be developed with detached single family houses, involve an economic waste and impose an entirely unnecessary burden upon the abutting owners. A reduction in the roadway width to one which will meet local needs until such time as there is a demand for greater highway capacity has frequently been recommended by this office, but owing to the uncertainty as to the future use of the land resulting from the entire absence of local restrictions it has been thought unwise to make any concessions as to the width of streets. The roadway can be widened at little expense, and the owner is saved the first cost of needless pavement and the city the burden of its maintenance until such time as it may be required, but the widening of a street which is too narrow between the buildings in order to meet changed conditions is very costly and often impossible.
>
> In the boroughs where development is most marked many of the home owners hold their property by a very slender thread. They carry mortgages, the interest on which requires all of their resources, and an assessment is almost confiscation. Many of them would be better off if they did not attempt to own their homes, notwithstanding the notion frequently prevalent that a city of home owners is on a sounder basis than a city of tenants. Many of them have been misled in attempting to own their own homes, but they have them and the city should try and make it as easy as possible for them to keep them. This can be done by reducing, as far as is consistent with the public interest, the cost of street improvements. Cheap building lots require cheap streets, and cheap streets can only come when the improvements are cut down to the lowest limit consistent with good sanitary conditions.
>
> With curbing at 80 cts. a linear foot, cement sidewalks at 20 cts. a square foot, and bituminous concrete at $1.25 a square yard, with an allowance of $1 a running foot for grading a 60-ft. street and 70 cts. a running foot for grading a 40-ft. street, the cost to each 20-ft. lot, not including corners, for the surface improvement of that part of the street on which it fronts would be as follows:

60-ft. street—30-ft. roadway, 5 ft. walks..	$87.67
60-ft. street—20-ft. roadway, 4-ft. walks..	69.78
40-ft. street—20-ft. roadway, 4-ft walks..	66.78
40-ft. street—16-ft. roadway, 4-ft. walks..	61.22

> A narrower street, with 16-ft. roadway and 4-ft. walks would answer every purpose in many cases provided an intensive development were made impossible, and this would represent a saving of $26.45 for each 20-ft. lot, or $52.90 for a 40-ft. plot with a detached cottage. A very important matter for the owner of a modest home struggling with a mortgage for a large proportion of its cost is that the assessment must be paid when due or carry 7 per cent interest. This argument is not believed to be inconsistent with the repeated recommendations of this office in favor of 60 ft. as a minimum street width under existing conditions when the character of future development cannot be controlled.

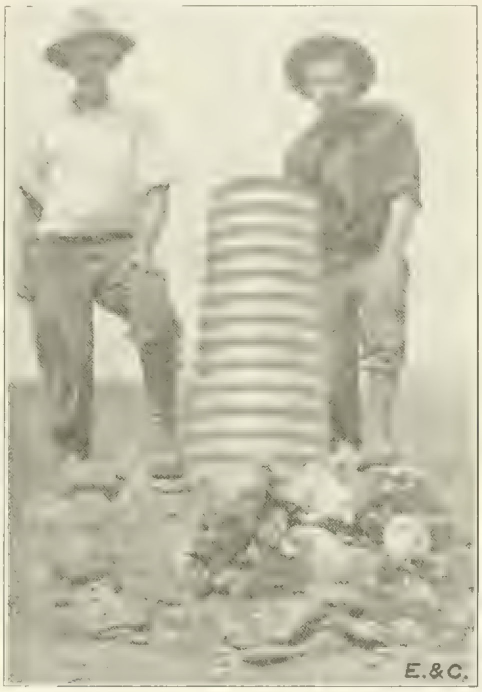


Fig. 1—Survey Monument of Concrete Filled Corrugated Culvert Pipe.

What Mr. Lewis says of the condition of the small home owner is a familiar matter to small town officials. Such officials are often greatly embarrassed by having a personal friend say to them: "If you pave that street I'll lose my home. I can barely meet my present obligations." In large cities where the officials know personally a relatively small number of people such embarrassments seldom occur. But it should be kept in mind that the condition of the small home owner in even such a great city as New York is not very different from that in any town of 20,000 or over. The rights of such individuals must be considered.

The form this consideration should take, we believe, is the insistence upon wide streets, narrow sidewalks and narrow paved roadways. Streets must be kept wide at the outset, for the nature of their future use cannot be accurately foretold. However, for the reasons so clearly set forth by Mr. Lewis, narrow walks and narrow paved roadways are worthy of the most careful consideration in residence districts. Thus a 60-ft. street, 4-ft. sidewalks and a 16 or 20-ft. pavement, with curb and gutter, would seem to be ample for the needs of such districts. It will seldom be necessary later to widen such walks and roadways, but, when necessary, it presents few difficulties.

There are two additional advantages of the street plan just suggested. The wide street and narrow roadway mean, of course, wide parkings. These parkings will be maintained in order by householders and will virtually amount to a lengthening of the lots. Moreover, pipe lines can be laid in wide parkings, as is the practice in many cities. This position of the pipe lines has an obvious advantage in saving the pavement. Service connections, in ordinary soils, can readily be pushed under such narrow pavements as that here under discussion. Another advantage from the narrow pavement is that it discourages speeding of automobiles. This is desirable in districts where small children are frequently on the roadway.

A Survey Monument of Corrugated Culvert Pipe Filled with Concrete.

Contributed by L. W. R. Allison, 170 Roseville Ave., Newark, N. J.

A novel and interesting use for corrugated ingot-iron culvert pipe is shown by the series of survey monuments of this material recently adopted for service on the dividing line between Stanislaus and Merced counties, California. New surveys of the Stanislaus-Merced county line were made in 1914 by E. H. Annear, County Surveyor of the first mentioned county, and to whom the writer is indebted for the accompanying data. In connection with this resurvey, new monuments have been erected, as shown in Fig. 1. These are formed of No. 20 gage American ingot-iron corrugated culvert pipe, 6 ft. long, about 3 ft. of this length being set in the ground. To afford stability, the pipes are filled with concrete, and, well tamped, are built up slightly at the ground level with rock and earth. These monuments are 23 ins. in diameter at the base, tapering to 12 ins. at the top, where, at the center, a 1½ in. galvanized iron pipe is imbedded in the concrete in order that the monument may be flagged conveniently. Thirteen of these monuments have been set along the county line for its distance of 35½ miles, being slightly less than 2¾ miles apart. Beyond the novelty of employing culvert pipe for this purpose, the advantages evidenced will be readily noted. It is a type of survey monument that affords both low initial and maintenance cost, permanency, and long life.

Costs of Sewerage in Nebraska.—Under average conditions in Nebraska, a 12-in. sewer can be laid at a depth of 10 ft. at a cost of about $4,000 per mile, and an 8-in. pipe at a cost of about $3,000 per mile. These costs vary greatly in different localities, but are a fair average. In the lateral sewer districts the total assessment would vary from $18 to $25 for a 50-ft. lot. These figures were recently given out by Mr. George W. Bates, Deputy City Engineer of Lincoln, Neb.

Oiling Streets in Victoria, B. C.—An average cost of 1.23 cts. per yard was the record for oiling 733,000 sq. yds. of streets in Victoria, B. C., in 1914. This cost includes cost of oil, sand and removing dust, sprinkling oil, teams and plant rental, but not overhead expenses.

Engineering and Contracting

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FOREIGN TRADE NOTES

The following foreign trade apportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409, U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank Bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should eb made to the file numbers.

Street Railway Rails.—An electric railway company in France desires to be placed in direct communication with manufacturers of rails, which it will need in the near future. Correspondence should be, if possible, in the French language. No. 16362. [For address see first paragraph.]

Well Drilling Machinery, Etc.—Cattle inspector in Honduras, who is a graduate of an American college, is trying to introduce various American devices, such as well-drilling machinery, windmills or air motors, and hydraulic rams. It is desired to have correspondence and literature in the Spanish language, but English may be used. No. 16366. [For address see first paragraph.]

Surveying Instruments.—Business man in Russia wishes to correspond with American manufacturers and exporters of surveying instruments and supplies for draftsmen. Correspondence should be conducted in Russian or German. Prices, weights, etc., should be stated in Russian equivalents, and quotations should be made c. i. f. Russian ports. No. 16422. [For address see first paragraph.]

INDUSTRIAL NOTES

The Pacific Flush Tank Co. has removed its general offices to 4241 East Ravenswood ave., Chicago, Ill. The new building will contain a testing laboratory in which the company will exhibit and demonstrate many of its appliances.

Charles Eckert Young, Technical Advertising Service, has moved his offices from the 1st National Bank Bldg. to Suite 1109, Ellsworth Bldg., 537 South Dearborn St., Chicago, Ill. Mr. Young has recently secured the services of Jos. H. Everston, formerly sales manager of the Arex Company, as copy writer, and Edwin Carrell as art director.

L. F. Hamilton, in charge of the Advertising and Specialty Department of the National Tube Co., has returned from an extended business trip to the Pacific Coast in connection with the exhibit at the Panama-Pacific Exposition. The National Tube Co. exhibit is part of the U. S. Steel Corporation Exhibit which is located in the Mines and Metallurgy Building and occupies 44,000 sq. ft.—the largest single exhibit at the Exposition.

Among the contracts recently awarded the Raymond Concrete Pile Co., of New York and Chicago, are the following: Concrete piles for the foundation of the factory for the Atlantic Can Co., Boston and Chester Sts., Baltimore, Md. Reinforced concrete foundation, including Raymond concrete piles for warehouse for the Logan-Gregg Hardware Co., Pittsburgh, Pa. Concrete piles for the foundation of addition to the Sharswood Public School, 2nd and Wolf Sts., Philadelphia. Concrete piles in the foundation of coal pockets for Morganthaler Bros., Swanson and Wolf Sts., Philadelphia. Concrete piles for the foundation of a warehouse and other buildings for the Standard Oil Co., Courtland St., Chicago. Concrete piles for the foundation of the new pattern storage warehouse for the Westinghouse Electric & Mfg. Co., Cleveland, O.

NEW CATALOGUES

Steam Tractors.—Paper, 10⅜x7½ ins.; 12 pp. Nichols & Shepard Co., Battle Creek, Mich.

Describes the Nichols-Shepard contractor's steam traction engine for heavy special duty. Gives details of construction and views of the machine and its various parts. Table of dimensions also included.

Metal Forms.—5x5½ ins.; 16 pp. Hotchkiss Lock Metal Form Co., Binghamton, N. Y.

A rather unique little book, giving nine reasons why Hotchkiss lock metal forms should be used for various kinds of concrete work. Also shows views of sidewalk, curb and steps under construction.

Drills.—Paper, 6x9 ins.; 36 pp. Sullivan Machinery Co., 122 S. Michigan Ave., Chicago.

Bulletin No. 65C, describing Sullivan Diamond Core Drills and giving up-to-date information on the capacities, equipment and prices and estimates of the items needed for complete outfits to drill to various depths under given conditions. Illustrated.

Sprays for Cooling Condensing Water.—Paper, 6x9 ins.; 16 pp. Spray Engineering Co., 93 Federal St., Boston, Mass.

Bulletin No. 101, describing spray cooling ponds and showing typical installations. Gives test data and information as to saving effected, power requirements, cooling capacity, water loss, arrangement of sprays, etc.

Drainage Castings.—Paper, 3½x6¼ ins.; 20 pp. The McDonald Foundry, 107 W. Liberty St., Columbus, O.

Catalogue No. 15-D, showing designs of catch basins, sewer inlets, manhole covers, park inlets, gutter grates, sewer grates, cistern covers, cess pools, sewer vents, coal and ash chutes, rubbish cans, etc. Attention is called especially to designs for safety sanitary rubbish boxes for streets and public buildings.

Graphic Methods.—Paper, 6x9 ins.; 20 pp. The Statistics Bureau, 5 E. 42nd St., New York City.

Catalogue of supplies and equipment for the graphic presentation of quantitative data or numerical facts, such as maps and pins, curve cards, co-ordinate paper for platting charts, logarithmic paper, gummed letters, etc. Especially calls attention to the book on "Graphic Methods for Presenting Facts." Illustrated.

Portable Compressed Air Outfits.—Paper, 6x9 ins.; 2 pamphlets, 4 and 12 pp. Chas. D. Schramm & Son, 318 N. 4th St., Philadelphia, Pa.

Specifications for and descriptions and illustrations of various applications of Schramm portable compressed air outfits. Smaller pamphlet particularly describes granite and marble cutting and lists necessary equipment with prices.

Motor Trucks.—Paper, circular. Sternberg Motor Truck Co., West Allis, Milwaukee, Wis.

Describes and illustrates Sternberg big tonnage trucks, gives comparative estimates of operating costs, specifications for 5-ton and 7-ton standard chassis, points out some of the special advantages and gives testimonial letters. Also describes the Sternberg automatic dump trucks.

Road Machinery.—Paper, 10¼x7 ins.; 16 pp. The Good Roads Machinery Co., Inc., Kennett Square, Pa.

"Blazing the Trail to Better Roads" describes and illustrates some of the road and street machinery manufactured by the company. List includes several types of reversible road machines, crushers, steam rollers, distributors, scrapers, heating kettles, pouring pots, etc.

"Safety First."—Paper, 6x7 ins.; 12 pp. New York Central Railroad Co.

The New York Central is sending out a neat little pamphlet telling the story of the recent award to that railway of the E. H. Harriman gold medal for the greatest progress in safety and in accident prevention. Illustrated by photographs of New York Central equipment and right of way.

Drawing Instruments.—Circular. Kolesch & Co., 138 Fulton St., New York City.

Special price list of Kern drawing instruments which are being sold out by the company at greatly reduced prices.

Scarifier.—Paper, 8½x11¼ ins. The Lehigh Foundry Co., Fullerton, Pa.

Describes the Wright-Lehigh scarifier and shows several views of the machine. Special features are the eight picks, spring and chain arrangement and positive gage.

Water Turbines.—Paper, 7x9 ins.; 12 pp. The James Leffel & Co., Springfield, O.

Reprint of an article on "Recent Tests of High-Power, High-Speed Water Turbines" by S. J. Zowski, professor of mechanical engineering at Ann Arbor. Also describes further tests by Jas. Leffel & Co. and the development of their Samson wheels. Illustrated.

Wire Rope.—Paper, 3½x5¾ ins.; 14 pp. Hazard Manufacturing Co., Wilkes-Barre, Pa.

Price list of Hazard wire lines for oil and gas wells. Also gives a few notes on the care of wire rope. Illustrated.

Concrete Mixers.—Paper, 7½x10¾ ins.; 32 pp. Raber & Lang Mfg. Co., Kendallville, Ind.

Catalogue No. 10 describing the "Crescent" mixers, showing the various mixer outfits, and views of operations. Also gives a number of testimonial letters. The mechanism of the mixer is described in detail.

Pile Hammers.—Paper, 6x9 ins.; 28 pp. McKiernan-Terry Drill Co., 236 Broadway, New York City.

McKiernan-Terry pile hammers, both light service and heavy duty, are described and their work illustrated in this booklet. Views of operations on steel sheet piling, interlocking steel piling, round piles, tongue and groove piling, etc., are shown. Specifications and table of dimensions, diagrams, etc., are also given.

CATALOGUE REVIEWS

Chain Belt Mixers.—Paper, 7½x9½ ins.; 64 pp. Chain Belt Co., Milwaukee, Wis.

Catalogue No. 60, containing information on chain belt mixers, pavers and concrete handling equipment, is largely composed of illustrations showing design of the machines, some of the manufacturing operations, and the actual work of the mixers on paving or construction. The necessary descriptive matter has been cut to a minimum, and printed in large type, so that the special features of the various types shown can be ascertained at a glance. Dimensional diagrams, tables of sizes, capacities and shipping weights and specifications for the different types are included.

Engineering Construction.—Paper, 8½x12 ins.; 64 pp. Arthur G. McKee & Co., Contracting Engineers, Cleveland, Ohio.

An unusually ambitious book for a contracting engineering firm to publish has been received from Arthur G. McKee & Co., of Cleveland. This firm has specialized in the design and construction of blast furnace equipment, blast furnace and smelting plants, power plants and industrial building. The publication mentioned is designed to illustrate the nature and scope of the work in those lines which has been carried out by the firm, and consists of photographs of installations, brief descriptive notes, diagrams of construction details, design, etc., and some general information as to construction methods followed.

The subjects treated are as follows: Blast Furnaces and Smelting Plants, Thin-Lined Blast Furnaces, Blast Furnace Distributors, Storage Bins, Material Handling Equipment, Power Plants, General Construction.

The typographical arrangement is excellent, and the book, which is listed as Catalogue No. 4, presents an attractive appearance and convincing advertisement.

CURRENT NEWS

The Doings of the Week.

Business and finance made further progress during the past week. Increased activity was shown by practically every representative industry. A marked rise in security prices was a feature of the week in the stock market. Export business continued in increased volume. The railroads have come into the material and equipment markets, the Pennsylvania R. R. alone placing a $20,000,000 order. Bank clearings for the week were $3,442,989,000, as compared with $3,167,048,000 for the corresponding week in 1914. Orders for war munitions amounting to $86,000,000 were placed last week with two concerns. In the construction field activities have been well sustained. A large amount of new work reached the call for bids stage during the past week and many large contracts were placed. In the municipal field many lettings, especially in the street paving line, are being advertised. Waterworks and sewerage undertakings for smaller cities also offer many construction opportunities. Highway improvements by states, counties and road districts are offering a large volume of work. The building industry in the Chicago district has received a setback owing to the development of labor troubles. Reports from other sections of the country, however, show gains in activities. Reports from 115 cities in the country show that building is now within only 2.2 per cent of normal; on Jan. 1 it was 15 per cent behind. An increase in shipment of 11 per cent over March last year is shown by national reports of the Portland cement industry, with reserve stock 10 per cent less. In the steel industry plants are now operating on about a 75 per cent basis. Were the railways doing their part in placing orders full capacity of plant operation probably would be obtained. Large fabricating contracts were booked for March. These ran up to about 64 per cent of a month's capacity, figured on a basis of 2,100,000 tons per year. The average of such work for the first 8 months of the war was less than 35 per cent capacity. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending April 14 were as follows:

Finished Iron and Steel.	Apr. 14	Apr. 7
Per lb. to large buyers	Cts.	Cts.
Bess. rails, heavy, at mill	1.25	1.25
Iron bars, Philadelphia	1.15	1.15
Iron bars, Pittsburgh	1.20	1.20
Iron bars, Chicago	1.15	1.15
Steel bars, Pittsburgh	1.20	1.20
Steel bars, New York	1.369	1.319
Tank plates, Pittsburgh	1.15	1.15
Tank plates, New York	1.319	1.269
Beams, etc., Pittsburgh	1.20	1.20
Beams, etc., New York	1.369	1.269
Skelp, grooved steel, P'gh	1.12½	1.12½
Skelp, sheared steel, P'gh	1.17½	1.17½
Steel hoops, Pittsburgh	[illegible]	[illegible]
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No. 28, P'gh	3.25	3.30
Wire nails, Pittsburgh	1.55	1.60
Cut nails, Pittsburgh	1.55	1.55
Fence wire, base, P'gh	1.40	1.40
Barb wire, galv., P'gh	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 to 1.20 cts.

Railways.—Several large construction jobs were let last week by the railroads and bids were opened on a number of other big jobs. Other especially large projects are understood to be reaching the taking of bids stage. One of these calls for the building of a cut-off for an eastern line, involving the expenditure of several million dollars. Contracts for the first 28 miles of the Chesapeake & Ohio Northern R. R. in Ohio were let to the following: Section 1, W. W. Boxley, Roanoke, Va.; Section 2, Rinehart & Dennis, Charlottesville, Va.; Section 3, Winston & Co., Richmond, Va.; Section 4, Robert Grace Contracting Co., Pittsburgh, Pa. This work involves 4,000,000 cu. yds. of excavation and 60,000 cu. yds. of concrete. Floyd Brown, San Bernardino, Cal., was awarded the grading for the first 12½ miles of a new railroad from Blythe, Cal.; Twohy Bros., Portland, Ore., secured a 12-mile extension from Goshen to Welcome, Wash., for the Chicago, Milwaukee & St. Paul Ry.; Utah Construction Co., Ogden, Utah., was awarded a 30-mile extension of Ogden, Logan & Idaho Electric Ry. Bids were opened last Thursday at the Pittsburgh offices of the Pennsylvania R. R. for the foundation work for the new freight house at the Union terminal, Chicago. This contract includes about 45,000 cu. yds. of concrete.

Roads and Streets.—Many large state highway construction jobs came up for advertising during the past week. County work also is offering many opportunities. In the south and on the Pacific coast a considerable amount of road work is now ready for bids. New York is asking proposals on 29 contracts covering 99 miles of highway; Ohio opens bids April 30 on 31 contracts; Illinois is asking proposals until May 5 on 6 road contracts and 3 bridge contracts. Baton Rouge, La., is asking bids on about $250,000 worth of street paving; Nashville, Tenn., also is advertising several good sized improvements. Decatur, Ill., awarded a $148,813 wood block paving contract. Winston & Co., Browns Station, N. Y., secured a $189,150 contract from the Board of Water Supply of New York City; the State Highway Commissioner of Connecticut let 21,923 ft. of reinforced concrete road at $70,637.

Bridges.—A considerable amount of small bridge and culvert construction is now being advertised. Webster County, Ia., is asking bids on 20 bridges and culverts; Marshall County, Ia., is calling for proposals on 26 culverts and bridges. Lake County, Indiana, opens bids May 14 for a Strauss trunnion bascule to be erected at 155th, East Chicago, Ind. The County Commissioners at Northampton, Mass., are asking bids for a good sized contract for repairing superstructure of the Connecticut River bridge. The towns of Canton, N. Y., and Cobleskill, N. Y., are asking bids on two fair sized bridges. The Pennsylvania R. R. is reported to have asked bids on a $1,000,000 bridge to be erected at Manayunk, Pa. The Interstate Bridge Commission, Portland, Ore., opens proposals April 26 for earth embankment work calling for the handling of 500,000 cu. yds. of material.

Drainage and Irrigation.—One of the largest jobs in the drainage field coming up for bids last week appears to be the work for the Reeds Creek Drainage District of Dyersburg, Tenn. This calls for about 15.4 miles of ditches requiring about 660,000 cu. yds. of excavation. R. H. & G. A. McWilliams, Memphis, Tenn., were awarded a $122,000 contract for drainage ditching and levee construction in Weakley County, Tennessee. The Tibbetts Pacific Co., San Francisco, Cal., was awarded a $71,000 contract by the Modesto Irrigation district, Modesto, Cal.

Waterworks.—A considerable amount of work, mostly for smaller municipalities, reached the call for bids stage last week. Montrose, Colo., is calling for proposals on a fair sized job, and Walterboro, S. C., opens bids May 14 on waterworks, sewers and electric light system. Morning Sun, Ia.; Orien, Mich.; Schoolcraft, Mich., and Gates, N. Y., are calling for bids for installing waterworks.

Sewerage.—A number of good sized sewerage contracts are being advertised. Philadelphia, Pa., is calling for bids on branch sewers and main sewers. Wilkes-Barre, Pa., opens proposals May 25 for brick, segment block and terra cotta pipe sewers. Great Neck Station, N. Y., is asking proposals for 12 miles of sewers, 2 pumping stations and disposal works. Jones & Erbeck, Pittsburgh, Pa., have been awarded a $193,000 sewer contract at Milwaukee, Wis.

Why Bethlehem Steel Advanced.

One feature of the security market during the last few days has been the sharp advance in shares of the Bethlehem Steel Co. Various reasons have been ascribed for this. One Wall St. rumor floater was responsible for the theory that the German government was buying the stock in order to prevent the making of war munitions for the allies. After this flight of imagination competing rumor mongers on the stock exchange folded their tents and departed. Another theory has been advanced, according to a cable dispatch, this time by a "highly placed employe of the British Government." He opines that the sensational rise in the market price of the Bethlehem Co.'s stock was due in part to orders placed for structural steel for building bridges over the Rhine for the allies. According to this authority everything is in readiness in several great manufacturing establishments in the north of England and in Scotland for the building of six bridges designed for erection at six different points on the Rhine. That is, everything is ready except the small matter of the steel. The plan calls for the construction of the bridges and their transportation across the English Channel. They will be used to replace the present structures which necessarily would be destroyed if the Germans are driven back across the Rhine. It is very well to be prepared for any contingency; but the old saying still holds good: "Never cross a river until you come to it."

Labor Troubles in Chicago.

The spring construction season commences very auspiciously in Chicago. The trouble twins walkout and lockout have arrived. As a result over $20,000,000 worth of building operations in Chicago and Cook County are tied up and perhaps 125,000 men are out of jobs. The main cause of the trouble is the demands of the carpenters' union for 70 cts. per hour for the first year, 72½ cts. per hour for the second year and 75 cts. per hour for the third year. The present scale is 65 cts. per hour. The employers offered a 2½ cts. per hour increase for the last 18 months of the proposed 3-year agreement period. Without referring the contractors' offer to a vote of the men the officials of the union ordered a walkout. This was promptly followed by lockout orders on the part of the Employers' Association. A more inopportune time for a labor war could not have been selected. Chicago has been particularly hard hit by the prolonged business depression. During the past winter there have been more men out of work than ever before in the history of the city. Just when real prosperity is in sight a few pigheaded union officials stir up trouble. Commonsense, seemingly, is not a qualification for leadership in some unions. It is to be hoped that some agreement will be reached between the employers and their employees. Labor troubles at this time are inexcusable.

The Clergy and Contracting.

Some people consider contracting as an easy method of obtaining money. A Western clergyman whose income and outgo balanced on the debit side has decided to take up contracting as a side line. Recently he secured his first contract for street paving. On Sundays he will preach the gospel and on week days he will boss a paving gang. The Rev. Philander Buxbee takes a philosophical view of his new profession. All you have to do, he says, to succeed in contracting, "is to bid low enough to get the work and then do it for less than you bid." No one will deny the truth of this statement, but it is easier said than done.

A $2,200,000 RAILWAY CONTRACT

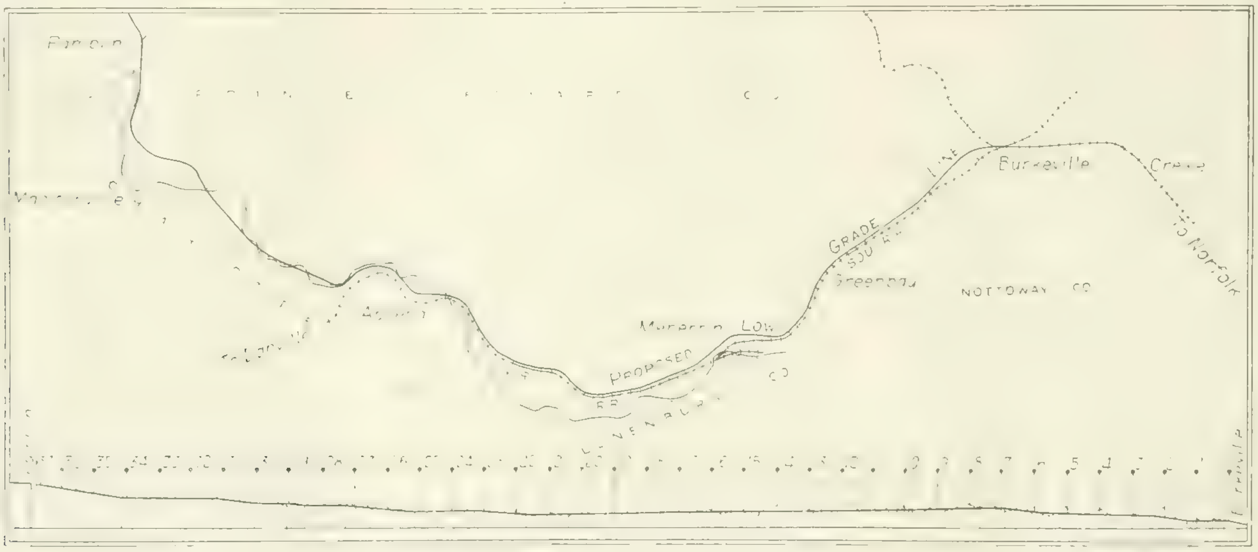
New 37-Mile Low-Grade Line for Norfolk & Western Ry.

3,000,000 Cu. Yds. of Grading; 5,000,000 Lbs. Cast Iron Pipe; 10,000 Cu. Yds. of Concrete.

The new low-grade connecting line in Virginia of the Norfolk & Western Ry. is one of the largest railway construction undertakings that has been placed under contract so far this year. The new stretch of track will extend from Burkeville, about 133 miles from Norfolk, Va., to Pamplin, and will be about 37 miles in length. The route lies in Prince Edward's County. From Burkesville to Mile 14 the new line is in close proximity to the Southern Ry., and from Mile 10 to Mile 25 it is paralleled by the Virginia Ry.

The accompanying illustration shows the route of the low-grade line and the profile for it. The line generally for its entire distance follows the water shed, so that no bridges are required. The maximum waterway will necessitate an 8 by 8 reinforced concrete culvert. The maximum cut is about 50 ft., and the maximum fill is about the same. The construction of the line will require approximately 3,000,000 cu. yds. of grading, 5,000,000 lbs. of cast iron pipe, and 10,000 cu. yds. of concrete head walls and culverts. The line will be provided with alternating current automatic signals throughout. The estimated cost of the line is $2,200,000.

The construction contracts were awarded early in April to the following: Paterson, Moran & Co., New York City; J. J. Sheehan, Roanoke, Va.; Rinehart & Dennis, Charlottesville, Va.; and the Robert Grace Contracting Co., Pittsburgh, Pa. J. E. Crawford, Roanoke, Va., is chief engineer of the Norfolk & Western Ry.



Route and Profile of Burkeville-Pamplin Low Grade Line of Norfolk & Western Ry.

Pan-American Road Congress.—Plans have been made for a gathering of good roads advocates at the Panama-Pacific International Exposition in September. It will be known as the Pan-American Road Congress and will be under the joint auspices of the American Road Builders' Association and the American Highway Association. The executive committee who will have charge of the affairs of the Congress consists of five members as follows: Chairman, Governor Charles W. Gates of Vermont, who for ten years or more was State Highway Commissioner of Vermont; W. W. Crosby, former State Highway Engineer of Maryland; E. L. Powers, editor of "Good Roads"; James H. MacDonald, former State Highway Commissioner of Connecticut; J. E. Pennybacker, chief of the Division of Economics, U. S. Office of Public Roads.

CONTRACTS BEING LET FOR RAILWAY CONSTRUCTION.

Several Large Contracts Awarded in Last Two Weeks.

A $2,200,000 Job in Virginia; 28 Miles of Line in Ohio.

One line of construction that has been dormant for many months is at last showing signs of activity. The railroads are commencing to let some sizable contracts. The Norfolk & Western Ry. started the ball rolling with its $2,200,000 Burkeville-Pamplin low-grade line in Virginia, described in another column in this issue.

The Chesapeake & Ohio Ry. on April 12 awarded the contracts for the first 28 miles of the Chesapeake & Ohio Northern Ry., its new line from the Ohio River to Columbus, O. The first work begins at Sciotoville. The construction of the 28 miles will require approximately 4,000,000 cu. yds. of excavation and 60,000 cu. yds. concrete. The contracts were awarded to the following: Section 1, W. W. Boxley, Roanoke, Va.; Section 2, Rinehart & Dennis, Charlottesville, Va.; Section 3, Winston & Co., Richmond, Va.; Section 4, Robert Grace Contracting Co., Pittsburgh, Pa.

This Chesapeake & Ohio work has been in the near-construction stage for some time. In fact, bids on it were taken last year, but on account of financial reasons and right of way difficulties the work was postponed, and new proposals were opened early this month. The contracts for the bridge over the Ohio River were placed some time ago. The new line will form a connection between the Chesapeake & Ohio and the Hocking Valley. It will be about 96 miles in length, and its construction has been divided into three sections: Sciotoville to Waverly, 28 miles; Waverly to Circleville, and Circleville to Columbus. The new line will be built under the direction of M. J. Caples, Columbus, O., vice-president of the Hocking Valley Ry.

Another big railway job on which bids were opened last week calls for work in connection with the construction of the new $65,000,000 Union Terminal in Chicago. About 45,000 cu. yds. of concrete, 20,000 lin. ft. of piling, and 40,000 to 50,000 cu. yds. of excavation are involved in the contract, which is one of the largest so far let for the terminal. The work calls for the building of foundations for freight houses. Bids were opened April 15 at the Pittsburgh offices of the Pennsylvania R. R.

In the Pacific Coast states a number of good sized railroad undertakings have been let in the last two or three weeks. One of the larger reported covers the last 34-mile section of the San Diego & Arizona Ry. Bids on this work were opened last July, but, owing to the commencement of the European war, no further action was taken at that time. The work of this section extends through canyons requiring numerous short tunnels and a considerable amount of heavy rock work. The estimated cost is said to be between $2,000,000 and $3,000,000.

A contract was awarded a few days ago for a 12-mile extension of a Chicago, Milwaukee & St. Paul line from Goshen, Wash., to Welcome. This is a comparatively small job as railroad undertakings go. Twohy Bros., Portland, Ore., secured the work at about $330,000. These same contractors also are understood to have become interested recently in the construction of the Coast R. R., projecting a line from Grant's Pass, Ore., to Crescent City and the Northern California Coast. The building of this road will call for an expenditure of approximately $5,000,000.

In the interurban construction field also there have been signs of activity, and several fair-sized contracts have been let. One of these was for a 21-mile extension from Sciotoville, O., to Hanging Rock, for the Ohio Valley Traction Co. Another contract let in the last two weeks provided for a 36-mile extension of the Ogden, Logan & Idaho Ry., from Brigham, Utah, to Wellsville. There has been very little construction undertaken in the last two years by electric railway companies. The contracts mentioned above are among the largest for this class of work that have been let for some time.

The mere fact that so much railroad construction has been placed under contract in the last few days is very encouraging. It is a good indication that a period of activity in this field is close at hand.

Bridge and Culvert Construction in Webster County, Iowa.—Bridge and culvert construction estimated to cost $27,616 is now advertised for bids by Webster County, Iowa. The letting covers 20 structures, ranging in size from a 3-panel wood trestle to an 80-ft. by 18-ft. deck truss with two 30-ft. I-beam approaches. The latter bridge will have a concrete floor and retaining walls. The present masonry abutments will be reconstructed. The estimated cost is $5,640. Of the structures 8 will be steel I-beams, and 6 will be concrete box culverts. Most of the first mentioned class will have concrete abutments and plank floors. Work is to commence within 15 days from contract date and is to be completed by Oct. 15, 1915. The county will furnish lumber, cement and reinforcing steel. Bids will be received until 2 p. m., May 5, by J. L. Hanrahan, County Auditor. G. P. Smith, Fort Dodge, Ia., is County Engineer.

WATER WORKS OF EVERETT, WASH.

Appraisal of Present System and Recommendations for New Supply.

Estimated Cost of Sultan Project Set at $582,000.

A report on an appraisal of the present water system at Everett, Wash., and recommendations for future supply were submitted to the City Council of that city early this month by Burns & McDonnell, Consulting Engineers, Kansas City, Mo. The reproduction cost of the existing water works is given in the report as $1,333,933. Charging of $242,300 as depreciation, the engineers estimate the prevent value at $1,091,633. The pipe system was examined at 200 points, and the mains were found generally to be in excellent condition. The old system has 73 miles of pipe line, of which 45.3 miles is steel pipe, 17.7 miles wrought iron, 0.3 mile cast iron, and 9.7 miles wood pipe. It was found that the average age of all pipes was 9 years. The average age of the wood pipe was 5 years, and it was in comparatively good condition. In arriving at the value of the present water supply, the engineers base their figures upon the recommendation that Pigeon Creek be abandoned upon completion of the new supply works, and that Woods Creek supply be held as a reserve as long as the present supply lines remain in serviceable condition.

For the future supply the investigations included a study of Deer Creek, North Fork, Stillaguamish River, Boulder River, Jim Creek, Canyon Creek, South Fork of Stillaguamish River, Pilchuck River, Sultan River, Miner Creek, Pigeon Creek, and Woods Creek. Many of these are eliminated from consideration owing to their inadequacy, excessive distance from Everett, or other unfavorable features. The ones considered feasible are Boulder River, Canyon Creek and Sultan River, all of these being within the range of practical engineering design and financially available to Everett. Sultan River was recommended as a source of supply.

The Sultan project contemplates taking the water at an elevation of approximately 200 ft. above the present upper reservoir. This will enable the water to flow by gravity directly into the present reservoirs in the city, thus doing away with the expensive pumping cost necessary under the present system. The cost of the Sultan River project is estimated as follows:

Right of way, 20 miles	$ 20,000
Clearing, 100 acres	10,000
Grubbing, 32 acres	6,100
Road building, 20 miles	60,000
Diversion dam and headworks	25,000
Settling basin	10,000
Keeper's house	1,000
Excavation and canyon hazard	40,000
28-in. steel pipe, 30,000 ft.	148,500
28-in. wood stave pipe, 102,000 ft.	183,600
Flow line appurtenances	12,000
Connection between reservoirs	2,500
Extra for Sultan River crossing	3,000
Extra for Snohomish River	10,000
Total	$532,000
Engineering and incidentals, 15 per cent	53,200
Grand total	$585,200

The estimated cost of an auxiliary supply from Miner Creek is set at $38,170. In addition, the report recommends reinforcing the present distribution system in the city at a cost of $41,242.

Work on Yuma Irrigation Project.—During the month of February 28,000 yds. of levee work were accomplished near the international boundary, making the levee complete below Yuma; 34,000 cu. yds. of riprap were placed on this levee at various points. Two miles of track were laid and 2 miles ballasted. On the distribution system 75,000 cu. yds. were moved by force account and 46,000 yds. under small contracts. One hundred and nine structures, containing 100,000 ft. b. m., were built. One engineering camp in Yuma Valley and one on the reservation have covered all field work required. Farm-unit plats for Yuma Valley were completed and forwarded to Washington on the 26th.

State Highway Construction in New York.

The second road construction letting of the present season of the State Highway Commission of New York was held on April 14. Bids were received on 14 contracts, covering a total of about 68 miles of roads. On most of the jobs there was a considerable number of bidders, and on some contracts the figuring was very close. On Road No. 1236, in Monroe County, Whitmore-Rauber & Vicinius, Rochester, N. Y., submitted a bid of $20,974, while the next lowest total was $20,997. The estimates on Road No. 1244, in Oswego County, also were very close. The Valley Construction Co., Sidney, N. Y., offered to build this road for $45,069; the bid of the Pathfinder Construction Co., Inc., Fulton, N. Y., was $45,141. The following tabulation shows the high and low bids and the number of bidders on each contract:

Road No.	Length, miles.	High bid.	Low bid.	Number bidders.
1229	2.80	$31,392	$23,668	17
1246	6.71	108,974	96,379	13
1177	5.34	52,042	55,985	4
1250	5.50	73,054	75,611	3
1251	4.91	46,554	41,418	6
1252	11.41	130,683	104,999	5
5507	2.14	23,153	18,357	19
1236	1.87	24,174	20,974	16
1158	2.65	59,038	51,530	9
1243	5.41	51,568	42,454	24
1244	5.22	51,928	45,069	17
1245	3.66	36,827	29,452	25
5535	6.66	79,760	65,818	12
5410	3.88	43,714	40,084	9

Few out-of-the-state contractors submitted bids at April 14 letting. Three firms from Connecticut bid on the Knox-Berne Road (No. 1229), in Albany County. Two Pennsylvania contractors bid on some of the other jobs.

The next letting of the State Highway Commission will be held on April 20, at which time bids will be opened on 21 repair contracts, the work consisting for the most part of resurfacing and bituminous applications. Two supply contracts also are being advertised by the Commission. One of these provides for furnishing bituminous materials A and T, and bids for doing this will be opened April 26. The other calls for furnishing about 40,000 tons of stone in various counties for maintenance work. The bids on this will be opened April 29.

The next highway construction letting of the Commission will be held on May 5. This takes in 20 contracts and provides for the improvement of about 99.34 miles of road. The roads, their location and length of contract are as follows:

County.	Road No.	Name.	Length, miles.
Allegany	1259	Belfast-Transit Bridge	4.00
Allegany	1260	Belvidere-Transit Bridge-Angelica	8.64
Cattaraugus	1254	Rutledge-Leon, Part 1.	4.13
Chautauqua	1026	Jamestown-Stockton, Part 1.	3.99
Chautauqua	1062	Fredonia Village	1.59
Dutchess	5549	Wappinger Falls, Main St.	.88
Franklin	5552	Malone-Duane, Part 1.	8.81
Hamilton	1258	Tupper Lake-Long Lake, Part 1	7.01
Herkimer	1257	Little Falls, E. Monroe St.	1.81
Herkimer	471 830	Richfield Springs-Warren Springfield	3.60
Herkimer	830	Little Falls-Montgomery Co. line	5.63
Jefferson	5548	Philadelphia-Antwerp	7.27
Livingston	1247	Moscow-Geneseo	3.51
Livingston	1248	Perry Center-Moscow, Part 2	3.96
Livingston	1249	West Rush-East Avon	2.18
St. Lawrence	1261	Massina-Helena, Part 1	5.66
St Lawrence	1263	Gouverneur-Edwards, Part 1	10.8[illegible]
St. Lawrence	1264	Brasie Corners-Edwardsville	9.09
Schenectady	5545	Schenectady-Duanesburg, Part 2	5.6[illegible]
Schoharie	1234	Richmondville-Summit	1.[illegible]9

The imports of Portland cement into Australia in 1912 totaled $1,273,406 in value, of which only $6,589 worth came from the United States. The total imports in 1913 amounted to $1,285,977, of which but $6,278 was from the United States.

STATE HIGHWAY WORK IN PENNSYLVANIA.

State Appropriation in Excess of $8,500,000.

Large Sums to be Expended on Maintenance.

The state appropriation for highway work in Pennsylvania during 1915 and 1916 will be in excess of $8,500,000. It is probable, however, that a considerable portion of this amount will be expended for maintenance. The bill providing the general appropriation for highways during the next two years was introduced in the Senate last week. It carries an appropriation of $8,500,000, and does not include the administration expenses of the department and of the requisition bureau, which will be provided for in the general appropriation bill.

Of amount carried by the bill $6,000,000 is specifically appropriated for the maintenance and improvement of state highways under the act of 1911, and its amendments. This means that the entire state highway system, including those roads added to the original Sproul plan two years ago, will be retained as state highways. The allowance will give about $300 a mile per year for the state highways, and it is believed by the officials that this amount will be sufficient to keep the roads in good condition, and also will allow of considerable permanent work.

The sum of $500,000 is appropriated in the bill for the purchase or condemnation of turnpikes upon state highway routes, and $1,000,000 is set aside for the construction and maintenance of state-aid highways. The remaining $1,000,000 is to be devoted to the payment of a portion of township roads, as provided by the Jones bill. A separate bill has been introduced making provision for the payment of deficiencies due by the state to townships under the operation of the law enacted by the Jones bill.

The appropriation bill before the Senate provides that the appropriations made therein shall include and not be in addition to the amounts received by the state for the licensing of motor vehicles during the next two years. This prevents there being any question regarding the validating of the appropriation of the funds received for automobile licenses, which matter is now pending in the Supreme Court upon appeal by the auditor general and state treasurer from a decision of the Dauphin County Courts on the application of the law of 1913, which provided that moneys received from automobile licenses should be devoted to highway purposes. In order to prevent any delay or risk of tying up these funds the present bill provides for a specific appropriation for the department

Governor Brumbaugh has appointed Robert J. Cunningham, of Pittsburgh, Pa., state highway commissioner to succeed E. M. Bigelow Mr. Cunningham for many years has been county controller of Allegheny County. The Governor has announced that the highway department activities will be carried on under his personal supervision, and that immediately upon the assumption of office by Mr. Cunningham a "roads council" will be organized, consisting of Commissioner Cunningham, the Governor, and Chief Engineer William S. Uhler. This council, it is reported, will hold frequent regular meetings at which details of the work will be discussed.

Panama Canal Machinery for Alaska.—Inquiry has been received by the Canal Commission from Lieut. Frederick Mears, on behalf of the Alaska Railway Commission, if the Panama Canal can transfer to the Commission a French ladder dredge, tugs and barges or clapets to serve the same, four 201-class locomotives, four locomotive cranes, 60 12-yd. dump cars, two steamshovels, and two piledrivers complete. The reply was that the material other than the dredge, tugs, barges, clapets, and locomotive cranes could be supplied, but that none of the former could be spared for several months.

Bids Asked on 26 Reinforced Concrete Culverts and Bridges for Marshall County, Iowa.

Approximately 1,500 cu. yds. of concrete are required for bridge and culvert construction now being advertised for bids by the Supervisors of Marshall County, Iowa. The work calls for the building of 23 reinforced concrete culverts of the box type and three reinforced concrete bridges. One of the latter will be a slab structure of 20-ft. span and 20-ft. roadway. The other two will be deck girders, each of 36-ft. span. The locations of the structures and various other details are given in Table I. Bids for the construction of the 26 bridges and culverts will be received at the office of the County Auditor at Marshalltown, Ia., until noon, April 26.

TABLE I.

Township.	Dimensions, ft.	Concrete, cu. yds.	Reinforcing steel, lbs.	Haul, miles.
Vienna	3x3x40	23	1,430	6
Liberty	4x4x21	23	1,170	1
Liberty	6x5x20	35	1,900	2
Marion	10x8x20	77	2,960	3
Marion	6x5x20	35	1,890	3
Marion	6x6x30	47	2,700	2
Marion	4x4x34	30	1,700	1
Taylor	6x7x24[1]	46	2,930	3½
Taylor	4x4x22	23	1,220	3
Iowa	4x4x27	26	1,370	3
Marietta ...	6x4x21	33	1,850	2½
Minerva	3x3x48	..	.....	3
Minerva	20[2]x20	274[3]	15,400[3]	3
Minerva	4x4x27½	26	1,420	2
Minerva	4x4x28	27	1,450	3
Le Grand...	6x6x31	52	3,800	4
Timber Creek	4x4x31	29	1,560	2
Washington.	4x4x28	26	1,450	3
Washington[4].	6x6x37	53	3,210	1
Greencastle .	36[5]x20	160	13,700	3
Greencastle[4].	4x6x33	60	2,700	4
Greencastle .	3x4x25½	17	1,190	2
Jefferson ...	36[6]x18	182	16,000	3
Logan	4x4x31	29	1,570	1½
Eden	6x5x20	35	1,880	4
Eden	3x3x20	18	1,200	5

[1] 15° skew. [2] Concrete slab, 20 ft. roadway, 45° skew. [3] Total for the 3 ft. 3 ft. box culvert and for slab bridge; also reference 2,240 lin. ft. foundation piling. [4] 45° skew. [5] Concrete deck girder, 20 ft. roadway; also 1,120 lin. ft. foundation piling. [6] Concrete deck girder, 18 ft. roadway; also 1,312 lin. ft. foundation piling.

Bids Asked on $250,000 of Street Improvements.

A $250,000 street improvement contract is now advertised for bids by the city of Baton Rouge, La. The work calls for surfacing 13½ miles of street with a bituminous gravel pavement and for about 1 mile of hard surface pavement. The latter will be laid on Main street and on North Boulevard. The gravel paving is to be constructed on portions of 37 streets.

The graveled streets will have concrete curbs and gutters and catch basins for caring for the drainage. The gravel surfacing will consist of a base course of washed gravel. After this has been rolled a layer of cementing gravel will be placed and rolled. The street then will be thrown open to traffic for about 60 days. After this it will be closed again, the surface swept clean and a tar product binding material applied. Over this pea gravel will be spread and a second binder coat applied and blanketed with another layer of pea gravel. The street will then be rolled again.

Bids for the hard surface pavement will be received on asphaltic concrete, bitulithic, vitrified brick, wood block and sheet asphalt. Bids will be received until May 15. W. P. Burden is city secretary. J. J. Mundinger is city engineer.

About 15 miles of state aid highway will be built in Washington County, Maryland, during the coming season, according to a recent report. It is estimated that the roads will cost about $5,000 per mile.

Highway work in Brown County, Wisconsin, during 1914 cost $96,977, according to the annual report of the county highway commissioner.

36 Miles of Concrete Road in California.

Bids are now being asked by the California Highway Commission on five state highway contracts, covering an aggregate length of 36½ miles. The roads are to be paved with Portland cement concrete, the work requiring 35,885 cu. yds. In addition 805 cu. yds. of concrete will be used for culverts and monuments. Table I gives some details of the five jobs.

One of the sections (IV-Son-1-C) is located in Sonoma County. It extends from Willow Brook to the northerly boundary of the country and is about 6½ miles in length. Section IV-C-C-14-A is in Contra Costa County. It extends from Richmond to Pinole and is about 5½ miles in length. The other three sections are in Monterey County. Section V-Mon-2-A extends from Salinas to Lagunita, and is about 6 miles in length. Section V-Mon-2-E is about 7½ miles in length, extending from a point 3.2 miles north of King City bridge to Greenfield. Section V-Mon-2-14 extends from a point 3 miles northwesterly of Bradley to San Ardo and is about 11 miles in length. For the first three sections the Highway Commission will furnish the contractor will the pipe railing for culverts, reinforcing steel, the corrugated iron pipe, Portland cement, sand and coarse aggregate for concrete. These materials with the exception of the sand and coarse aggregate also will be furnished by the commission for the last two sections. Bids for constructing the five sections of highway will be received until 2 p. m., April 26, by the California Highway Commission, 515 Forum Bldg., Sacramento.

TABLE I.—QUANTITIES IN FIVE STATE HIGHWAY CONTESTS IN CALIFORNIA.

	IV-Son-1-C.	IV-C-C-14-A.	V-Mon-2-A.	V-Mon-2-E.	V-Mon-2-H.
Excavation without classification, cu. yds.	31,000	11,200	14,135	9,900	96,760*
Corrugated iron pipe, 12-in., lin. ft.......	260	350	725	600	850
Corrugated iron pipe, 15-in., lin. ft.......	200	130	...	60	120
Corrugated iron pipe, 18-in., lin. ft.......	400	50	40	30	44
Corrugated iron pipe, 24-in., lin ft.......	140	...	36	...	28
Corrugated iron pipe, 30-in., lin. ft.......	110	...	...	...	172
Concrete, Class B, culverts and monuments, cu. yds..........................	310	10	16	53	416
Concrete, Class B, pavement, cu. yds.....	7,100	6,150	4,830	7,185	10,620
Rubble masonry, retaining walls, cu. yds.	...	...	174	...	...
Guard rail, 7,000 lin. ft....................	7,000	9,840	850	600	5,400
Monuments, hauling and setting..........	146	13	42	60	274

*Includes 89,420 cu. yds. earth excavation, 4,990 cu. yds. loose rock and 1,350 cu. yds. solid rock excavation.

THE AGLER BRIDGE, FRANKLIN COUNTY, OHIO.

Bids to Be Opened May 1 for a 1,166-Ft. Reinforced Concrete Arch Structure.

5,150 Cu. Yds. Concrete—20,000 Lin. Ft. of Piling —415,000 Lbs. of Reinforcing Steel.

The Commissioners of Franklin County, Ohio, are now calling for bids on a good sized bridge contract. The improvement is known as the Agler Bridge. It is to be constructed over Alum Creek at a point about 5½ miles northeast from Brood and High Sts., Columbus. It will be a concrete arch structure, with a total length of 1,166 ft., and a width over all of 27 ft. 2 in. There will be 10 main spans, six small spandrel spans of 10 ft. 2 in. each and a short curved retaining wall abutment. The lengths of the main spans are as follows: Two spans each of 136 ft. 8 in., two spans each of 113 ft. 8 ins., three spans each 90 ft. 8 ins., one span of 102 ft. 2 ins., one span of 67 ft. 8 ins., and one span of 44 ft. 8 ins. There will be a 20-ft. roadway and 4-ft. sidewalk, the latter being on the north side of the bridge.

All spandrel spans will be of the same length for the entire structure. The floor system will consist of floor beams, framing into spandrel columns and spaced 11 ft. 6 in. centers. The floor beams will be spanned by 12-in. slabs. No stringers are required except a small one, supporting the sidewalk slab. The sides of the floor beams and inside faces of sidewalk stringers and facia beams will be beveled ¾ in. per foot. Each arch consists of two ribs spaced 20-ft. centers. The crown section of the various arches varies from 25 by 34 in. for the 67 ft. 8 in. span to 39 by 42 in. for the 136 ft. 8 in. spans.

The arch piers will be supported on wooden piles driven in gravel through loam, clay and in some cases through a mixture of sand and water of such consistency as to flow quite readily. The maximum load per pile will be 20 tons. Owing to the unfavorable sub-soil conditions the foundations will be quite expensive.

A 1:2:4 mix will be used for all concrete, except that in the hand railing. Approximately 5,150 cu. yds. of concrete, exclusive of the amount required for the railing, will be placed. About 20,000 lin. ft. of wood piling will be driven and 415,000 lbs. of medium open hearth, deformed reinforcing steel will be required.

The contract time for finishing the structure complete is Sept. 1, 1916. A bonus of $20 per day will be given for the completion before that date, and a penalty of $20 per day will be required for every day of noncompletion after the specified time.

The Agler bridge was designed by E. P. Knollmann, Assistant County Surveyor, under the supervision of Walter Braun, County Bridge Engineer. John Peake, Columbus, O., is County Surveyor. Bids for the construction of the bridge will be received by the County Auditor, Columbus, O., until May 1.

Progress on the $65,000,000 Railway Terminal at Chicago.

Preliminary construction work is now underway on the new $65,000,000 union terminal in Chicago, the biggest railroad job of the year. The contract for the temporary freight house for the use of employees of the Pennsylvania Lines during the erection of the new freight house was let to the Sumner Sollitt Co., Chicago. The grading for the new freight house was let some weeks ago to P. T. Clifford & Sons, Valparaiso, Ind., and this work is now well advanced. Bids on the foundations for the building proper were opened April 15 at the Pittsburgh offices of the Pennsylvania R. R. This foundation work involved approximately 45,000 cu. yds. of concrete, 20,000 lin. ft. of piling and 40,000 to 50,000 cu. yds. of excavation. The contract for some steel work necessary for the reconstruction of the Lake St. bridge has been let to the Chicago Bridge & Iron Works, Chicago.

Bids Asked on 48 Miles of State Road in Ohio.—The largest state highway letting in Ohio so far this year is now being advertised. Bids will be opened at Columbus, O., on April 30 for 31 contracts. Of this number one calls for a 40-ft. by 18-ft. steel bridge estimated to cost $11,896; two contracts call for 4.33 miles of glutrin bound macadam. The remaining contracts provide for waterbound macadam, brick or concrete construction. The mileages of each of these is as follows:

	No contracts.	Total miles.
Water bound macadam.......	12	23.78
Brick	9	10.40
Concrete	6	13.07

Clinton Cowen, Columbus, O., is State Highway Commissioner.

Milwaukee has started operation of the first unit of a municipal lighting system. The plans for the city include the gradual installation of more units until the entire city is served by the municipal system.

Personnel of Boards of Review of Reclamation Projects.—The following table shows the personnel of the boards appointed to review the cost of the projects, as approved by the Secretary of the Interior:

Project.	Reclamation Service representative.	Water Users' Association representative.
Southern Division.		
Salt River	F. W. Hanna	F. A. Jones
Yuma	F. L. Sellew	
Rio Grande	L. M. Lawson	Lafayette Clapp
Carlsbad	D. W. Murphy	Scott Etter
Third member for district, Thomas U. Taylor		
Pacific Division		
Orland	A. N. Burch	F. S. Reager
Truckee-C'rs'n.	D. W. Cole	T. Williamson
Umatilla	H. D. Newell	F. B. Swayze
Klamath	W. H. Sanders	Abel Ady
Third member for district, B. A. Etcheverry.		
Northern Division.	J. B. Bond	B. S. Adams
Lower Yellowstone.	G. O. Sanford	W. G. Owens
North Dakota Pumping.	G. O. Sanford	S. A. Nelson
Shoshone	J. B. Bond	L. E. Baldwin
Sun River	J. B. Bond	E. C. Sampson
Huntley	No review contemplated	
Milk River		
Third member for district, Edward Gillette.		
Rocky Mountain Division.		
Grand Valley	R. F. Walter	W. S. Wallace
Uncompahgre Valley.	C. T. Pease	
North Platte	Andrew Weiss	H. G. Stewart
Belle Fourche	R. F. Walter	J. C. Milne
Third member for district, P. J. Preston.		
Central Division		
Boise	F.E.Weymouth	E. C. Bradley
Minidoka—North Side Gravity Unit.	C. H. Paul	A. C. Demary
Minidoka—South Side Pumping Unit.	C H. Paul	Ben Edwards
Strawberry Valley.	No review contemplated	
Third member for district, C. R. Burkey.		
Washington Division.		
Okanogan	Calvin Castell	B. E. Hendrick
Yakima, Sunnyside.	C. H. Swigart	G. E. Rodman
Yakima, Tieton.	C. H. Swigart	W. L. Lemon
Third member for district, O. L. Waller.		

PERSONALS

Mr. George E. Johnson has been appointed state engineer of Nebraska, succeeding Mr. D. D. Price, resigned. Mr. Johnson was bridge engineer for the Missouri Pacific Railway for two years. For seven years he has been engaged in municipal and electrical engineering.

Mr. Paul E. Kressly has resigned as city manager of Englewood, Cal., though his resignation has not as yet been accepted. Mr. Kressly states that during his one year in office he has effected a saving of 16.2 per cent over the cost of running the city the previous year under the old form of government.

Mr. C. A. Stephens, who was recently appointed chief engineer for the Texas City Transportation Co. and the Texas City Terminal Co., has had 16 years of engineering experience. For six years he was in the government service. One year he spent as chief draftsman for the Modern Ice Machinery Co., and two years as chief engineer for the Nuevo Leon Mining & Development Co. He was also at various times employed for a short time as foreman, draftsman, inspector, superintendent or manager of various corporations. For the past year he has been assistant engineer with the companies for which he is now chief engineer.

Mr. W. S. Fallis has been appointed state highway engineer of North Carolina under direction of the new State Highway Commission, which was recently organized under provision of a special act of the legislature. Mr. Fallis is an experienced highway engineer and is well acquainted with the work in that state. He was formerly, in 1890-91, with the American Bridge & Iron Co. of Roanoke, Va. From 1891 to 1898 he was engaged in contracting and surveying work in Rockingham county, Virginia. From 1898 to 1907 he engaged in municipal and general engineering work. Since 1907 he has been in highway engineering work and has built roads in Franklin, Iredell, Vance, Wilson and Columbia counties of North Carolina.

Mr. J. S. Garland has been appointed to succeed the late Mr. W. A. McFarland as superintendent of the water department, District of Columbia. Mr. Garland was for a time with the Baltimore & Ohio Railroad, later with the Southwest Branch, Pennsylvania Central, the Oregon Railway & Navigation Co., and the Richmond & Danville Railroad Co. While employed by the last named company he built the railroad bridge over the Yadkin River, near Winston-Salem, N. C. Mr. Garland joined the District of Columbia engineer department in 1891, and was transferred to the water department in 1893. As assistant engineer and engineer he has since remained in that department, receiving his appointment as superintendent on March 26. All of the outside construction work during the time mentioned has been done under his orders. He made the surveys for the Reno and Brightwood reservoirs, the present pumping station, property yards, Anacosta pumping station and numerous other projects.

Mr. Robert F. Hall, who succeeds Mr. J. P. Beck as publicity manager of the Universal Portland Cement Co., has spent the last six years in the sales department of that company. He is well known throughout the cement industry because of his activities in its association. Mr. Hall is a graduate of the University of Michigan, where he completed the academic course in 1894 and the law in 1895. He is a resident of Chicago, having begun the practice of law there on leaving college, in the office of Mr. A. W. Green, now president of the National Biscuit Company. He held an important position with that company before going into the cement business with the Universal. He is a member of the University Club of Chicago, the Saddle and Cycle Club, the Military Order of the Loyal Legion of the United States, the Western Society of Engineers, the Advertising Association of Chicago and several other local organizations. His experience and education equip him well for the work he has now undertaken.

Robert M. Hall, Publicity Manager Universal Portland Cement Co.

Mr. Samuel D. Foster has resigned as chief engineer for the Pennsylvania State Highway Department to open an office as consulting engineer on highway work at Harrisburg, Pa., and will give special attention to investigations, reports and preparation of specifications. Mr. Foster was formerly in the U. S. Engineer Corps. From 1906 to 1908 he was with the Isthmian Canal Commission in charge of highway improvements, city of Panama; and with Cuban government as second engineer in charge of highways in Havana province. From 1908 to 1911 he was principal assistant and chief engineer, Allegheny County, Pennsylvania, highway department. Since 1911 he has been chief engineer of the State Highway Department. During the past seven years he has had direct charge of the expenditure of over $20,000,000 in highway work.

Mr. W. D. Uhler has been appointed chief engineer of the Pennsylvania State Highway Department, succeeding Mr. Samuel D. Foster, resigned. Mr. Uhler was for five years in the engineering department of the Lehigh Valley Railroad Co. From 1895 to 1903 he was with the Queen Anne's Railroad Co. in the various capacities of assistant engineer, assistant general manager and chief engineer. From 1904 to 1908 he was county roads engineer, Caroline County, Md. The four years following he was with the Maryland State Roads Commission as engineer in charge of maintenance. Since April, 1912, he has been principal assistant engineer Bureau of Highways and Street Cleaning, Philadelphia.

CONTRACTORS.

The G. H. Schartzer Co., general contractors, was recently incorporated for a general contracting and wrecking business at Dayton, Ohio. Mr. G. H. Schartzer, president and manager, has been in business in that city 12 years. Mr. Otto Marlatt is secretary and treasurer. Offices of the company are at 519 West Third street, Dayton, Ohio.

The Widell Company, Mankato, Minn., which has been largely engaged in railroad construction through Minnesota, North and South Dakota, etc., has been awarded a large drainage contract in Cottonwood and Murray counties in Minnesota. The contract includes the furnishing of and laying of about 23,000 ft. of tile ranging from 6 ins. to 26 ins., and 6,000 ft. of open ditch work. Mr. Gustaf Widell is president of the company, Mr. O. O. Eberhart, secretary and treasurer, and Mr. C. A. Ingwalson, assistant secretary.

The Warren Construction Company of Portland, Ore., which was recently awarded the $100,000 highway contract at Lewiston, Idaho, has operated on the Pacific coast for the past thirteen years. During this time the firm has specialized in street paving work, Bitulithic for city streets and Warrenite for country roads. The prevalence of these types of pavement on the coast is well known, and the above company has held the contracts for this work. The officers of the company at the present time are W. E. Hacker, Tacoma, president; J. O. Hoyt, Portland, vice-president; M. J. Lynch, treasurer; O. Enger, secretary; R. D. Hoyt, M. E., general manager.

CIVIL SERVICE NEWS

The Chicago Civil Service Commission announces examinations as follows:

Manager Parks, Play Grounds and Beaches, $2,700 per annum (local residence waived); April 23.

Cast Iron Pipe Inspector, union scale; April 26.

The United States Civil Service Commission will hold the following examination:

Oil and Gas Inspector, Grade 1, $2,160 to $3,300 per annum; Grade 2, $1,500 to $2,160; May 18.

The New York State Civil Service Commission announces the following state and county examinations to be held May 15:

Landscape Gardener and Superintendent of Parks, State Reservation Commission, Saratoga Springs, $100 per month and traveling expenses.

Chief or Deputy Chief, Automobile Bureau, Office Secretary of State, $3,200 per annum.

Inspector of Construction, State Department of Highways, $3.50 to $4.50 per day.

Mine and Tunnel Inspector, Department of Labor, $1,200 per year.

RAILWAYS

PROSPECTIVE WORK.

Georgia:

Lumber City, Ga.—Ocmulgee Valley Ry., proposing 20-mile line from Lumber City to Jacksonville, has completed 10 miles of road and has other sections under construction. The line will have maximum curves of 4°, and 1 per cent grade; 56-lb. steel is being used. Work involves 1,500 cu. yds. earth excavation and 35,000 cu. yds. embankment; about 10,000 lin. ft. of piling and 300M ft. B. M. of bridge timbers will be used. The work is being done by day labor. J. B. Work, Lumber City, is the engineer in charge.

Kansas:

Lawrence, Kan.—Kansas City, Lawrence & Topeka R. R. (electric), F. P. Dickson, President, Gumbel Bldg., Kansas City, Mo., is considering extending its line to Lawrence.

Salina, Kan.—Public Utility Commission has authorized Salina Northern R. R. to issue $1,250,000 of stock for its proposed line from Salina to Osborne, 80 miles. Company is reported to have purchased 9,000 tons of rail. F. C. York is President.

New York:

Corona, N. Y.—Right of way between Corona and Lakeville for a new high-speed electric railroad, to be built by interests connected with the New York Central System, is understood to have been secured, and it is believed that contracts for that portion of the line in Queen's Borough will be let soon. The Lakeville Holding & Development Co. is reported to be interested.

North Carolina:

Durham, N. C.—Durham Traction Co., proposes 1 mile extension down Holloway St.

Ohio:

Canal Dover, O.—Dover, Millersburg & Western Ry. Co. has been incorporated, with $10,000 capitol stock; to build standard interurban railway.

Oklahoma:

Cushing, Okla.—Oil Fields & Santa Fe Railway Co. chartered recently, propose immediate construction, it is said, of 20-mile line from point on Santa Fe Railroad to Cushing oil fields. S. W. Hayes, Oklahoma City, is incorporator. This is understood to be a Santa Fe line.

South Carolina:

Furman, S. C.—The Furman & Yemasse Railroad Co. has been chartered with capital stock of $10,000 and proposes 20-mile line between places named. J. H. Adams, W. P. Ellis and H. Weindal are interested.

South Dakota:

Huron, S. Dak.—Huron & Northwestern Ry. Co. has been incorporated with $25,000 capital stock and proposes line from Huron to Roselyn, 106 miles. Incorporators include F. W. Henderson, Summit, and C. B. Adams, Chicago, Ill. Same parties have incorporated construction company to be known as Huron Investment & Construction Co., capital stock $50,000.

Virginia:

Petersburg, Va.—Petersburg & James River Co., composed of Washington capitalists, and the Petersburg & Appamattox Co., recently chartered, have applied to County Commissioners for franchise to construct electric railway from Petersburg to City Point, 10 miles.

West Virginia:

Stone Coal Junction, W. Va.—Virginia Ry. has made surveys for construction of 6 miles of railroad from Stone Coal Junction to mines in Stone Coal Creek. Railway company, however, is not ready to construct at this time.

Alberta:

Edmonton, Alberta.—Legislature has adopted resolutions to guarantee branch line of Edmonton, Dunvegan & British Columbia Ry., from point on main line south to Grand Prairie, 60 miles, at $20,000 per mile.

BIDS OPENED; CONTRACTS LET

California:

Blythe, Cal.—Contract for first 12½ miles of grading for railroad from this place has been let to Floyd Brown, San Bernardino. This is the line promoted by J. M. Neeland, Los Angeles.

Illinois:

Chicago, Ill.—Bids were opened April 15 at offices of the Pennsylvania Railroad in Pittsburgh, for a large contract in connection with the Union Terminal at Chicago. Work on which bids were opened called for foundations for freight house and involved 45,000 cu. yds. concrete, 20,000 lin. ft. piling, 40,000 to 50,000 cu. yds. of excavation. The contract for steel work for the reconstruction of the Lake St. Bridge, in connection with the terminal development, has been let to the Chicago Bridge & Iron Works, Chicago.

Indiana:

Indianapolis, Ind.—Contracts were to be let last week by Indianapolis Union Ry. Co. for razing buildings preparatory to beginning construction of track elevation. The first work will probably be the elevation of tracks in the Union Station. P. J. Landers is Chief Engineer.

New York:

New York, N. Y.—Public Service Commission for the First District has awarded the contract for the construction of Section No. 4 of Route Nos. 4 and 36 to the Litchfield Construction Co., New York City, for $1,937,509. This section is a part of the Broadway subway in Manhattan, to be operated by the New York Municipal Railway Corporation, and lies in Seventh Ave., between 51st and 59th Sts. It will be a four-track structure.

Ohio:

Columbus, O.—Contracts for the first 28 miles of the Chesapeake & Ohio Northern R. R. have been awarded to the following: W. W. Boxley, Roanoke, Va., Section 1; Rinehart & Dennis, Charlottesville, Va., Section 2; Winston & Co., Richmond, Va., Section 3; Robt. Grace Contracting Co., Pittsburgh, Pa., Section 4. The first 28 miles extend from Sciotoville to Waverly, O., and involves 4,000,000 cu. yds. of excavation and 60,000 cu. yds. concrete. This is the new Chesapeake & Ohio connecting link.

Utah:

Ogden, Utah.—Utah Construction Co., Ogden, has been awarded contract for Brigham-Wellsville extension of Ogden, Logan & Idaho Ry. (electric). Work covers 30 miles of line, and involves no heavy grading or cuts.

Virginia:

Norfolk, Va.—Virginian Ry. has taken bids for construction of Devil's Fork branch, beginning at Mile Post 7.5 on Winding Gulf branch and extending about 1.16 miles up Devil's Fork, W. Va. Contracts for the work will be awarded at once.

Washington:

Bellingham, Wash.—Twohy Bros., Portland, Ore., have been awarded contract for 12-mile extension from Goshen to Welcome for Chicago, Milwaukee & St. Paul Ry. Cost will run about $30,000 per mile.

ROADS STREETS

BIDS ASKED.

Alabama:

Russellville, Ala.—Until May 10, by S. J. Petree, Chairman Court County Revenue, for grading, draining and graveling about 19 miles of road.

Florida:

Pensacola, Fla.—Until 11 a. m., May 1, by Bureau of Yards and Docks, Washington, D. C., for macadam road 1,469 ft. long and 16 ft. wide at Navy Yard, Pensacola.

Illinois:

Springfield, Ill.—Until 11 a. m., May 5, by State Highway Commission, W. W. Marr, Chief Highway Engineer, for the following proposed State Aid work: All cement to be furnished by the state: Ford County, Section A, brick, 5,900 ft., $15,917 estimate; Pike County, Section A, concrete, 7,800 ft., $12,241; Shelby County, Section A, concrete, 4,800 ft., $7,143; Kankakee County, Section B, concrete, 1,200 ft., $2,049; Bureau County, Section C, concrete, 4,000 ft., $8,228; Bureau County, Section D, concrete, 4,200 ft., $7,362. Advertisement in this issue.

Chicago, Ill.—Until 11 a. m., April 24, by Bureau of Streets, Department of Public Works, for furnishing 1,500 tons of refined natural asphalt and 2,000 tons of refined oil asphalt.

Peoria, Ill.—Until 2 p. m., April 26, by Board of Local Improvements, for about 18,000 sq. yds. of resurfacing with sheet asphalt. Advertisement in this issue.

Indiana:

Bloomington, Ind.—Until 7:30 p. m., April 26, by Horace Blakely, City Clerk, for oiling certain streets.

Vincennes, Ind.—Until 4 p. m., April 26, by E. G. Meyer, City Clerk, for 18,500 sq. yds. of pavement.

Martinsville, Ind.—Until noon, May 4, by Sam Watson, County Auditor, for roads in Washington, Jefferson and Ray townships.

Marion, Ind.—Until 2 p. m., May 4, by E. H. Kimball, County Auditor, for 2 roads in Jefferson Township and 1 road in Fairmount Township.

Vincennes, Ind.—Until May 4, by J. J. Muentzer, County Auditor, for 3 mile gravel road in Washington Township.

Knox, Ind.—Until noon, May 4, by Chas. W. Weninger, County Auditor, for 3 roads in Oregon Township.

Rensselaer, Ind.—Until 2 p. m., May 4, by J. P. Hammond, County Auditor, for stone road in Carpenter Township.

Boonville, Ind.—Until 10 a. m., May 4, by G. H. Bass, County Auditor, for rock roads in Boon and Greer Townships.

Bloomington, Ind.—Until 2 p. m., May 4, by Geo. E. Kidd, County Auditor, for 4 macadam roads.

Monticello, Ind.—Until 10 a. m., May 4, by A. G. Fisher, County Auditor, for gravel roads in West Point, Jackson and Princeton Townships and crushed stone road in Honey Creek Township.

Evansville, Ind.—Until 10 a. m., May 6, by C. P. Beard, County Auditor, for rock road in Union Township.

Huntington, Ind.—Until 10 a. m., May 6, by Harold Guthrie, County Auditor, for county line gravel road.

Corydon, Ind.—Until 2 p. m., May 7, by J. L. O'Bannon, County Auditor, for macadam or gravel road in Spencer Township.

Peru, Ind.—Until noon, May 10, by F. K. McElhemy, County Auditor, for roads in Jackson, Jefferson and Peru Townships.

Frankfort, Ind.—Until 2 p. m., May 18, by Edw. Spray, County Auditor, for county line road.

Terre Haute, Ind.—Until 11 a. m., April 24, by N. G. Wallace, County Auditor, for gravel roads in Prairieton and Prairie Creek Township.

Kentland, Ind.—Until 2 p. m., May 3, by S. R. Sizelove, County Auditor, for macadam road in Lake Township.

Goshen, Ind.—Until 1 p. m., May 3, by J. W. Brown, County Auditor, on brick and gravel road in Elkhart Township.

Shelbyville, Ind.—Until 10 a. m., April 28, by F. W. Fogel, County Auditor, for gravel road in Washington Township, gravel road on township lines, crushed stone road in Liberty Township.

Connersville, Ind.—Until 2 p. m., April 29, by J. C. Kennedy, County Auditor, for gravel road in Connersville Township.

English, Ind.—Until 2 p. m., May 3, by J. B. Enlow, County Auditor, for stone road in Whisky Run and Liberty Township.

Jeffersonville, Ind.—Until 10 a. m., May 3, by G. W. Stoner, County Auditor, for bituminous macadam road in Jeffersonville Township.

Versailles, Ind.—Until noon, May 3, by J. F. Lochard, County Auditor, for macadam roads

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

Volume XLIII. CHICAGO, ILL., APRIL 28, 1915. Number 17.

Quoted Articles in Engineering and Contracting.

Articles published in ENGINEERING AND CONTRACTING are of three kinds: Articles prepared by editorial staff writers; articles contributed by writers not editorial employes; *articles abstracted or quoted from other publications.* Articles of the third kind are emphasized; they are made more of a feature than in other civil engineering journals. They originally have usually been prepared painstakingly for professional reports or scientific studies and are of exceptional quality. They also are, in their original form, available to comparatively few engineers and the many others can rarely benefit from them if they are not republished in a form available to everyone. That they are not new-born is the only argument that can be urged against their publication. It is pure piffle. Inherent value is of more worth than mere originality and in inherent value articles quoted from reports and bureau publications often surpass anything that editors have the means to secure originally. Since this journal is a purveyor, not of illusions but of usable facts and suggestions, it does not hesitate to quote facts and suggestions from any source.

The use of quoted articles involves an obligation to credit *invariably and precisely* the author and the original medium of publication. This is so not merely because common honesty demands acknowledgment of debt, but because by this way only can the worth and reliability of the facts and opinions presented be intelligently appraised by the reader. To neglect frankly to give credit for quoted information is of a species with the old journalistic doctrine never to confess editorial fallibility and it is quite as much a relic of benighted tradition. This journal proposes to exterminate from its pages even the semblance of implying that quoted matter may be original to those pages. In the case of copyrighted matter, consent of the origial publisher will be secured for any quotation giving in substance the arguments of the author or the essential data presented.

The origin and authorship of all articles published in ENGINEERING AND CONTRACTING are definitely stated. Contributed articles and articles prepared by staff writers are specified by suitable wording immediately following the caption or title. Quoted articles have heretofore always had their source acknowledged in the text of the article. To make it impossible for such credit to be overlooked because of its position each quoted article hereafter will be labeled immediately following the caption with the words "Staff Abstract." At the end of the article, under the subcaption "Acknowledgements," there will be stated in full the sources of information from which the article was prepared. This detailed method of acknowledgement is necessitated by three facts: (1) quoted articles are seldom printed in full, (2) they nearly always contain condensations by the editor interspersed with parts directly quoted, and (3) frequently they contain added information and illustrations secured from the author subsequent to original publication.

A Timely Comment on Gravel Road Maintenance.

A timely article on gravel road construction and maintenance is published in this issue. Another merit of this article is that it is simple and elementary. It is timely because, first, despite all the hard paved road construction being prosecuted in many states, a considerable mileage of the roads of these states is gravel roads and must remain of no more expensive construction for years. Second, it is timely because it emphasizes the vital influence of maintenance in securing economic worth from gravel roads. One of the strongest arguments supporting expensive hard paved roads is that they minimize the necessity for systematic maintenance. Lack of systematic maintenance, generally prevalent in all states, is the greatest drawback to economic service of gravel and other earth roads.

The gravel road is not an obsolete construction even in this present era of expensive hard road pavements. In Ohio some 17 per cent of the total road mileage of the state are gravel roads. In Maine only two types—gravel and bituminous macadam—of improved roads are built. In Wisconsin water bound gravel roads are being built in greater mileages than any other kind of road. The gravel roads of New Jersey are widely known for their heavy traffic and good service. In a large measure these roads are a revival of old custom. Gravel roads once extensively built fell into disrepute because of poor construction but more because of improper maintenance. They are coming back into good repute because state road making and maintenance are vastly improved. In making this argument for gravel roads it is not maintained that they take the place of hard paved roads, or that they have any place where traffic conditions call for brick or concrete or bituminous macadam.

High "Development Cost" of a Canadian Railway and Its Lesson.

The "development cost" of American railways is likely to be a matter of serious dispute in the appraisal of railway values. It will probably be contended that where the development cost has actually been great, the railway promoters showed such excessively bad judgment that no consideration should be given to the actual deficits in fair return. And, on the other hand, where there have been only slight deficits in fair return during the early days, it will be argued that the good judgment of the promoters should not be rewarded, because it presumed they should always exercise good judgment.

The Canadian government has long made it a practice to assist in financing Canadian railways, and of late years it has gone heavily into the building of lines to develop new territory. After nine years' work it has just finished an 1,800-mile line from Moncton to Winnipeg, forming the National Transcontinental Ry., the western part of which was to be the Grand Trunk Pacific Ry., which terminates on the Pacific at Prince Rupert. This new 1,800-mile line has cost the government $100,000 a mile, or about six times the original estimate. An investigating commission has reported that the cost has been at least $22,000 a mile more than was necessary. The line was to have been leased for 50 years to the Grand Trunk Ry.; the first seven years being free of rental and the rest of the term at 3.5 per cent. But the Grand Trunk now refuses to carry out its leasing agreement.

Apparently the Grand Trunk sees no possibility of paying operating expenses and interest on the rolling stock during the next seven years. This is significant as to the minimum probable development cost of this 1,800-mile railway.

While Canadians are gloomily appraising the past construction cost and the probable future development cost of this great venture, our American press is cheerfully commenting upon our own first extensive plunge into government railway construction. We have appropriated $35,000,000 for a government railway system in Alaska. When the appropriation was made some one guessed that it would build 1,000 miles of line. Then a commission reported that only 733 miles could be built. Now a second commission reports that construction will cost 25 per cent more than the first commission estimated. It is not rash to predict that the $35,000,000 will not buy the existing 70 miles of railway and build 500 additional miles. But even if the existing appropriation does go as far as is now estimated for construction, what will the subsequent "development cost" be? To this important question no one has ever offered even a guess in reply.

It is to be hoped that the Interstate Commerce Commission will be given jurisdiction over this projected government railway in Alaska, if for no other reason than to secure complete costs and operating expenses. We predict that the craze for government construction of railways will receive as hard a jolt in America as it has already received in Canada.

Failure by Engineers to Utilize Established Bureaus for Information.

It is an old charge that engineers make small use of the various public bureaus which supply engineering information. Even the engineering society libraries are not called upon for full service. This charge may appear to be disproved by the increasing annual number of "library searches" called for by members of the national engineering societies, but it is not. The total number of these searches is small compared with the total society membership. There is no engineering journal of size which does not receive each year some hundreds of letters asking where information on some subject exists and how it may be obtained. The significance of these inquiries is not that the requirement indicated exists, but that there are bureaus whose purpose it is to satisfy it and that these bureaus are not adequately utilized.

The Federal Government alone has perhaps a score of bureaus for the sole purpose of amassing information on numerous subjects in which engineers are interested and it is rapidly coming to be the fact that almost every state has one or more similar service bodies which can be consulted. Why is more frequent use of these not made? The answer is, we think, that these bureaus, their purposes, their work and their willingness to serve are not widely known. This may appear to be a rash assertion, but is it? Of the letters of inquiry which come to this journal a very considerable proportion are answered by referring the writers to some Federal or state or city bureau whose work it is to collect and distribute just the sort of information requested. This can indicate nothing except that these bureaus were not known to those who made inquiry or rather, perhaps, that their willingness to serve was not known.

The remark is too often heard that the American engineer is at a disadvantage compared with an engineer in Germany or France with their great Government engineering laboratories. This is perhaps true in a measure, but it is not true in the sense that the American engineer has no helps of a similar kind. All the laboratories of the state supported universities are for public service. So are the records of state health boards and state highway commissions. At Washington are the several "surveys," the Bureau of Standards, the Bureau of Public Roads, the drainage and irrigation experiment stations, and other similar service bodies. Here and further back we have named those organizations *service* bureaus, and this is a conception that it is desired to emphasize to engineers.

These governmental bureaus are not activities extraneous to the engineering life of the country, but are accessories to it. It seems to be difficult for engineers generally to grasp this fact. Those who have and who also have cultivated the habit of calling for service and co-operation have gained a strong ally in their work. They have, moreover, strengthened that ally. All these bureaus are weak to serve only in the one respect that adequate funds are wanting for their work of experimentation and of collection and compilation of information. Demand by engineers for more experiments and more complete compilations is the strongest weapon which the bureaus can wield in exacting more liberal financial support.

Engineering journals have for years found in these service bureaus one of their most fruitful sources of information. At the most, however, only a very small portion of the data available can be repeated by the engineering journals. The need is that the individual practitioner shall seek service. This engineering journal can guarantee that its readers who have not done this will be astonished by the results secured. This assertion does not mean that any question that may be asked can be answered, but that where data are available for the answer of any question they will be forthcoming.

Modifications in Shaft Design Influenced by Concrete as a Lining Material.

Those who have made search state that the first use in the United States of concrete shaft lining was in 1903 at Tug River, W. V. Since that time concrete has been exclusively used in a variety of forms for shaft lining. There has been, naturally, much progress in a dozen years of use in methods and plant employed, but a review of development is less interesting because of such progress than it is because of the modifications in shaft design influenced by the new lining material.

The advent of concrete as a lining material permitted, and, in a measure, has brought about, a modification in shaft shapes. Before concrete came to be used all shaft linings were of timber (wall sets, buntons and lagging). Latterly in the timber lining era, steel sets or buntons or both were in instances substituted for timber and occasionally steel plates took the place of wood lagging. There were isolated instance shafts lined with brick or steel tubbing, but they represented an exception and may be dismissed with mention.

The shaft shape best suited to timber lining is the rectangle. This became the usual shape for both tunnel and mine shafts. There were other reasons than their fitness for cheap and convenient timber lining which influenced the adoption of rectangular shafts, but none of them was so insistant a reason. With concrete there was had a material equally suited to any shaft shape, and soon discussion arose concerning the best outline of shaft cross-section. The character and progress of this discussion is not of present concern; out of it came the important conviction that rectangular shaft shapes were no longer essential for effective use of lining material—framed timber or steel—and curvilinear sections could be used wherever they appeared to present advantages.

It may not be understood that a radical change in shaft shapes occurred with the employment of concrete for lining. American hoisting practice is adapted to the rectangular shaft or, perhaps a better statement of conditions is, the rectanglar shaft is particularly well adapted to the practice in America of using large cages hoisting in balance. Also where shafts have been relined with concrete no change was made in shape of the shaft section. With concrete lining, however, other shaft shapes than the rectangular have come increasingly into use. The circular section, limited almost entirely to ventilating shafts, is now represented. Also hoisting shafts of curvilinear section are common. The shapes vary from rectangular with circular ends to elliptical shapes of various combinations of arcs. These sections give the area required for large balanced cages, give room for pipes in the end segments and eliminate the expensive cutting of corners in excavating. Possibly, too, a merit can be claimed of greater strength of arched sections, but this is a value whose practical importance is disputed. To epitomize, in the problem of choosing shaft shapes, concrete for lining has released the engineer from any necessity of adapting the cross-section to limitations imposed by rigidity of lining material.

Like shape of shaft, the thickness of concrete lining is controlled by other considerations than the theoretical pressures. At one extreme is advocated a thickness capable of resisting a static head equal to the full depth of the shaft. At the opposite extreme is suggested a mere veneering to prevent weathering. Neither extreme finds place in practice, but the one last mentioned is least logical. Experience indicates that shafts are rare in which some inward acting pressure does not exist at some time. This is particularly true where, as is becoming common, the shaft is grouted to close leaks instead of having drains provided. Thickness is required to resist grouting pressures necessary to close the rock fissures carrying water. There are also swelling rock, slips of strata, blocky rock, etc., to guard against which there must be strength of lining.

Generally, practice in regard to thickness of lining is substantially as follows: A minimum thickness based on experience is specified. Here it is worth noting that, however uncertain it may be what thickness the conditions disclosed by excavation may make necessary, it is desirable to specify some minimum thickness to have the contract definite. The minimum thickness specified is seldom less than 6 to 8 ins. Thinner walls than these are difficult to construct even if they are sufficient in strength. With a minimum thickness adopted the lining is built thicker as in the best judgment of the engineer occasion demands. It is one of the notable merits of concrete as a material for shaft lining that it permits almost perfectly variation in thickness to suit requirements. With almost no alteration in processes and plant a concrete lining can be thickened or strengthened by steel reinforcement to meet local extraordinary pressures due to shaky strata or to head of water.

The task of shaft drainage is the third feature in shaft construction which concrete lining has greatly modified. With timber lining elimination of wetness from shafts is a strictly drainage problem. No attempt is made to prevent inflow; it is admitted, collected by drains and disposed of by pumping. The same procedure was adopted for the earlier shafts lined with concrete, but latterly with the development of grouting another procedure is being established. This is to grout the rock behind the lining and so seal all veins and pores through which water can enter the shaft. Grouting may be employed with timber lining, but concrete lining is the ideal seal to grout against. Also grouting is of a family with concreting, so the two may allowably be considered as parts of a single process of concrete shaft lining. Concrete shaft lining has simplified greatly the problem of shaft drainage. Indeed, it is not extravagant to claim that concrete lining has developed a modern shaft construction without drains or pumps.

Standardizing Field Signals for Engineers.

At the latest annual meeting of the Ohio Engineering Society a committee was appointed to begin work on the standardization of field signals used by engineers and surveyors. This committee will make an effort to compile a record of all signals now in use and will endeavor to interest and to secure the co-operation of other engineering societies in this work. A joint committee will eventually be appointed to recommend a standard code which will then be adopted by the societies represented and doubtless by field engineers generally. It is thought that the standard code will be promptly adopted by the engineering schools and it will soon become universal.

The fact that there is not a universal code of signals at present is often a source of annoyance and expense. In joining a new party the young engineer is often embarrassed by finding in force a system of signals with which he is not familiar. This always leads to delays, in fact it is not an uncommon experience for an entire field party to be delayed for a period ranging from a few minutes to a half hour due to the inability of a detached new member of the party to understand the signals waved to him. Engineers generally should extend their co-operation in this effort to standardize field signals.

Self-Elected.

The ablest leaders are self-chosen. This is true industrially as it is true politically. When the civil war began, many volunteer companies and regiments elected their own officers. The choice commonly fell upon the men who looked or talked the military part. However, a few months of actual service under gun fire effected radical changes. Then brave and resourceful men in the ranks proceeded to make themselves leaders. The iron soldier pushed the tin soldier aside. Every war repeats such history.

In politics we see much the same phenomenon, but there it is obscured by the fact that the real political leaders often remain hidden from the public eye. From the advisor who dominates a king to the ward boss who controls a city council, it is the self-chosen man who often rules. Unfortunately political rule of this sort is apt to be bad, because secret control is conducive to selfish and dishonest action.

In the industrial world, co-operative production, under chosen managers, has usually proved inefficient. The workmen who chose a manager of a co-operative factory either select a "good fellow" type of man or one who talks plausibly. In either case the chance of selecting wisely is not great.

In every walk of life the really capable leader nominates and elects himself. The soldier, by virtue of his own fighting force, seizes the epaulettes. The industrial worker, ignoring the opinions of his mates, sets up in business for himself—elects himself a sergeant in the industrial army. It is true that thousands thus self-elected fail to maintain their positions. Their courage or their self-esteem often exceeds their ability. But, none the less, by this process of self-election do the fittest business managers emerge from the crowd.

The training of engineers, coupled with their ethical codes forbidding self-advertising except in the mildest manner, have not been favorable to their pushing themselves into managerial positions. In spite of these handicaps, however, engineers, here and there, have decided that they were more fit to manage affairs than were the existing occupants of certain managerial positions. Accordingly, they have not waited to be "urged to run," but have set about making themselves ex- that have adopted the new form of govern- ecutives. Thus, it has come about that most of the "city managers" in the two dozen cities ment are engineers.

Only in a restricted sense it is true that "all things come to him who waits." All that a waiter commonly gets is tips—the pecuniary crumbs from the rich man's table. Much truer is it that all things come to him who nominates himself, and, ballot after ballot, casts a unanimous vote for his nominee.

WATER WORKS

Construction Plant and Methods Employed on New Water Works Intake Tunnel at Milwaukee, Wis.

(Staff Abstract.)

II

The former article dealing with the construction plant and methods employed in building the new Linwood avenue waterworks intake tunnel of the Milwaukee waterworks was published in the issue of April 21, 1915. That article described the new comprehensive water collection system and took up the tunnel construction in detail. The present and concluding article also pertains to this construction. Figures 1 to 7, inclusive, were in the first article.

GAS DEFLAMATION AND VENTILATION.

On June 29, 1914, a severe deflamation of methane or marsh gas occurred at the heading station 20 + 44, just as the mining crew had started to work on the morning shift. As a result of this accident, 21 men were more or less burned. The collection of methane necessary to cause this deflamation resulted from the fact that the ventilating fan was out of service during the entire previous night. The nature of the material encountered in excavating is shale of the class that gives off methane when it decomposes, upon exposure to air. As a result of this deflamation, the continual operation of the ventilating system was ordered by the engineer, and was maintained thereafter by the contractor.

The ventilating system consists of one No. 4 Garden City 6-in. fan, rated at 3,675 cu. ft. per minute. This fan was placed on a platform adjacent to the air lock and on the heading side of it, as shown in Fig. 8. It was connected to two 12-in. galvanized iron pipes, one extending to the heading side of the concrete forms, where it terminated into a perpendicular riser reaching almost to the roof of the excavation. The other 12-in. pipe extended from the discharge end of the fan to the shaft, up the shaft and discharged into the free air. During blasting the perpendicular riser on the inlet end of the fan pipe was removed. For warning measures, two miner's safety lamps were constantly maintained in the heading, one suspended on the timber above the platform for the forms for concreting the side walls, and one suspended on the roof timber about 8 ft. back of the face of the heading. The city's inspectors and the contractor's men were instructed in the use of these lamps for the detection of methane. An additional precaution was taken by securing three times a week a sample of air from the heading. The samples were analyzed by the city chemist. About 10 samples of air were secured for analysis by the U. S. Government Bureau of Mines. The government analyses and lamp tests showed only traces of methane. The purity of the tunnel air was maintanied on a high standard.

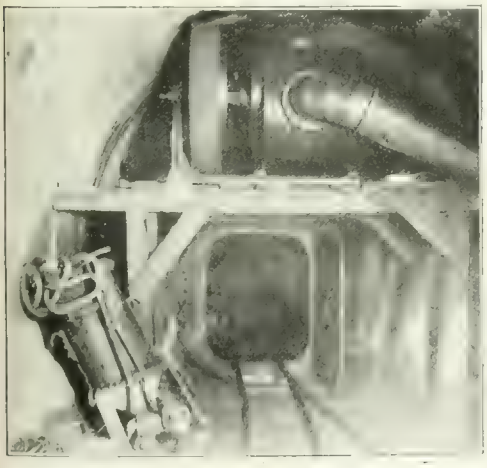


Fig. 8. View Showing Ventilating Fan, Grouting Machine and Heading End of Air Locks, Milwaukee Intake Tunnel.

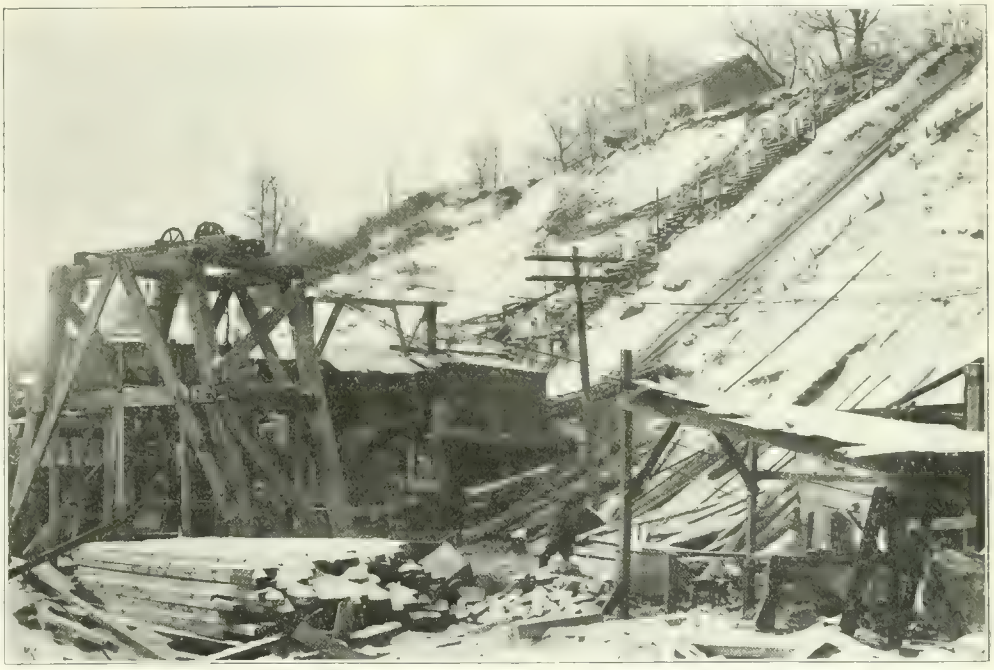


Fig. 9. View Showing Head-House, Concrete Mixer and Material Railway, Milwaukee Intake Tunnel Construction.

TEST HOLES.

Last August the drilling of two 10-ft. test holes, one in each upper quarter of the face on each shift, was started and was continued until the excavation was finished. These test holes were driven as advance explorations to ascertain the condition of the material in advance of the face and also to warn the drillers of the presence of water in advance of the face. The value of these test holes was very great, both from a tangible and from an intangible viewpoint. Upon one occasion they gave warning of a roof rupture. The intangible value was the confidence gained by the drillers in knowing advance conditions.

CONCRETING.

All of the concrete is mixed in a 1 cu. yd. Smith mixer situated on the surface, as shown in Fig. 9. From the mixer the concrete is dumped into the tunnel cars and then by the cage into the tunnel, and then hauled by mules into the forms. The forms are composed of steel plates and angles, and were of the Blaw type. The side walls and arch forms were separate. Each of these forms rested on wheels which were supported on movable rails, so that the forms could be advanced by means of the hoisting engine on the side wall form. The side walls and the arch were placed by separate operations, the side walls being placed in advance of the arch. The invert is now being placed. The reinforcing rods in the side walls are driven 18 ins. into the shale bottom, so that they may be recovered, by excavating beneath the side walls, and a bond is secured with the reinforcing rods in the invert when the invert is placed.

TIMBERING.

A short comment upon the method of timbering is in order. Commencing at station 1 + 95, the contractor started placing 12x12 in. square, long, yellow pine timbers, spaced from 2 ft. to 15 ft. apart. This method of procedure was continued to station 5 + 04, where timbers were spaced from 2 ft. to 7 ft. apart. This plan was followed to station 32 + 61. From station 32 + 61 to station 35 + 46 the timber sets were on 2 to 3 ft. centers. At station 32 + 61, the plan of placing a diagonal strut or sprag extending on each side of the roof timber, from the roof timber to a hitch in the wall of the excavation, about 6 ft. below the bottom of the timber, was started. In addition to this sprag, at this station, installing three 1½-in. by 3-ft. iron rods under each end of the roof timber or under the lower end of each sprag was also inaugurated and was continued. These rods are driven in the holes, previously drilled in the hitches by jack drills. Undoubtedly, the adoption of the use of the sprags and of the iron rods was a very important factor in preventing further rupturing or collapsing of the roof. All timbering is permanent, being allowed to remain in the concrete.

GROUTING AND PACKING.

Grouting outside of the 18-in. shell was considered advisable at several locations, due to two previous roof collapses and to other exigencies. A total of 1,954 bbls. of Portland cement grout, being in the proportion of one of cement to two of sand, was placed during the year 1914. This was done to fill the voids between the cribbing in the holes caused by roof ruptures and other possible voids between the concrete and the walls of the excavation, and also to stop the leakage of water through the finished lining. This leakage was caused by the enormous pressure of the water coming through the roof ruptures and advancing outside of the concrete lining and through it. Excellent results were attained from this grouting, stopping the leakage wherever it occurred. Undoubtedly, the additional expenditures by the city in grouting was well spent and has been justified. Fig. 10 is an actual cross section showing the method of packing with shale and concrete. The shale was imbedded in and surrounded by concrete as directed by the resident engineer.

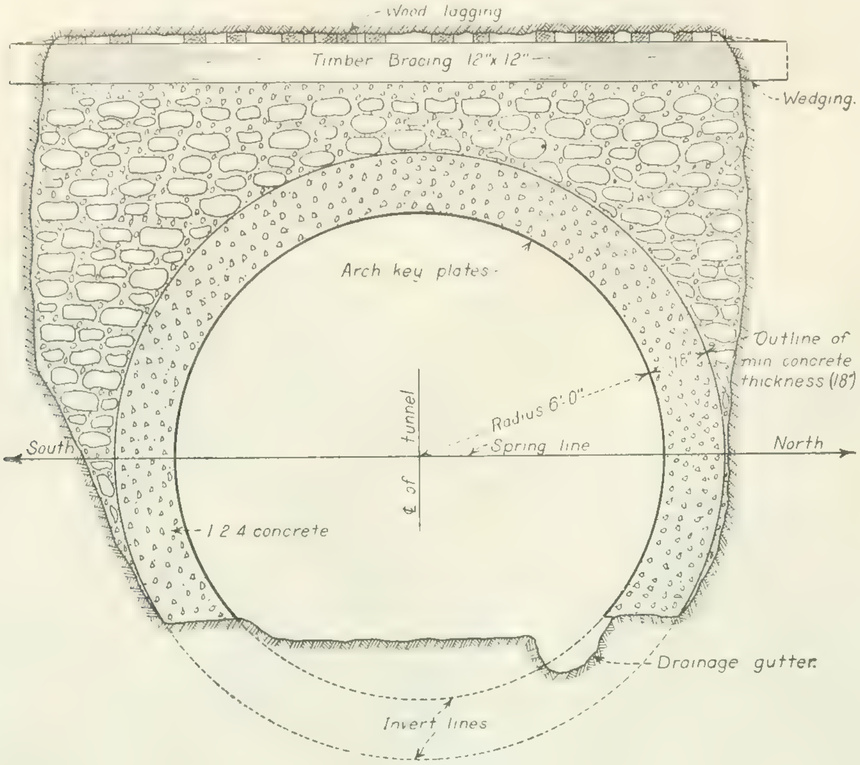


Fig. 10. A Cross Section Showing Method of Packing with Shale and Concrete Around Concrete Lining, Milwaukee Water Works Tunnel.

WATER INFLOW AND PUMPING.

The amount of the inflow of water averaged from a minimum of 112,500 gals. for 24 hours to a maximum of 180,000 gals. per 24 hours. All of the water from station 25 + 00 is drained to the shore shaft. In advance of station 25 + 00 the water is drained toward the heading. At the heading one duplex pump, having a 10-in. stroke, a 3-in. suction and a 4-in. discharge and a capacity of 175 gals. per minute, elevated water from the heading through a 3-in. discharge main to the upper grade summit at station 25 + 00. An emergency No. 7 Cameron Duplex Pump having a 3-in. discharge, 4-in. suction, capacity of 200 gals. per minute was installed at station 36 + 00. In addition to this last named discharge main, another 3-in. discharge main was laid from the last named pump to carry the possible increase of water from the heading over the grade summit at station 25. It was found that at all times the first named pump carried the volume of water collected in the heading. At the bottom of the shaft, one No. 5 Janesville Volute type pump having a 6-in. suction and 5-in. discharge and a capacity of 750 gals. against a 130-ft. head and also a No. 4 Janesville Volute type pump having 5-in. suction and 4½-in. discharge and having a capacity of 650 gals. per minute against 130-ft. head, was installed. These pumps were motor driven. The suction pipe from both pumps extended to the shaft sump. It was found necessary to operate only the No. 5 pump, and that, at intervals. The No. 4 pump was used for emergency purposes.

INJURIES.

No deaths have resulted up to date in the construction of the tunnel. However, injuries consisting of broken bones, lacerated fingers and heads, and burns resulting from the gas deflammation in June have occurred.

PROGRESS.

The highest month in excavation progress was reached in September, when 2,500 cu. yds. of excavation were removed. The minimum month of excavation was February, the contractor removing 1,692 cu. yds. of excavation. September gave the maximum progress in placing arch concrete, when 552 cu. yds. were placed. July represents the minimum month in placing arch concrete, when 292 cu. yds. were placed. May was the maximum month for installing side wall sections, 213 cu. yds. being placed. February was the minimum month for placing side wall sections, 133 cu. yds. of concrete being installed. A sample section of the progress profile is shown in Fig. 11.

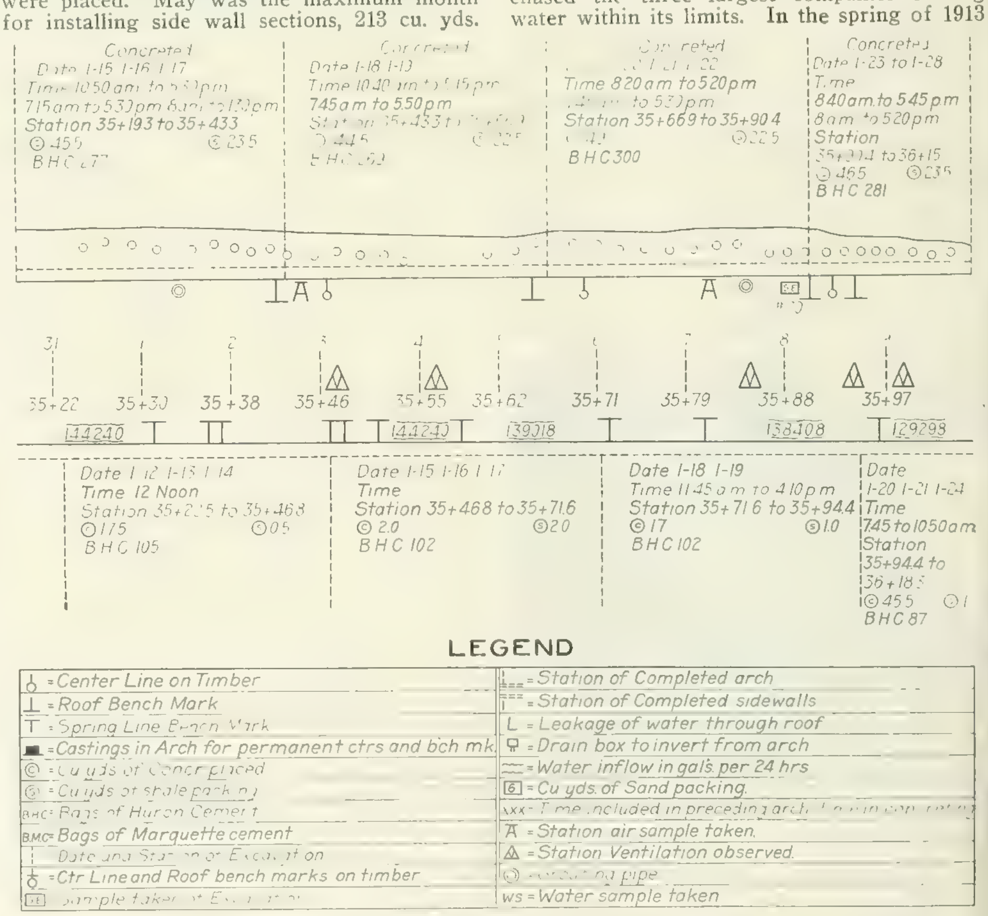


Fig. 11. A Portion of the Progress Profile on Milwaukee Water Tunnel Construction, Showing Conventional Signs Used.

The excavation is now completed and so are the arch and side walls. The invert is being concreted. The driving of the lake shaft still remains to be done. The contractor is planning to start this work soon.

CONTRACTOR'S ORGANIZATION.

The contractor has employed a force of men averaging from 70 to 110 per 24 hours, classified as follows: 4 drillers; 4 drill helpers; 2 pump men; 27 muckers; 1 general foreman; 2 hoisting engineers; 2 power house engineers; 1 blacksmith; 1 blacksmith helper; 1 superintendent; 1 clerk; 4 timbermen; 4 sub-foremen; 29 laborers; 16 concreters; 1 master mechanic and 1 carpenter.

CITY'S ORGANIZATION.

The city's organization, in immediate supervision of the work, consists of a resident engineer, 4 inspectors, 1 transitman and 1 draftsman. It has been the good fortune of the city to have been able to have experienced men for tunnel inspectors. The efficiency of the inspectors and their unusual conscientious devotion to the interest of the work have secured a high standard of construction. The inspector's daily report blank is shown in Fig. 12.

ACKNOWLEDGMENT.

The foregoing information is from a paper by Mr. George F. Staal, city engineer of Milwaukee, before the Wisconsin Engineers' Society. Mr. Staal furnished this journal with the copy for illustrations. Mr. Lee G. Warren is resident engineer and Mr. Roland E. Stoelting, assistant engineer, has been chief designing engineer under the city engineer.

Organization of and Procedure in the Water Department of Pasadena, Calif.

(Staff Abstract.)

On Sept. 1, 1912, the city of Pasadena purchased the three largest companies serving water within its limits. In the spring of 1913 three smaller water companies were bought out by the city. On Nov. 1, 1912, the Pasadena

Water Department was organized. With the approval of the Board of City Commissioners, Commissioner M. H. Salisbury organized the Water Department into four divisions, each with a responsible head. The organization is here outlined and the procedure in the business manager's division is described.

DIVISION I.—ENGINEERING AND PURCHASING.

Mr. S. B. Morris, chief engineer, is head of the division and P. T. Keenan is purchasing agent. This division covers all field and office engineering, as well as the ordering and purchase of all supplies for all divisions of the water department.

The chief engineer, subject to the approval of the Commissioner of Public Utilities, Mr. Salisbury, decides on all matters of new equipment, new construction or important repairs required in Divisions II and III. It is his duty to select the material, lay out the work, prescribe the way it shall be done, and see that it is done by these divisions. Generally speaking, he bears the same relation to the physical end of the Water Department that a supervising architect does to a building construction job.

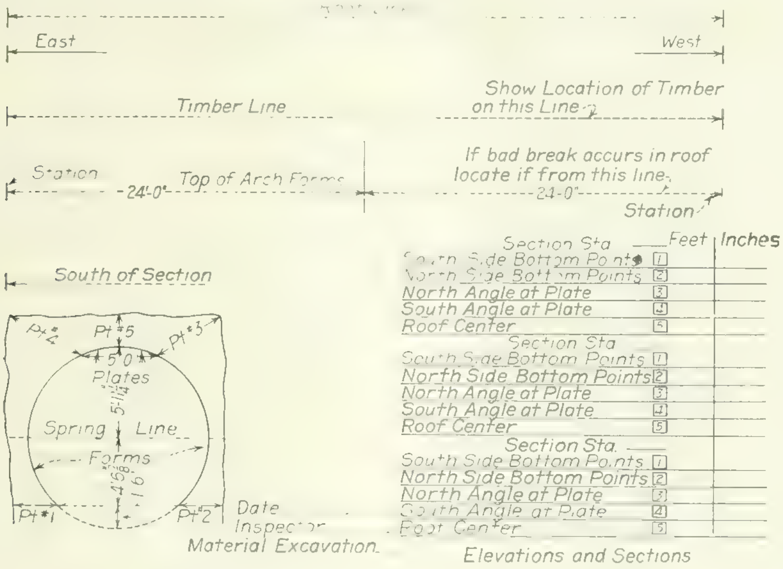


Fig. 12. Inspector's Report Blank Used on Milwaukee Water Tunnel Construction.

DIVISION II.—CONSERVATION AND GRAVITY SUPPLY.

Mr. S. S. Smith is head of this division and is designated as Foreman of Water Supply.

This division covers the construction, maintenance and care of dams, supply mains, shafts, tunnels, roads and reservoirs and other sources of gravity water, as well as the diverting of and spreading of flood water in the Arroyo Seco Canyon over the water bearing sands drawn upon by the city, and also patrolling the sources of water supply.

DIVISION III.—PRODUCTION AND DISTRIBUTION.

The head of this division is J. E. Carpenter, designated as Superintendent.

This division covers the installation of equipment, new construction, operation and maintenance of pumping plants, wells, services, mains, meters, shops, buildings, live stock and all vehicles.

DIVISION IV.—GENERAL ADMINISTRATION.

The head of this division is William Selbie, designated as Business Manager.

This division embraces all accountants, clerks, cashiers, collectors, meter and service clerks, inspectors and meter readers, storekeepers and stenographers.

Generally speaking, it handles all the clerical work of the Department, making daily deposits with City Treasurer of all moneys collected and certifying all demands to City Auditor for payment of labor and material, and makes proper accounting of all receipts and disbursements. It is also authorized to adjust complaints, rectify bills and make rebates in charity cases, serious matters when disputed coming to the Commissioner of Public Utilities for final adjustment.

PROCEDURE IN THE DIVISION OF GENERAL ADMINISTRATION.

There are about 11,000 individual accounts with consumers besides all the general accounts, pay-rolls and bills for supplies and material purchased, so it is absolutely necessary, in this Division, to work on a system that will give the maximum of accuracy and efficiency at a minimum of cost and labor. An effort has been made to eliminate all unnecessary detail and small labor-saving improvements have frequently been made in the system. The work of this Division is concisely described by the Business Manager, Mr. William Selbie, as follows:

The desk of the Meter and Service Clerk is the natural point at which to start, as here all applications are made for the installation of services or meters. Serial receipts are issued covering these and also for special sales of water or meters and for permits to contractors and others. All receipts are reported daily to the accounting department and merged in the daily report and remittance to City Auditor. This desk also attends to all trouble calls, ordinary complaints and orders for closing bills and changes of address, etc. Here are kept the service record book and service file; meter and flat rate service card index, which gives a continuous history of the meter on each service; a meter maintenance card which gives a continuous record of each individual meter, showing its performance and cost of maintenance, and various other subsidiary files and devices making for accuracy and efficiency are also maintained in this department.

For all services duly registered machine addressing stencils are cut, giving address and service number. From these stencils are addressed meter book sheets and all monthly water bills and postal cards.

Beginning on the tenth of each month the meter readers go out and take the reading of every meter on the list. This takes some ten to twelve days. The town is divided into convenient adjacent districts, each of which is covered by a corresponding meter book.

The stencils are arranged in a cabinet safe in trays to correspond with the meter books. The bills and postal card notices are printed from these stencils in the early part of each month, so that as fast as the meter readers return their books the corresponding bunch of bills and cards is handed to the bill makers and the bills are made direct from the meter book.

Bill Making and Collecting.—Each bill has two stubs and both stubs and the bill proper have been printed with service stencil. One stub is detached and goes to bookkeeper to be checked as to figuring and to be charged to that service in consumers' ledger, in which is also noted meter reading for the month. These debits are all checked and entered before end of month, and when this is done the post card notices are mailed and the bills go to the counter cashier to be filed for payment. When bills are collected the other stub is detached and saved by cashier or collector and these stubs are turned over daily to the accounting department with the cash. Here the stubs are listed and balanced with the cash turned over, and included in daily report and remittance to City Auditor. The stubs then go to the bookkeeper for credit entry in the consumers' ledger.

This book has been specially prepared with appropriate headings and ruling, so that a single line across a double folio serves to take care of a consumer's account for a whole year, and by having a short leaf insertion with the service number and address on it for permanent use, only the service numbers have to be printed with a numbering machine on the new sheets at the end of the year.

At the end of each month the credit balances and unpaid balances are brought forward and checked with the bills actually on hand, so that no collection can escape being accounted for.

All water bills are due on the first day of the month following the meter reading and they become delinquent on the twentieth. Delinquent bills are presented as soon after the twentieth as they can be reached and if not paid, shut off notices are left. About three days afterward the shut off man locks off all unpaid services unless the bills are first paid to him.

Warehouse.—At the warehouse all material and supplies that do not go direct to a job are entered in a continuous balancing stock ledger by the storekeeper and are held by him just like a checking account in a bank. He delivers only on written requisition on which he notes the proper account to be charged and credits warehouse. He prepares for the general office every month a distribution sheet showing all receipts and deliveries of material on the various work orders and requisitions. At the general office the receipts are checked with the original purchase orders, the warehouse is credited and the distributions charged to the proper accounts. The warehouse balance on hand is checked at least once every year by actual inspection of the stock.

Accounting.—We will now pass to the system of accounting used in the general office and as briefly as possible outline its main features.

Our general accounting is modeled on the system prescribed by the United States Bureau of the Census, the American Water Works Association, et al., and also on the system prescribed for water corporations by the Railroad Commission of the State of California, and is believed to possess all the important features of each, adapted to the needs of the Pasadena Department. The accounts have been divided into groups, each with a separate series of numbers and each designated by appropriate letters, so that the number of accounts in any group may be added to indefinitely and the letters at once designate the group to which the particular entry or account belongs.

Many of these accounts are subdivided in a cost ledger, so as to show the cost of any specific line of work at any particular point.

In addition to the above, a special work order is issued for each important job of construction or equipment, so that the individual cost of that particular item is shown in the cost ledger and is merged in the appropriate general account.

The ordinary supplies and materials purchased are charged to the warehouse and distributed there as required and charged by storekeeper on the appropriate work order, as used, either in maintenance or new construction.

Every employe working by the day turns in a daily time card, signed by himself and his foreman, showing just how many hours he has worked and on what jobs. Monthly employes have monthly cards, on which the time spent on each line of work is specified, and from these cards the time-rolls are made up and the various expense and construction accounts debited with the amounts properly chargeable thereto.

In addition to the accounts above specified, a property book has been prepared, which covers all the property embraced in the Fixed Assets group of accounts, in detail, item by item. It is arranged in groups, to harmonize with the general ledger, and it has been appropriately headed and arranged, to show how acquired, date of acquisition or construction, age, life, original cost, rate of depreciation, value realized if sold, amount charged off for discard or depreciation, and value on July 1 of each year.

ACKNOWLEDGMENT.

The system of accounts used is specified in detail in the first annual report of the department. All the information here given is based upon that report.

Economy of Large Water Mains.

(Staff Abstract.)

That it is cheaper to lay a water main which is too large for present needs than to use a smaller one which must be supplemented by one or more additional small mains within a few years, is brought out by Mr. Nicholas S. Hill, Jr., in a paper just published in the Journal of the American Water Works Association.

In planning a pipe distribution system the engineer must decide upon the future period for which the improvements are to serve without duplication or enlargement. This period will bear no relation to the useful life of cast iron pipe, which depends largely on the service for which it is used and may exceed 100 years. It would be impossible to predict the amount or direction of a city's growth for so long a period as 100 years with any degree of certainty. It is possible, however, to predict with sufficient accuracy, both the extent and distribution of population growth, upon which the future demand for water will in great measure depend, for a period of 20 to 30 years to come.

The reasons for predicating estimates on results which are expected to obtain so far in the future are not that one can undertake to forecast the future with mathematical exactness even for this limited period, but rather because it is the safest and most rational way in which to make reasonable provision for future needs.

Failure to make such provision frequently results in a high capital investment in mains. It is cheaper to lay a main which is too large for present needs than to lay one which must be reinforced within a few years. To show the expense which a company or city incurs by pursuing such a policy, Mr. Hill presents Table I, which shows the comparative cost of different pipe sizes to give the same service.

The costs given in the table do not and, of course, can not take into consideration the damage to improved streets, and the additional cost of maintaining them, which results from continual tearing up, nor can they take into account the inconvenience, annoyance and the disturbance of traffic which results from repeated removal of the street surface. They further do not include the additional cost of repairs due to the increased main mileage which results from duplication of mains and the increased liability of having to excavate for repairs, nor any consideration of the enhanced pumping costs ensuing from greater main leakage resulting from an increase in the number of pipe joints. The table clearly shows that even where the period of usefulness of the first main laid is 18 out of 26 years, the saving in favor of two mains in most cases is not sufficient to offset the other losses incurred.

TABLE I.—COMPARATIVE COST PER FOOT FOR DIFFERENT WATER PIPE SIZES TO GIVE THE SAME SERVICE.

		*	*		Relative annual costs per foot under following plans.						Capitalized annual cost.				Saving in favor of plan 1,—the immediate installation of larger pipe.	
					Plan. 1. Immediate installation of single pipe of size given in Col. (1).			Plan. 2. Immediate installation of single pipe of size given in Col. (2) to be followed after expiration of period given in Col. (5) by installation of second pipe of same size.			Plan 1.	Plan 2.				
Diameter of pipe required to supply the service for period of 26 years. (1)	Number and size of smaller pipes required to give same service as single pipe opposite in Col. (1). (2)	Single pipe of diameter given in Col. (1).. (3)	Single pipe of diameter given in Col. (2).. (4)	Assumed number of years during which a single pipe of diameter given in Col. (2) will suffice. (5)	Interest on initial cost at 5 per cent (6)	Annuity required to amortize capital investment at end of 70 year life at 4 per cent. (7)	Total annual cost per foot. (8)	Interest on initial cost of one pipe at 5 per cent. (9)	Annuity required to amortize capital investment at end of 70 year life at 4 per cent. (10)	Total annual cost per foot of one pipe. (11)	Total annual cost per foot as given in Col. (8) capitalized at 5 per cent. (12)	Total annual cost per foot of first pipe as given in Col. (11) capitalized at 5 per cent. (13)	Present value of total annual cost per foot of second pipe as given in Col. (11) when capitalized at 5 per cent. (14)	Total. (15)	Amount in dollars per foot. (16)	In per cent of cost of plan 1. (17)
					= (3) ×.05	= (3) ×.00274	= (6) + (7)	= (4) ×.05	= (4) ×.00274	= (9) + (10)	= (8) ÷.05	= (11) ÷.05	= (11) ÷.05 reduced to present value.	= (13) + (14)	= (15) — (12)	= (16) ÷ (12)
ins.	ins.	$	$		cts.	cts.	cts.	cts.	cts.	cts.	$	$	$	$	$	%
24	2.05-18	4.61	2.87	6	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	2.26	5.29	0.43	8.8
				12	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	1.69	4.72	—0.14	—2.9
				18	23.05	1.26	24.31	14.35	0.79	15.14	4.86	3.03	1.26	4.29	—0.57	—11.7
16	2.05-12	2.42	1.59	6	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	1.25	2.93	0.38	14.9
				12	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	0.94	2.62	0.07	2.7
				18	12.10	0.66	12.76	7.95	0.44	8.39	2.55	1.68	0.70	2.38	—0.17	—6.7
8	2.05-6	0.96	0.69	6	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.54	1.27	0.26	25.7
				12	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.41	1.14	0.13	12.9
				18	4.80	0.26	5.06	3.45	0.19	3.64	1.01	0.73	0.30	1.03	0.02	2.0

*Initial cost, Class C pipe, at $25 per ton in medium digging with labor at $1.75 per 10-hour day.

ROADS AND STREETS

A Proposed Construction to Reduce the Cost of Brick Roads.

(Staff Abstract.)

Brick laid flat on a very thin reinforced concrete base is the construction proposed by Prof. Jas. S. Tucker, Director School of Civil Engineering, University of Oklahoma, to reduce the cost of brick road construction. The full discussion of his plan is given in a paper recently presented to the Iowa State Engineering Society, and the discussion is of particular interest in connection with the new designs for brick road construction in Illinois described in our issue of March 17, 1915. A large portion of the paper by Prof. Tucker is devoted to a proof of the fibrous structure of paving brick, and to a discussion of the advantages of placing the brick in pavement so that wear is across the fiber, with a plea for a soft joint filler instead of grout filler. The paper then presents the facts and reasoning supporting the proposed new construction and these we give here somewhat condensed from the original.

RESULTS OF TESTS.

Late in 1912 there were made in the engineering laboratories at the University of Oklahoma a series of tests to indicate the behavior of concrete pavement foundations. Concrete slabs, representing a section of the pavement 1 ft. wide of various thickness when suitably aged were placed in the testing machine and supported on knife-edges 27 ins. apart and the load applied directly to the center of the slab. The average center concentrated load borne by 6-in. plain slabs at twelve days, was 1,200 lbs.; by 5-in. plain slabs at eleven days, 1,125 lbs.; by the 4-in. plain, at ten days, 630 lbs. A 2-in. slab, reinforced with wire fencing in the middle, averaged 460 lbs. at ten days or four-fifths as much as the 4-in. plain; 3-in. slabs, reinforced near the bottom, gave 1,180 lbs. in ten days; or the same as the 5-in. slab and nearly as much as the 6-in. Four-inch slabs, also reinforced near the bottom, gave 1,150 lbs. in ten days. One 4-in. slab with three wires at age of 27 months gave the remarkable test of 3,000 lbs.

The reinforcement used in every case was ordinary commercial rectangular mesh hog-fencing of galvanized wire, costing from 3 to 5 cts. per square yard in place in the street foundation. The slabs tested had either three or four longitudinal wires, just as it happened to come from the top or bottom of the fencing. The meshes ranged between 5x6½ and 3½x6½ ins. The top of the fencing had wires of ⅛-in. diameter, while the balance were 9/16 in. diameter, and the transverse knotted stay wires were 7/64-in. In none of these cases did the wires break except in the 27-month test, but as the ends of the strands were not even turned up, or hooked, and as in numerous specimens the wires were embedded only about ¾ in. from the bottom of the slab, they frequently pulled loose and slipped as the upper part of the slab crushed under the load. The concrete was of the most ordinary sort, made in a hand mixer, proportion 1:4:5, with ¾-in. limestone, and a coarse and a fine grade of sand in equal parts. The slabs were aged in an open field between Oct. 28 and Nov. 12, for the most part.

ECONOMIC LESSONS.

The significance of these tests appears when we consider the cash value of the facts learned. Wherever there is need for a 6-in. base, one 3 ins. thick with 5 cts. worth of reinforcement will do equally as well. The cash saving is notable since the concrete will cost from 15 to 20 cts. per square yard per inch of thickness. Hence this simple use of hog-fencing means from 40 to 55 cts. per square yard of pavement actually saved, or 25 per cent saving on a pavement costing from $1.60 to $2.00. This is a saving of $1,000 upon about 2,000 sq. yds. of pavement, and a small job of paving usually runs to several times this amount. Nor is this all. Having seen that we can do with 3 ins. of concrete all that is now done with 6 ins. the next obvious question is: Is a pavement base of even that strength ever needed?

It will be observed that the loads of 1,500 lbs. obtained with the 4-in. slab represent a wagon wheel carrying one-fourth of a three-ton load. This is probably about twice as great an intensity as would occur for a ten-ton road roller, and somewhat greater than under a large traction engine. Note, however, that the slab tested had the following very great handicaps: First, the load was applied at the center of a clear unsupported span of 27 ins. Second, the slab was discontinuous in both directions, and hence could receive no support from adjacent portions of the concrete. Third, this discontinuity, of lack of anchorage, was of vital importance to the reinforcement, since only in the one case of the block aged 27 months did the wires break. That is, the capacity of the wires missed development by from 50 to 80 per cent.

The most vital variation between this experiment and practice, however, lies in the unsupported span tested. We certainly need not assume that we must design to meet this non-supported condition in practice. Nor need we figure safe loads without taking into account the supporting power of the sub-grade. Every engineering text on foundations suggests that almost any dry soil can be safely relied upon to carry two tons per square foot, if kept free of excess moisture. The soil will be very bad indeed which will not carry one ton per square foot, and for particularly good ones it may run to eight or ten tons. Taking two tons as a reasonable figure for soil which is to have a tight roof, any which may be assumed to have received the attentions of a steam roller, this would give a supporting capacity of about 30 lbs. per square inch, running up to six or eight times that with the better soils.

If we consider a 3x8-in. brick as receiving a wheel-load of 1,500 lbs., and it is resting on a 1-in. sand cushion carried by concrete 3 ins. thick, then taking the usual assumed divergence of load lines as 45°, this wheel load is distributed over 170 sq. ins. of earth surface, giving an intensity of 9 lbs. per square inch. Since we are counting upon a 30-lb. soil as a minimum, which figure already includes an ample factor of safety, it is evident that the soil can not be overstressed, even though we consider the area of concrete loaded as a separate flagstone, and not part of a continuous slab, which it certainly will be.

Without assuming that our foundation has any particular tensil strength, therefore, we are forced to conclude that a soil area of 50 sq. ins. would carry the 1,500-lb. wheel load with perfect safety, while in fact the area receiving the load is over three times as great as this. This it is thought, will serve as an ample allowance for the case where the load is applied to the joint between two bricks where there is a non-rigid joint filler.

We thus find ourselves to have reasoned around to our starting point, the contention of MacAdam that a well-drained and compacted road surface would bear any wheel loads that could be put upon it. We see that if a space 4 ins. long under our 12-in. wide test-slab had been occupied by soil of the supporting capacity named, instead of the slab having a clear unsupported span, then there would have been no need of reinforcement in it.

Pursuing the logic still further, it appears that the thickness of the slab is of little import, since it is the subgrade which must really and eventually carry the load in any case. As the thinner slabs deflected about ¾ in. without falling it is seen that the soil area called into support will greatly exceed what is needed to bear any load coming upon the pavement surface.

This reasoning indicates that a 2-in. slab with the wire in the middle would be amply strong, and would affect a still further saving of money over that already indicated. The speaker is not prepared to recommend this thickness, however, unless the paving specifications are otherwise radically amended, notably in the preparation of the subgrade. He is convinced, however, that an average expenditure of 3 or 4 cts. per square yard in excess of the present practice devoted to watering, raking, and continued rolling of the subgrade would render the 2-in. base entirely feasible. He is also convinced that such rolling and painstaking treatment of the subgrade would surpass in effective supporting power and increase pavement stability more than the introduction of four extra inches of concrete foundation as now commonly practiced, while the cost reduction might then amount to 30 per cent of the total.

It may here be claimed that this paper first makes a great argument for wire reinforcement, and then shows that it is unnecessary. The practical difficulty of getting a uniform and homogeneous subgrade is freely admitted, even with the care and effort here asked for. This is exactly where the reinforcement comes in,—to render the pavement stable and secure from disturbance by reason of such defects in its support, for if these thin slabs with the trifling reinforcement used, will under all the handicaps herein indicated virtually carry any possible loads over clear spans of 2 ft., it is certainly rational to suppose that they will carry and distribute the loads properly when resting on almost any soil short of liquid mud. This we certainly need not provide for, nor need we regard a general settlement in any pavement as fatally defective.

Having now considered the pavement foundation at length, let us turn back and see what bearing, if any, this discussion has upon joint fillers, and its possible relation to the shape and size of the brick. To the speaker there is a most profound and significant relationship between all these factors. It is thought that those who have contended most strongly for the rigid cement grout filler do so through failure to recognize fully the meaning of the MacAdam principle. They have seemed to consider that the brick-wearing surface must not only furnish a strong wearing surface which would then resist the abrasion of traffic, and that it must also perform all the functions of the foundation as well. As already suggested if temperature stresses did not enter into the problem results under this theory might still be fairly satisfactory. But since temperature strains are bound to occur, and are likely to cause cracks and fractures, why not guard against them by using ample expansion joints around each brick, and use bituminous filler. If the foundation and subgrade have been planned and executed to develop their legitimate functions then there is no need for the wearing surface to attempt to include that also, and perfect stability of the wearing surface is insured not by attempting to make it immovable and unbreakable in itself but by furnishing it with a strong immovable and unbreakable support.

It is at once evident that the single quality which has given brick such a prominent place as a paving material is its wonderful resistance to abrasion. Even where paving has been done in violation of all the principles herein studied no one has yet seen a brick pavement really worn out. It follows therefore that with an adequate support provided, and temperature stresses relieved as above outlined it will then be pre-eminently sound engineering design to lessen the thickness of the wear resisting surface. The speaker believes that 2 or 2¼-in. paving brick laid flat with a bituminous filler, upon 1-in. or less of sand supported by a 2-in. reinforced foundation, all borne upon a carefully, but cheaply, prepared subgrade, represents the distinctly modern type of economical pavement construction for every sort of traffic except the most intense steel-shod traffic when bricks of the usual thickness would be economical. Also with sub-grades of special difficulty as to drainage and known instability of soil an extra inch might be added in the foundation.

Methods and Costs of Constructing Three Sections of Sand-Clay Road.

(STAFF ABSTRACT)

The work considered is three sections of sand clay object lesson road built in 1912 in North Carolina. In both cases the construction methods are described and the costs are computed from data given in the Report for 1913-14 of Joseph Hyde Pratt, State Geologist, North Carolina.

The first section of road extends from Calypso, N. C., southeast toward Kenansville. The adjacent land is slightly rolling and the soil is sandy throughout the length of the section. The grading consisted in plowing the ditches and bringing the road to the proper cross-section with a road machine. A small amount of material was moved for an average distance of 50 ft. with drag scrapers. For 1,650 ft. the road was graded 24 ft. wide and surfaced 14 ft. wide, making the area graded 4,400 sq. yds. and the area surfaced 2,563 sq. yds. The crown of the finished roadway was three-fourths inch to 1 ft. Clay to the amount of 248 cu. yds. was hauled an average distance of 2,400 ft., and 55 cu. yds. of sand was hauled an average distance of 1,760 ft. Farm wagons having an approximate capacity of 1 cu. yd. were used for hauling both sand and clay. They were loaded and unloaded with shovels. Two corrugated-iron culverts were ordered for this work, but were not received before the surfacing was completed. Directions were furnished for placing them.

The equipment consisted of 1 road machine, 1 rooter plow, 1 turn plow, 1 split-log drag, 2 drag scrapers, 1 disk harrow, farm wagons, and hand tools. Labor cost $1 and $1.50 per day and teams cost $1.20 and $2.50 per day. The cost of grading and shaping 4,400 sq. yds. of subgrade was $3,860 or 0.88 ct. per square yard. The costs for 2,563 sq. yds. of surfacing proper were as follows:

Item.	Cost.
Loading sand	$ 3.75
Hauling sand	6.25
Spreading sand	1.50
Loading clay	22.6[illegible]
Hauling clay	49.25
Spreading clay	5.50
Mixing clay and sand	4.8[illegible]
Final shaping with drag	1.00
Total	$ 95.[illegible]
Add grading	38.60
Grand total	$133.[illegible]

Cost per square yard, 5.21 cts.

The second section constructed extends from Cooleemee northeast to Jerusalem, N. C. The land adjacent to the road is rolling and the soil varies from "black-jack" gravel to micaceous clay. This road had been graded to a width of 24 ft. in cuts and 18 ft. in fills, and the drainage structures were all completed before the object-lesson work was begun.

The sand for use in surfacing was loosened with plows, loaded with hand shovels, hauled appproximately 1¼ miles in slat-bottom wagons, and spread with grader and by hand. The subgrade prepared for surfacing was 20,020 ft. long and 16 ft. wide, making a total area of 35,590 sq. yds. The same area was given a sand-clay surface 6 ins. thick after compacting, with a crown of ¾ in. to 1 ft. For the surfacing 4,820 cu. yds. of material were used, about 3,000 cu. yds. of which were purchased. The wages per day were labor $1.25, and teams $3. The costs were:

Item.	Cost.
Loading sand at 6.05 cts. per cu. yd.	$ 291.61
Mixing surfacing at 0.1 ct. per sq. yd.	37.25
Shaping at 0.15 ct. per sq. yd.	53.25
Spreading sand at 1.37 cts. per cu. yd.	66.00
Hauling sand at 25.46 cts. per cu. yd.	1,227.00
Sand pits	105.25
General expense	19.25
Total	$1,799.61
Per square yard, 5.06 cts.	

The cost of superintendence, which is included above, was 6.33 per cent of the total cost.

The third section of road was constructed in Lexington, N. C. The adjacent land is rolling and the natural soil is clay of a plastic nature, but lacking in toughness. The first work was grading. The earth was loosened by a traction engine and a road plow; loaded and hauled with drag scrapers, wheel scrapers, and wagons, and spread with shovels. The maximum cut was 4 ft. and the maximum fill 3 ft. The maximum grade was reduced from 3 per cent to 1 per cent.

The equipment consisted of three No. 2 wheel scrapers, six No. 2 drag scrapers, two plows, three 1½-cu. yd. dump wagons, one 12-HP. traction engine, picks, shovels, etc. The average haul for excavation was 150 ft. and the maximum haul 400 ft. The sand mixed with the clay for surfacing was obtained from a pit and hauled for an average distance of 3 miles in 1-cu. yd. slat-bottom wagons. The quality of the sand was excellent for the purpose for which it was used. Free labor cost $1.25 and $1.50, and foreman $3 per 10-hour day. Convict labor was estimated at $1 per day, and teams cost from $2 to $3 per day.

The total length graded was 3,000 ft., and the width graded, both in cuts and fills, was 30 ft., making the total area graded 10,000 sq. yds. The entire length of 3,000 ft. was surfaced for a width of 18 ft., making the area surfaced 6,000 sq. yds. The compacted depth of surfacing material was 4 ins. and the crown ¾ in. to 1 ft. The earth excavation amounted to 3,975 cu. yds., and the sand used for surfacing amounted to 815 cu. yds. The cost of the work was:

Item.	Cost.
Excavation at 11 cts. per cu. yd.	$ 440.35
Hauling sand at 80 cts. per cu. yd.	652.00
Spreading at 1.6 cts. per cu. yd.	12.75
Mixing sand and clay	60.60
Sprinkling	6.00
General expenses	5.75
Total	$1,177.45
Per square yard, 19.6 cts.	

Methods of Constructing and Maintaining Gravel Roads.

(Staff Abstract.)

Gravel road construction has and for many years will continue to have a place of importance in rural highway systems. Like all of the less permanent road constructions, gravel roads must be systematically maintained if their full economic value is to be secured. The notes that follow outline gravel road construction and maintenance methods in relation specifically to Ohio conditions but also to conditions in most states of the Mississippi basin. These notes are from an address by A. H. Hinkle, Deputy Highway Commissioner in charge of maintenance, Ohio State Highway Department.

SELECTION OF GRAVEL.

Gravel of suitable quality for gravel roads may have from 6 to 20 per cent of clay or loam to furnish binding material. Gravel containing a higher per cent than this is sometimes used but with the higher per cent of clay or loam the gravel will mortar up much worse when wet. The amount necessary to properly bind the gravel depends very much upon the grading and quality of the gravel. A gravel grading uniformly from the larger gravels down to and including some sand will require much less loam or clay to make it bind than a gravel of about a uniform size. Sometimes a gravel is found with a lime deposit on it which aids very materially in making it cement together. The gravel may sometimes be so highly cemented as to be called a conglomerate. The cementing value of any gravel can usually be determined by the way it stands up in the pit. Clay containing iron oxide, usually indicated by its reddish color, is a good binding material. It is desirable that no large excess of clay over that required to bind the gravel be present for the presence of a small amount of excess clay will cause a muddy road in wet periods. If this binding material is not present, it may be added in the form of clay or loam or limestone dust. If the first method of constructing the road described below is followed, the binding material need not be present in the added gravel (or at least in a very small amount) as it will be supplied by the old road surface. Much of the gravel used on the roads and that soon binds well under traffic has much less than 6 per cent of binder. Upon examination it will usually be found to contain sand much of which is of such a soft nature that it soon grinds up into dust and furnishes the necessary binder. The maximum size of gravel used in the surface of a road should pass a 1½-in. circular mesh. In the base course a maximum size of about 3 ins. should be used.

LOOSE GRAVEL METHOD OF CONSTRUCTION.

This method consists in placing loose gravel over the surface of the road not to exceed 4 ins. in depth. This thin layer should be used in order that the loose gravel will not seriously interfere with traffic, while the gravel is being compacted by the traffic. The loose gravel will rut quite badly. The ruts should be eliminated and the surface kept smooth and well-crowned by the frequent use of the road drag, and harrow. Harrowing the loose gravel is of much value as it aids in distributing the gravel and producing an even surface and this uniformity in material and surface is one of the fundamentals of all road building. If there is a small amount of binding material in the gravel it will soon be compacted by traffic under this treatment, after which the process of adding more layers may be repeated as often as desired, until a hard crust is built up of sufficient strength to carry the load that will come on it. By this method a much thicker crust can be formed than will form where a thick layer of gravel, say 8 ins. to 10 ins. in depth, is placed on the road at one time. It will frequently be found in digging into a road built by this latter method that the hard crust formed on the surface of the road is not made more than 3 ins. to 5 ins. in depth. Underneath this crust will be found loose, uncompacted gravel. This may be due to the lack of sufficient binder in the gravel and to the fact that the crust forms no deeper than the depth of the mortaring effect produced by traffic. Hence the value of building the road by the addition of successive layers is easily seen. If the thin layer of gravel is placed on the road in the spring of the year it will be apt to compact much quicker. The loose gravel method of construction has the disadvantage of having loose gravel on the road which interferes to some extent with the traffic, but it has the advantage of never closing the road entirely against traffic. It has the great advantage of being low in first cost. Future additions may be made to the road as the money is available. The secret of this method is the proper and frequent dragging and thus keeping the surface smooth while it is being compacted by traffic. This method is very appropriate on roads having a very light traffic and the results with proper dragging will eventually be as good as where some other more expensive method is used. You will note, however, that this method is quite different from that in common practice of dumping great heaps of loose gravel in a narrow ridge down the center of the road which does as much damage by obstructing traffic for a year as it does good after it is compacted.

WATER BOUND GRAVEL METHOD OF CONSTRUCTION.

In this method the gravel is placed, rolled and waterbound in the same general way as water-bound macadam. It is usually laid and rolled in two or three layers using a size of gravel not exceeding 1½ ins. in the top layer and 3½ ins. in the bottom. If the gravel does not compact well because of a lack of binder, clay, loam sand, or limestone dust should be added and harrowed into the gravel after it is placed. The gravel should be thoroughly rolled and sprinkled with water in the finishing process of rolling as in making a water-bound macadam. The process of construction may differ from the macadam road in that if there is a deficient amount of fine material in the gravel as it is spread on the road, it may be necessary to add the binder (clay, sand loam or limestone dust), and harrow it in before the gravel will compact under the roller. The construction of the water-bound gravel will differ from the macadam in one other feature in that the "setting up" process will be slower to take place. For this reason the surface after it is once thoroughly compacted, should receive attention for several weeks thereafter by re-rolling occasionally when damp. If in the process of wet rolling the binder sticks to the roller wheels and picks up badly, clean sand may be added to the surface. If the surface is then sufficiently wet the sticking to the wheels will be largely avoided. It will sometimes happen that after being sprinkled the gravel will apparently soften during the process of rolling and the more rolling the softer it will become. This may be due to an excess of clay which becomes soft and acts as a lubricant when saturated, or to the subgrade becoming soft from the addition of too much water. Whatever be the cause, the most economical remedy is to stop the rolling and give the road time to dry out after which the rolling can be completed with success. It may be necessary to do the rolling on the installment plan by doing a small amount at a number of different times.

MAINTENANCE METHODS.

The maintenance of the gravel road will consist mainly in keeping the ruts and depressions filled with gravel and after it is worn down to a certain extent, resurfacing with gravel as described in the first method of construction. If a roller can be used in this resurfacing, so much the better. The ordinary repairs will be made by filling the depressions and holes just slightly more than full of fine gravel, this gravel to be kept in place by the frequent use of the road drag. No great excess of gravel over what is required to fill the depression should be used.

The drag can be used any time of year on a gravel road after a rain. On an old gravel road it can be best used in the spring of the year after the frost has left the ground. A good plan to follow is to keep adding from time to time new gravel so that there will be enough loose gravel to fill all depressions in the surface in the process of dragging. This will avoid the necessity of deep scraping and tearing up of the hard compacted gravel in order to get sufficient loose material to fill the depressions, and we should avoid as far as possible the tearing loose of compacted material. Many gravel roads have been ruined by scraping them too hard and deep with the large road grader. Many times the large road grader blade is made to cut clear through the edge of the gravel. This not only leaves a ditch for water to stand in which softens the subgrade of the road (which in itself is sufficient to ruin it), but also soil and sod by this process are scraped onto the gravel. We then soon find reason to complain of our gravel road for this excess loose material makes the road extremely dusty in dry weather and sloppy in wet weather. It should be unnecessary to say that we should never put soil or sod onto a gravel road.

The secret of the maintenance will then be the adding of a little new gravel as the occasion demands and systematic dragging, taking care not to drag too deep. When the shoulders are built up by the washing from the road surface and sod, they should be cut off to the proper slope with the large road grader and the scrapings either hauled off the road, or if the ditch is sufficiently deep and wide, they may be scraped outward and evenly spread so as to widen the shoulder. Never under any conditions should these shoulder scrapings be drawn onto the road surface.

When the road is worn down so as to need resurfacing, a uniform layer of gravel over the entire surface should be added and treated as described in the first method for construction. Mr. Sargent, State Highway Commissioner of Maine, says gravel roads formerly built by the water-bound method, are now being resurfaced in his state with about 2 ins. of 1½-in. gravel and the roads are giving splendid satisfaction.

It will frequently happen that old gravel roads that are rough and uneven have had quantities of gravel hauled on them yearly or every few years until the gravel may be from 15 ins. to 2 ft. deep. On such roads it would seem poor economy to deposit more gravel. A road in this condition should be scarified, reshaped to a proper crown, thoroughly harrowed so as to bring the large sized stones near the surface to the top, which stones should be raked up and hauled off the road. The surface can then be rolled or maintained with the drag until traffic compacts it, and an excellent road produced. The State Highway Department has treated roads in this manner and widened the old gravel out to a width of 20 ft. The cost on two of these roads has been per mile as follows:

Item	(1)	(2)
New gravel	$ 50.56	$ 0
Scarifying, reshaping, etc.	1,525.72	1,394.58
Depreciation of machinery	175.72	125.42
Total for 2 miles	$1,750.00	$1,520.00
Per mile	$75.00	760.00

In many parts of the state good gravel roads can be built after one of the methods described above at from $1,200 to $2,000 per mile exclusive of heavy grading with only a moderate traffic, will be roads that can be repaired and maintained at much less cost than any other type of improved road. In fact, the great argument for a gravel road is the low cost of maintenance.

In regard to the system to be used in repairing, it would seem that the soft surface roads, by the very nature of their surface, will more nearly admit of continuous maintenance than any other types. A few shovels of gravel placed in a depression in a gravel road in its early stages will prevent the formation of an ugly hole later on. It would therefore seem that the one-man patrol system on gravel roads would be very appropriate. The dragging could be done after rains, the depressions filled with new gravel in their first stages of development, large loose stones removed from the surface, the culverts and ditches kept open and the weeds and grass cut on the roadside. Quite different from many other types of road, there is scarcely any class of work on the surface roads that could not be done by one man and inasmuch as it is so important that the repairs be done without delay, it is certainly fit and proper that this system be used on such roads.

Piling Building Material in City Streets.

To the Editors: In your issue of March 24, you mention that "in Philadelphia, a contractor, who piles building materials in the street, must pay a monthly rent of 25 cts. for the space occupied," that "the Bureau of Highways of Philadelphia, which needs money for its work of maintaining streets, proposes that the rent be increased from 25 cts. to $5.00 per month," and that "the annual rental, that would result from this increase, is estimated at $40,000."

Philadelphia Street Obstructed by Piles of Building Material.

Like the narrowness of our streets (mostly only 50 ft. wide between house-lines), this archaic practice of allowing a builder to occupy more than a third of the driveway with an unsightly brick pile, which frequently remains a nuisance for months, doubtless dates from the time when the city was little more than a village, and when 50-ft. wide streets were unnecessarily wide for the little traffic carried.

Today our central streets are so congested that they have been made "one-way" streets; and yet (as the accompanying photograph shows) Eleventh Street, immediately north of Market Street (in the very heart of the city) was obstructed, a few years ago, by *two* such brick piles, immediately opposite each other, occupying together more than *two-thirds* of the drive-way, and leaving, between them, barely room for the single line of trolley cars on Eleventh Street.

It is a sad commentary upon the business sense of our people, or upon the virtue of their representatives in the City Council, that the City Highway Bureau is allowed to "need money for its work," and is perforce willing to see our already far too narrow streets nearly closed to traffic, in order to eke out its funds by a pitiful $40,000 per annum, selling the city's birthright for a mess of pottage.

Are such outrages, by individuals, upon the public, tolerated in European cities, or is the builder there required to carry on his client's operations upon his client's own premises?

A similar practice, in which the public is victimized by unscrupulous individuals, is that of allowing business men to confiscate the sidewalks to their own private uses by backing up their wagons on the sidewalks and keeping them there while loading and unloading; occupying not only the entire width of the sidewalk, but, of course, a considerable part of the driveway besides.

In Locust St., near my office, two large manufacturing establishments, recently erected, laid out their concrete side-walks (presumably in accordance with city regulations) with driveways crossing them for the express purpose of enabling wagons to back up to the doors, to load and unload. The two sidewalks are partly opposite; and, during business hours, the pedestrian must usually leave the sidewalk and pick his precarious way between the horses' heads, which sometimes "interlock" in the axis of the alleged "highway."

If I should place my desk in the center of the sidewalk, I should expect to be called to order, although I should have the decency to leave part of the sidewalk, on each side of my desk, for the hapless pedestrian. Is there one law for the captains, and another for the low privates, of industry?

John C. Trautwine, Jr.

257 S. 4th St., Philadelphia, Penna.

April 16, 1915.

BUILDINGS

Some Details of the Exterior Wooden Framing of the Tower of Jewels, Panama-Pacific International Exposition, San Francisco, Cal.

(Staff Article.)

In our issue of Jan. 20, 1915, we published an article describing in detail and illustrating the structural steel framework of the Tower of Jewels, Panama-Pacific International Exposition, San Francisco, Cal. In this article we shall consider some features of the enclosing wooden frame of this structure. The truss and bracing details of this framing involved some interesting problems in the use of heavy timbers. The tower has a total height of 435 ft. and forms the main entrance to the exposition grounds. To an elevation of 152 ft. above the ground level the walls of the tower rise vertically, forming a huge rectangular box 120 ft. square in plan, this section being pierced by a barrel arch, the soffit of which is 119 ft. above the court. Above the top of this section the structure consists mainly of a series of cylindrical portions of variable and rapidly decreasing diameters, composed of balustrades, colonnades and heavy belt courses. The outstanding ornament upon these upper decks is elaborate. (The erection of the timber work was described in our Jan. 20, 1915, issue. The loads for which the structure was designed are also given in that issue.)

GENERAL FEATURES OF TIMBER FRAMING.

The main rectangular portion of the tower, below elevation 152 ft., and the colonnades to the east and west of the tower proper are self-supporting timber structures.

Along the east and west walls of the rectangular portion a series of two-post columns extends from the foundation to elevation 152 ft. These columns are tied together by bracing trusses, which, in addition to their stiffening function, support the studding for the exterior plaster walls. The north and south elevations of this portion are framed with four-post columns, also tied together with bracing trusses. Above the main arch the walls and floor are carried on heavy timber trusses of 64-ft. span. These trusses are placed in pairs, one above the other, and are so tied together as to form a thoroughly stiff portal across the archway. From these trusses circular furring arches of timber are suspended for the support of the arch ceiling.

The colonnades are also self-supporting timber structures, the tops of the colonnade columns being built into horizontal trusses, which in turn are carried into the steel frame at the interior or tower end, and into a large four-post abutment tower at the outboard end.

The timber framing above elevation 152 ft. is comparatively light, but was complicated by the batter of the steel frame and by the diagonal bracing rods. The circular plan of the decks necessitated the scarfing of many of the large sticks.

ALLOWABLE STRESSES.

The following working stresses were used in the timber design:

	Lbs. per sq. In.
Tension with grain	1,200
Compression, end bearing	1,600
Compression, cross grain	350
Bending, extreme fiber	1,500
Shearing with grain	150
Modulus of elasticity, dead load	1,000,000
Modulus of elasticity, live load	1,[illegible]00,000
Columns under $\frac{l}{d} = 15$, P =	1,200
Columns over $\frac{l}{d} = 15$, P =	$1{,}600 - \frac{l}{60d}$

FRAMING BELOW ELEVATION 152 FT.

The arrangement of the various columns, trusses and bracing in the rectangular portion below elevation 152 is shown in the drawings of Fig. 1. Figure 1 (a) is a quarter plan of this framing; Fig. 1 (b) is a half elevation showing the timber trusses and columns which form the main entrance; Fig. 1 (c) is an elevation of the interior columns and bracing trusses; and Fig. 1 (d) is an elevation of the exterior construction. These drawings show the type of framing used and give the general dimensions of this part of the structure.

On account of the size of the main archway the portal bracing is exceptionally heavy. As shown in Figs. 1 (a) and (d) this portal bracing consists of four trusses, those in the same horizontal plane (A and B) being spaced 9 ft. 2 ins. on centers; while those in the same vertical plane have their upper chords spaced about 25 ft. on centers.

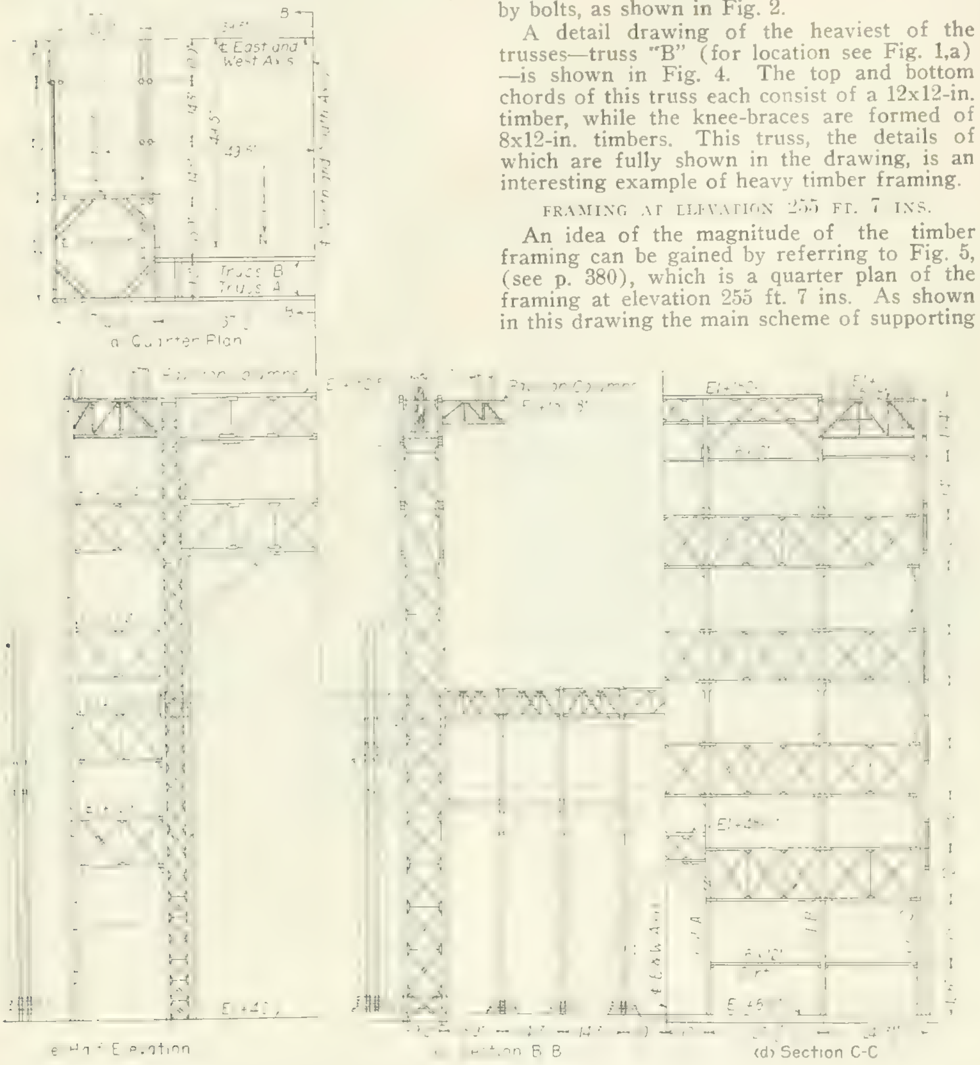


Fig. 1. General Framing Plans of Rectangular Portion Below Elevation 152 ft.—Tower of Jewels.

TWO-POST COLUMNS.

Figure 2 shows two views of the lower part of column A (for location see Fig. 1, d). Below the connection of this column to the steel column, at about elevation 20 ft., the column consists of two 12x12-in. timbers and one 8x12-in. timber. The 8x12-in. member extends a short distance above the knee-brace of the portal truss which connects to the column. Above this level the column consists of two 12x12-in. timbers spaced 12 ins. apart and connected at intervals with short pieces of 12x12-in. timbers. The shear between the various pieces composing the column is provided for by means of 2-in. wooden pins and by bolts, as shown in Fig. 2.

A detail drawing of the heaviest of the trusses—truss "B" (for location see Fig. 1,a) —is shown in Fig. 4. The top and bottom chords of this truss each consist of a 12x12-in. timber, while the knee-braces are formed of 8x12-in. timbers. This truss, the details of which are fully shown in the drawing, is an interesting example of heavy timber framing.

FRAMING AT ELEVATION 255 FT. 7 INS.

An idea of the magnitude of the timber framing can be gained by referring to Fig. 5, (see p. 380), which is a quarter plan of the framing at elevation 255 ft. 7 ins. As shown in this drawing the main scheme of supporting this framing is by means of cantilever brackets, attached to the main steel columns. These brackets carry heavy timber trusses, to which the exterior framing is attached by 6x8-in. members. A 2-in. shiplap floor covers a considerable part of the area at this level.

A detail drawing of truss "Y" (for location see Fig. 5) is shown in Fig. 3. This truss

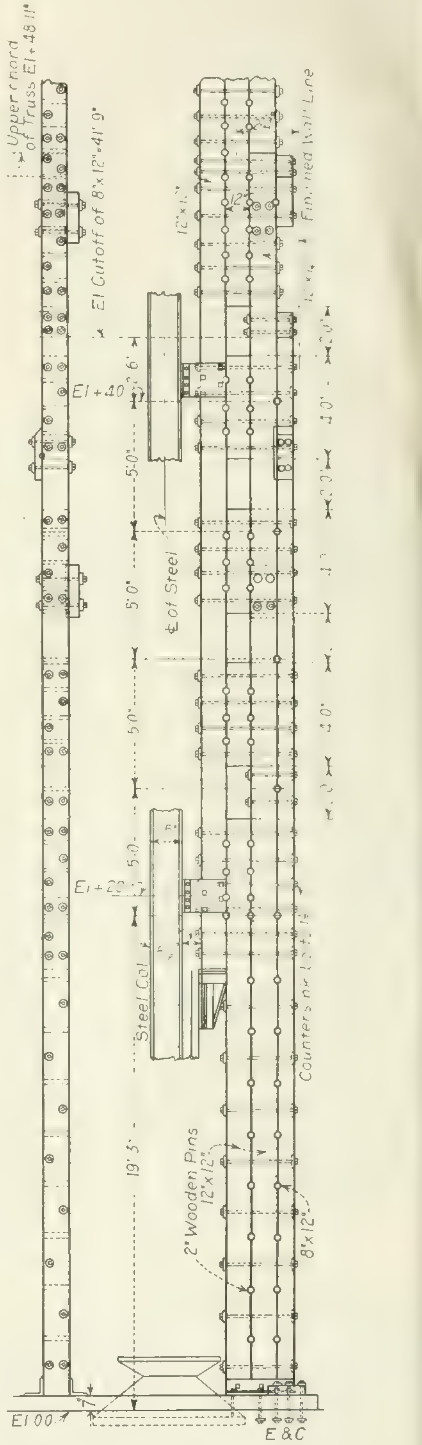


Fig. 2. Details of Lower Portion of Two-Post Column A of Tower of Jewels—Total Height of Column About 152 ft.—For Location See Fig. 1 (d).

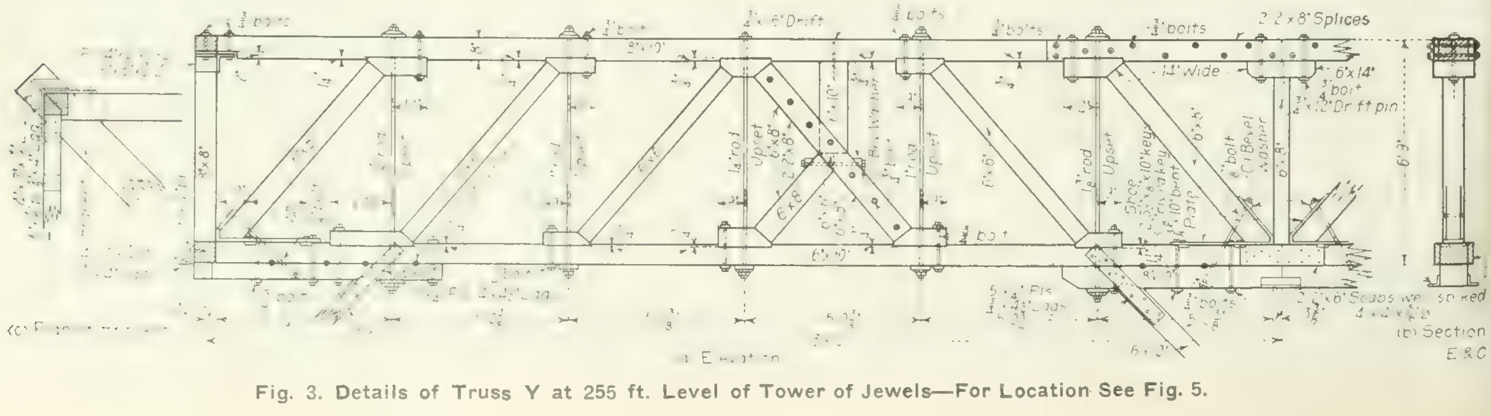
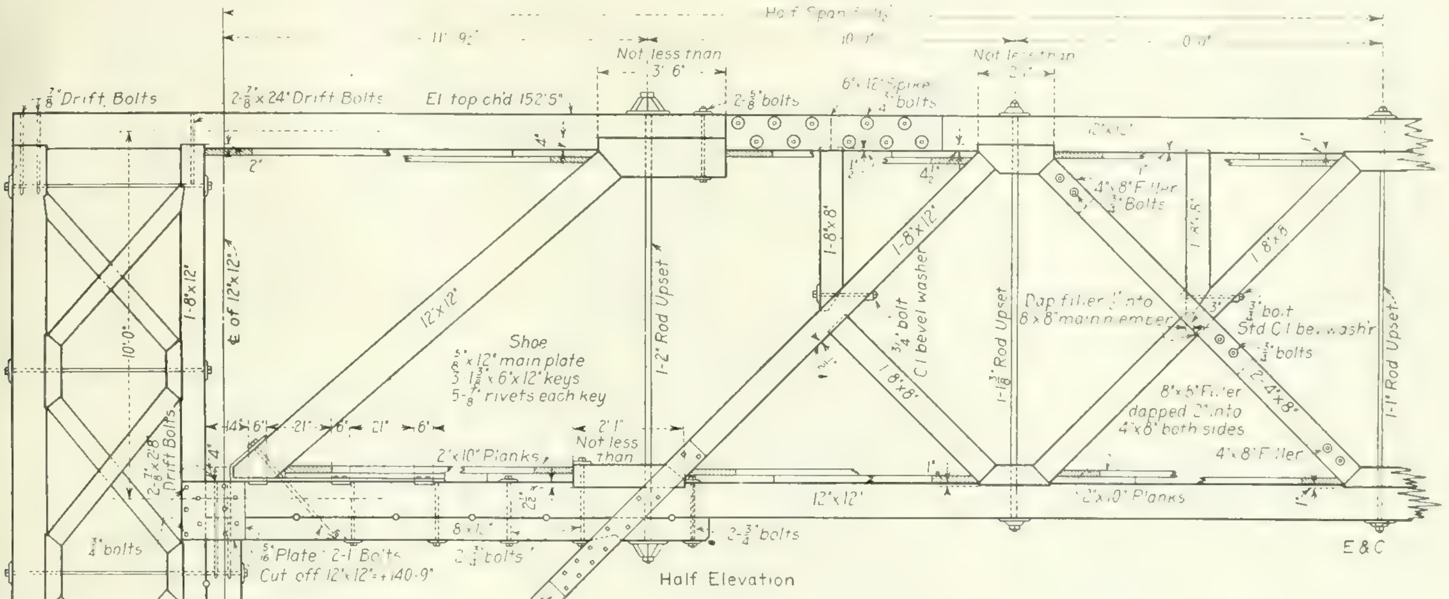


Fig. 3. Details of Truss Y at 255 ft. Level of Tower of Jewels—For Location See Fig. 5.

rests on heavy timber brackets attached to the steel columns. It is held rigidly in place by 6x10-in. knee-braces which are attached at their lower ends to the inclined posts of the brackets. The framing details of this truss are clearly shown in Fig. 3 (a), and the connection of the lower chord of the truss to the bracket, in Fig. 3 (c).

PERSONNEL.

The plans for the Tower of Jewels were prepared by the Division of Works of the Exposition Company, of which H. D. H. Connick is director and A. H. Markwart, assistant director. The structural work was designed by Frank S. M. Harris, assistant structural engineer, and others, under the immediate supervision of H. D. Dewell, chief structural engineer of the Division of Works. The architectural design was by Thomas Hastings, of New York. We are indebted to Mr. Harris for the data upon which this article is based.



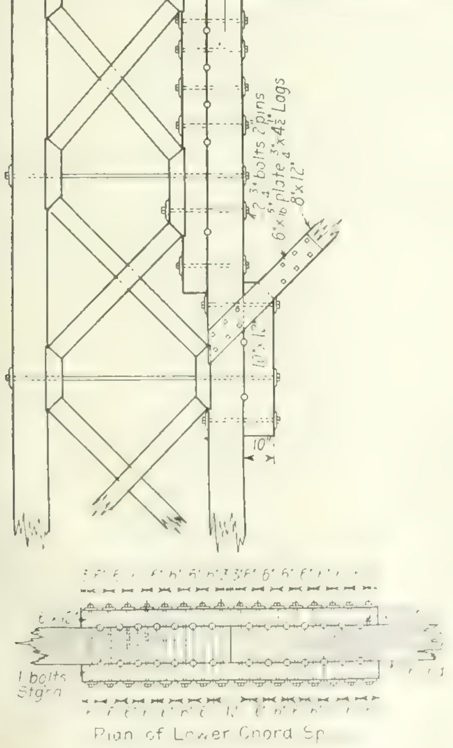


Fig. 4. Details of Portal Truss B Above Main Archway of Tower of Jewels—For Location See Fig. 1.

The city of Janesville, Wis., has finally obtained possession of the water works after five years of litigation, both state and federal, two years of valuation proceedings before the state railroad commission, two special elections and one general election at which it was the main issue. The price paid was $265,000.

Results of Tests of Cinder Concrete Floor Slabs, with Conclusions and Recommended Methods of Design.

(Staff Abstract.)

In our issues of May 27, 1914, and March 31, 1915, we gave data and discussion both on the use of reinforced cinder concrete for floors in buildings and on the strength of typical New York cinder concrete. In this article there are given the results of a series of tests conducted by the Department of Civil Engineering of Columbia University, partly in co-operation with the Bureau of Buildings of New York City. The data were abstracted from a paper by Harold Perrine and George E. Strehan, in Proceedings, American Society of Civil Engineering, Vol. XLI, p. 259. In our abstract we have included most of the essential data, the conclusions, and the recomended formulas and testing procedure; but have omitted computations and most of the detailed discussion. The use of reinforced cinder concrete floor in buildings in the larger eastern cities is extensive, the data in this article referring particularly to construction in New York City.

MATERIALS AND CONCRETE.

The cement used in both the 1913 and 1914 series was "Dragon" Portland cement. The sand was the typical bank material obtained from the north shore of Long Island. The cinders for the 1913 series were a typical commercial product furnished by a dealer in this material, and those for the 1914 series were obtained from the Columbia University power plant. The steel reinforcement consisted of wire mesh furnished by the American Steel and Wire Co.; expanded metal furnished by the Expanded Metal Engineering Co.; and the following types obtained in the open market: electrically welded wire mesh, triangular wire mesh, expanded metal, plain round, plain square, and twisted square rods.

The concrete for all tests consisted of 1 part cement, 2 parts sand, and 5 parts steam cinders, all by volume.

For the 1913 series the materials were brought to a continuous mixer, mixed about one minute, deposited in wheelbarrows, transported about 200 ft., and dumped into the forms. The consistency of the concrete was wet in some slabs and medium wet in others.

For the 1914 tests a ¼-cu. yd. "Blystone" batch mixer was used. The cement, sand and cinders, carefully measured by volume, were deposited dry in the mixer. Water, through a hose, was played on the ingredients as the mixing progressed, the percentage of water being practically constant throughout the series. The process of mixing occupied about two minutes per batch. The concrete was taken to the forms in wheelbarrows, and when deposited was of a wet, viscous consistency. It was stirred and pushed into the spaces between the wires or rods with narrow pieces of scantling, the concrete being too wet to permit of tamping. An excellent, dense, homogeneous concrete was thus obtained.

SCOPE OF TESTS AND TEST SLABS.

Of the 58 slabs constructed, 39 were simple slabs, 18 were restrained, and one was of special construction. Sixty-five 8-in. diameter cylinders 16 ins. long were also cast. In general the slabs and cylinders remained in the room in which they were cast until the time of testing, being sprinkled occasionally during the early periods of aging. All slabs were 22 ins. wide. Table I indicates the scope of the tests.

TABLE I.—SCOPE OF SLAB TESTS.

Concrete consistency.	Number of specimens.					Reinforcement	Variables.
	Restrained.	Simple.	Span, in ft.	Thickness, in ins.	Cylinders, 8 by 16 ins.		
1913 Series.							
Wet ...	6	10	6	[illegible]	[illegible]	Triangular mesh. Weld. wire mesh. Expanded metal.	Span; thickness; condition of end restraint; percentage and character of reinforcement.
Wet ...	6	[illegible]	[illegible]	[illegible]	[illegible]		
Medium.		3	[illegible]	[illegible]			
1914 Series.							
Viscous.	[illegible]	[illegible]	7	4	[illegible]	Triangular wire mesh. [illegible] metal. Round rods. [illegible] square rods. Twisted square rods.	Span; Thickness; Condition of end restraint; Percentage and character of reinforcement.
Viscous.	3	3	6	4	[illegible]		
Viscous.		14	5	3-4			
Viscous.	[illegible]	[illegible]	[illegible]	[illegible]			

*Special.

The conditions of end restraint and other details of construction of the type referred to as "restrained" are shown in Fig. 1 (a) (see p. 381). In this type wire mesh reinforcement was used exclusively. The "free" slabs, or simple beams, were cast as shown in Fig 1 (b). The special type is shown in Fig. 1 (c). The uniform width of 22 ins. was taken to facilitate testing, as this was the maximum width possible in the machine used.

METHODS OF TESTING.

A hydraulic jack and hand pump were used in applying the load on all restrained beams, the load being indicated on the gage. The apparatus was calibrated as a unit in a testing machine of known capacity. The load was applied in increments of 5-lb. gage pressures, corresponding to about 250 lbs. actual load The simple slabs were tested on rollers, either on the testing machine or by the jack.

The strain produced on the tension side of the slabs was measured on 10 or 12-in. gage lengths between two points symmetrically placed in the surface of the slabs, in the plane of the reinforcing steel. The compressive strain was measured on 10 or 12-in. gage lengths on the sides of the slabs, ½ in. down from the top surface of the arch, and afterward corrected for the corresponding probable extreme fiber strain.

The tensile and compressive stresses were computed from these measured strains, assuming the modulus of elasticity of steel to be 30,000,000 lbs. per square inch, the proper modulus for the concrete depending on compression tests of corresponding material.

DISCUSSION.

Curves were drawn for the various tests showing the relation between the applied load and the unit tensile and compressive strains and the deflection, and the following observations were made:

Simply Supported Slabs.—Analyses of the curves for the simple slabs show in general three stages of action. Up to a point on the curves designated as "first break," at a load corresponding to about one-third to one-half of the ultimate load on the slab, the ratio between load and stresses is direct. The observed strain in the steel is low, the deflection of the slab being very small. It is along this region of the curve that working loads occur. The "second stage" of the action is indicated by a rapid increase in the deflection, with a corresponding response in the working of the steel. The tension in the steel and the compression in the concrete both increase rapidly up to a point corresponding to the yield point of the steel. What may be designated a third stage of the action occurs at this point, with

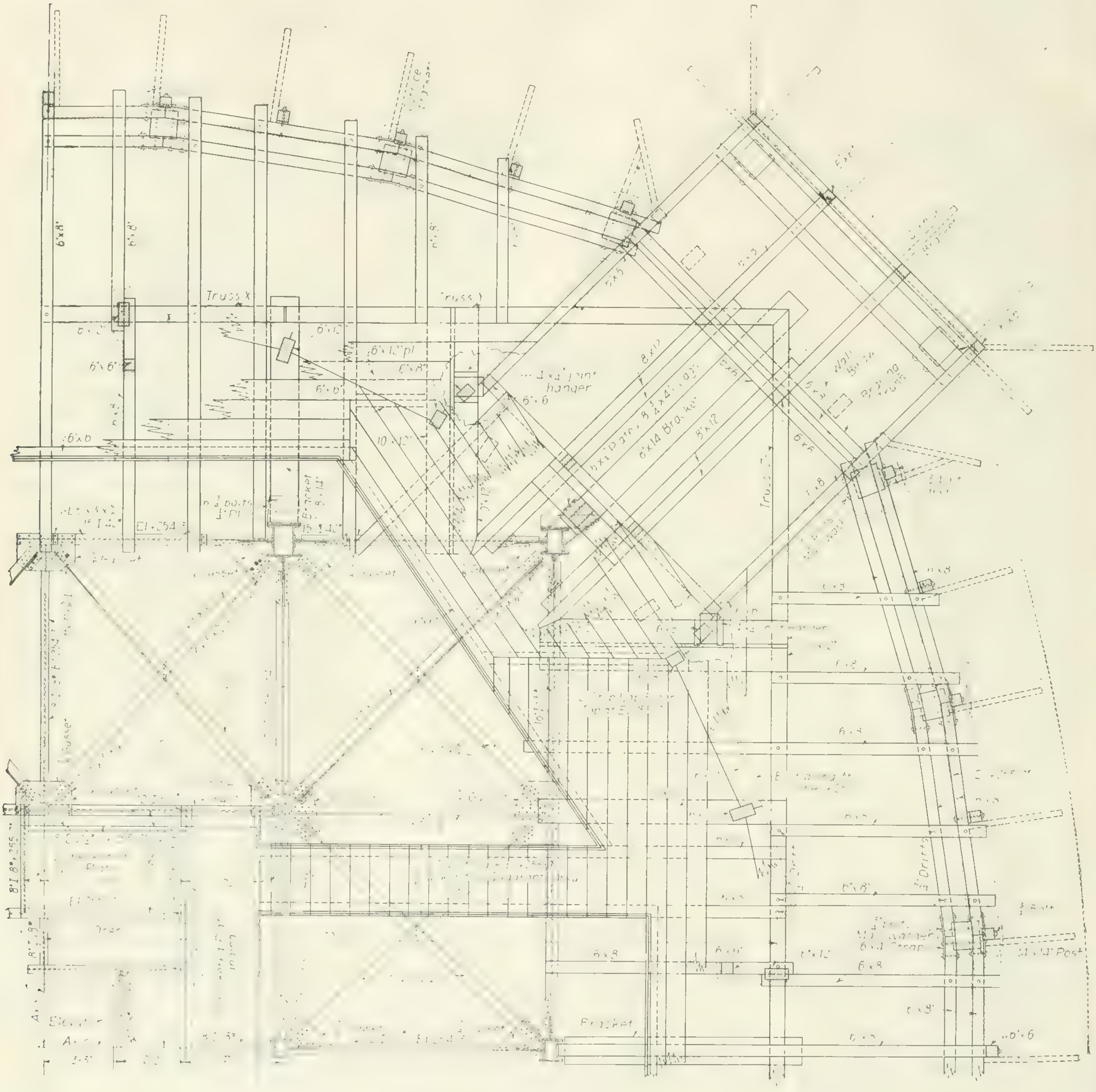


Fig. 5. Quarter Plan of Framing at Elevation 225 ft. 7 ins.—Tower of Jewels.

a second break and a flattening out of the curve, running off rapidly to failure.

Restrained Slabs.—Analysis of the curves for the restrained slabs, built in between steel beams with reinforcement securely anchored, indicates a possible distribution of stresses differing from that to be expected from ordinary beam action.

The first stage again occurs with the "first break," at a load about twice as great as in the simply supported slab and about one-fourth to one-third of the ultimate load on the slab. The steel and concrete stresses during this stage are both low. The steel assumes its load very slowly, and the compression in the concrete is also lower than would be expected. These stresses may be influenced either by suspension or by pure arch action. If there is pure suspension or catenary action the measured concrete stresses would be less than the computed ones by the amount of this pure tension, and the steel stresses would be correspondingly large. If there is arch action the steel stress would be low and the concrete compression would be distributed over a greater portion of the cross section, giving possibly a lower unit intensity at the extreme fiber than would be indicated by the ordinary theory of flexure. In the application of the ordinary theory of flexure, assumptions are made as to the relation between the concrete and steel stresses and the ultimate compressive value of concrete in flexure, about which there is little or no definite information. The flat slab held between rigid I-beam supports, with the resistance to lateral motion offered by adjoining panels, will develop considerable strength or end restraint, even without reinforcement. This is the so-called arch action referred to previously.

The second and third stages follow in general the action of the simple slab, except that the "curve breaks" for correspondingly reinforced slabs occur at absolute loads about twice as great as for the simple slab. The slab itself under load gives its first sign of failure in negative tension cracks over the haunches. Thereafter the adjoining anchor spans deflect upward and the test span downward. Numerous tension cracks then appear along the bottom of the arch, developing most rapidly under one or both of the concentrations. Ultimate failure in all cases except two occurred in tension in the steel. The percentage of steel was in all cases made purposely low, both to insure tension failure and because this type of construction in practice is generally used with a low percentage of reinforcement. It is possible that the concrete was stressed to its ultimate capacity preceding the failure in the reinforcement, but signs of crushing of the concrete were not visible to the eye until the tension break of the steel.

Conversion of Observations into Stresses.—During the first stage of action, in both types of construction, the straight line variation of stresses has been assumed. The modulus of elasticity used has been taken from the stress-strain curves, obtained from cylinders cast with concrete from the corresponding slabs. The absolute value of the modulus was taken as the average along the one-quarter to three-eighths points of the curve. It must be recognized that the modulus thus obtained is based on concrete under conditions of stress which do not represent those obtaining in the slab proper. It was noted that the modulus obtained from unreinforced slabs in flexure is considerably higher than that obtained from the cylinders.

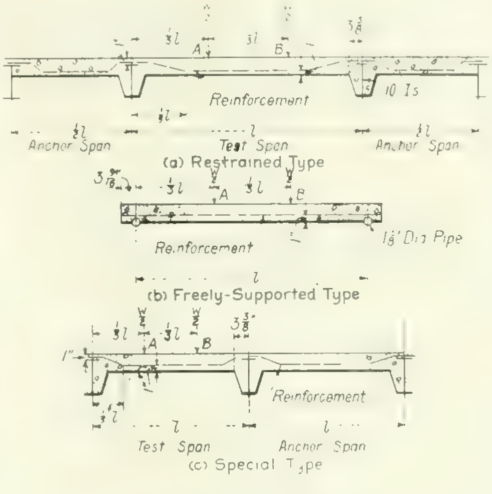


Fig. 1. Types of Reinforced Concrete Test Specimens Showing End Conditions and Manner of Applying Loads.

The neutral axis was located, and the factors were derived, on the assumption usually made in applying the common theory of flexure for the composite material of concrete and steel. The ratio *n* was based on a modulus of elasticity of 30,000,000 for steel.

Computation of Derived Bending Moment Factors.—With the stresses in concrete and steel known, in addition to the total load applied on any one span of known thickness, the corresponding bending moment factor to be applied to produce these stresses can readily be ascertained. In Table II this factor has been derived in four different ways, based on the following quantities:

(1) Measured compression at known load.

(2) Measured tension at known load.

(3) Measured compression and deflection at known load.

(4) Ratio of imposed loads on simple and restrained slabs.

It should be noted that the attempt to measure fiber deformations in the surface of the concrete is at best only in approximate operation. In the case of thin slabs, such as those with which this investigation is concerned, the depth to the neutral axis is so small that a small variation in the location of the contact points for measurement may produce a very large error. Moreover, the selection of the proper modulus of elasticity is an indeterminate feature. The method of determining safe loads and moment coefficients by the absolute supporting power of the slabs, as indicated by method (4) is not subject to such errors, and presumably leads to approximately accurate results.

EMPIRICAL FORMULAS FOR SAFE LOADS.

In the ordinary practice of cinder concrete floor construction between steel beams, as applied in New York City, the safe load to be supported have been determined by various load tests. During the past two years it has been suggested, by a joint committee of architects and engineers, that the results of the more satisfactory of these tests be combined in a table from which the safe load for varying conditions of span and reinforcement can readily be obtained. Such a table was prepared and has been embodied in two of the drafts of a proposed code for New York City.

A study of the results of this investigation would indicate that this procedure is rather drastic, and that the working loads thus obtained are excessive in some cases and discriminating in others. An attempt was there-

TABLE II. DATA SHOWING DETERMINATION OF BENDING MOMENT FACTORS

Span and end condition.	Reinforcement: Nominal area, in sq. ins.	Reinforcement: Effective area, in sq. ins.	Load, in lbs.: W	Load, in lbs.: W'	Equivalent uniform load, $\frac{4}{3}$W + W', in lbs.	Analysis of slab at deformation within first stage: Measured stress, in lbs. per sq. in.: Steel	Measured stress: Concrete.	Computed stress: Common theory: Steel	Computed stress: Common theory: Concrete.	Computed stress: Deflection: Steel.	Deflection, in inches: Measured.	Deflection, in inches: Computed.	Derived bending moment coefficient. Method (1)	Method (2)	Method (3)	Method (4)
C—7-ft., No. 1............	0.202	0.173	[illegible]	181	3,313	3,000	117	35,500	570	3,690	,045	0.040	$\frac{1}{78}$	$\frac{1}{190}$	$\frac{1}{155}$	$\frac{1}{21}$
C—7-ft., No. 2............	0.202	0.173	2,400	473	3,673	9,000	520	41,000	675	.....	0.09	0.17	$\frac{1}{21}$	$\frac{1}{[illegible]}$		$\frac{1}{21}$
C—7-ft., No. 3............	0.202	0.173	2,200	481	3,414	12,000	138	36,000	580	6,720	0.13	0.17	$\frac{1}{[illegible]}$	$\frac{1}{49}$	$\frac{1}{88}$	$\frac{1}{21}$
7-ft., No. 1............	0.202	0.173	880	478	1,770	7,500	[illegible]	35,900	413	927	0.10	0.15	$\frac{1}{[illegible]}$	$\frac{1}{41}$	$\frac{1}{33}$	$\frac{1}{8}$
7-ft., No. 2............	0.202	0.173	1,268	525	2,215	[illegible]	772	19,200	800	1,935	0.13	0.21	$\frac{1}{[illegible]}$	$\frac{1}{[illegible]}$	$\frac{1}{17}$	$\frac{1}{8}$
7-ft., No. 3............	0.202	0.173	1,056	501	1,910	5,000	[illegible]	41,250	666	.....	0.04	0.13	$\frac{1}{[illegible]}$	$\frac{1}{62}$		$\frac{1}{8}$
C—6-ft., No. 1............	0.187	0.173	4,300	386	6,126	14,050	175	60,500	1,134	24,060	0.24	0.17	$\frac{1}{[illegible]}$	$\frac{1}{[illegible]}$	$\frac{1}{41}$	$\frac{1}{20}$
C—6-ft., No. 2............	0.187	0.173	4,800	393	6,793	8,325	660	65,800	1,205	16,050	0.21	0.17	$\frac{1}{[illegible]}$	$\frac{1}{130}$	$\frac{1}{60}$	$\frac{1}{20}$
C—6-ft., No. 3............	0.187	0.173	4,800	423	6,823	1,200	590	59,800	988	.....	0.07	0.11	$\frac{1}{27}$	$\frac{1}{200}$		$\frac{1}{20}$
6-ft., No. 1............	0.187	0.173	1,375	400	2,235	4,010	240	42,700	759	.....	0.01	0.06	$\frac{1}{26}$	$\frac{1}{88}$		$\frac{1}{8}$
6-ft., No. 2............	0.187	0.173	1,585	436	2,561	9,500	476	43,300	695	.....	0.04	0.11	$\frac{1}{12}$	$\frac{1}{37}$		$\frac{1}{8}$
6-ft., No. 3............	0.187	0.173	1,855	401	2,876	5,500	280	54,300	975	12,000	0.11	0.01	$\frac{1}{28}$	$\frac{1}{79}$	$\frac{1}{38}$	$\frac{1}{8}$

fore made to develop empirical formulas which would check the theoretical design of floors of this type when based on the coefficients developed by this investigation.

From a study of the tests made in this investigation, and from data on the results of tests from records of the Bureau of Buildings (made under practically identical conditions), the following empirical formula was developed for *restrained slabs:*

$$w = 3{,}500{,}000 \frac{da}{l} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where w = total safe load in pounds per square foot,
d = depth of steel from extreme fiber, in inches,
a = area of steel, in square inches,
l = length of span, in inches.

In the case of *plain bars hooked over the steel beams, without lateral reinforcement,* a study of all available data indicates that the following expression meets the conditions of this type of reinforcement:

$$w = 2{,}500{,}000 \frac{da}{l^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Based on the results of this investigation the following empirical formula was developed for *simple slabs* unrestrained by steel beams and without anchored reinforcement:

$$w = 550{,}000 \frac{d^2a}{l^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The tests indicate that safe bond stress of about 40 lbs. per square inch should not be exceeded for unanchored or loose reinforcement.

The safe loads as determined by the tests and those obtained from equations (1) and (3) are given in Table III. From a study of the typical cinder concrete gathered from about the city, and from that used in the test slabs, the following working unit stresses were selected as being best suited for the basis of design:

Concrete, extreme fiber stress, 300 lbs. per square inch.

Steel, tensile stress, 16,000 lbs. per square inch.

With these factors as a basis of computation, using the value of n determined by tests on the slab concrete given in columns 9 and 10 of Table III, and a ratio of 30 in columns 5, 6, 7 and 8, the corresponding factor for implied bending moments was derived, as shown in Table III. The factor in the bending moment formula, $\frac{1}{C}$ Wl, for simple slabs, was found to be approximately $\frac{1}{8}$ and for restrained slabs approximately $\frac{1}{20}$ (see data in columns 9 and 10, Table III.

No special care was taken in preparing these tests, nor was the material specially selected. It is to be presumed, therefore, that the results are indicative of what may be expected from cinder concrete placed with ordinary care and under proper supervision. With the foregoing loads considered as safe, the average factor of safety on the ultimate load basis is approximately five.

TABLE III.—SAFE LOADS, BASED ON TESTS AND EMPIRICAL FORMULAS.

Restrained type, $w = 3{,}500{,}000 \frac{da}{l^2}$. Simple type, $w = 550{,}000 \frac{d^2a}{l^2}$.

Type. (1)	Safe load. One-eighth of test load plus dead load. (2)	Safe load. Empirical formula. (3)	Ratio of formula load to ultimate load. (4)	Coefficient, $\frac{1}{C}$, based on. Ratio, n = 300 and f_1 = 300 and— Load column (2). Concrete. (5)	Load column (2). Steel. (6)	Load column (3). Concrete. (7)	Load column (3). Steel. (8)	Ration, n, determined by test and load column (3). Concrete. (9)	Steel. (10)
C—7 ft. 1 in.	210	137	6.4	$\frac{1}{23.6}$	$\frac{1}{27.4}$	$\frac{1}{23.4}$	$\frac{1}{27.3}$	$\frac{1}{16.8}$	$\frac{1}{19.5}$
C—6 ft. 0 in., 1914	185	182	6.8	$\frac{1}{23.4}$	$\frac{1}{27.1}$	$\frac{1}{23.1}$	$\frac{1}{26.7}$	$\frac{1}{18.2}$	$\frac{1}{19.2}$
C—6 ft., 0 in., 1913	216	182	8.0	$\frac{1}{26.4}$	$\frac{1}{31.4}$	$\frac{1}{22}$	$\frac{1}{26.4}$	$\frac{1}{18.2}$	$\frac{1}{19.2}$
C—8 ft. 0 in., 1913	97	107	4.9	$\frac{1}{22.2}$	$\frac{1}{27.7}$	$\frac{1}{24.3}$	$\frac{1}{28.4}$	$\frac{1}{21}$	$\frac{1}{20}$
Official, 7 ft. 6 in.	274	225	7.7	$\frac{1}{17.5}$	$\frac{1}{28.0}$	$\frac{1}{15.1}$	$\frac{1}{23.0}$	$\frac{1}{11.2}$	$\frac{1}{19.8}$
Official, 8 ft. 0 in.	172	214	7.3	$\frac{1}{32.0}$	$\frac{1}{27.5}$	$\frac{1}{39.8}$	$\frac{1}{31.6}$	$\frac{1}{28}$	$\frac{1}{21.2}$
Triangular, 7 ft. 1 in., 1914	76	65	6	$\frac{1}{10.9}$	$\frac{1}{11.8}$	$\frac{1}{9.8}$	$\frac{1}{11.7}$	$\frac{1}{7.2}$	$\frac{1}{8.6}$
Triangular, 6 ft. 0 in., 1914	92	90	5.7	$\frac{1}{11.1}$	$\frac{1}{13.3}$	$\frac{1}{10.9}$	$\frac{1}{17.1}$	$\frac{1}{8.2}$	$\frac{1}{9.1}$
Triangular, 4 in., 8 ft. 0 in., 1913	66	51	[illegible]	[illegible]	$\frac{1}{17.3}$	$\frac{1}{11.6}$	$\frac{1}{13.6}$	$\frac{1}{9.9}$	$\frac{1}{9.4}$
Triangular, 5 in., 8 ft. 0 in., 1913	85	90	4.4	$\frac{1}{12.0}$	$\frac{1}{16.3}$	$\frac{1}{12.6}$	$\frac{1}{17.3}$	$\frac{1}{11.3}$	$\frac{1}{12.5}$
Welded, 6 ft. 0 in., 1913	**88**	**124**	**3.7**	$\frac{1}{9.8}$	$\frac{1}{9.6}$	$\frac{1}{13.8}$	$\frac{1}{13.6}$	$\frac{1}{12.5}$	$\frac{1}{9}$
Exp., 6 ft. 0 in., 1913	68	97	4.5	$\frac{1}{9.7}$	$\frac{1}{14.7}$	$\frac{1}{13.9}$	$\frac{1}{20.3}$	$\frac{1}{12.5}$	$\frac{1}{12.9}$
Triangular, 6 ft. 0 in., 1913	90	90	[illegible]	[illegible]	$\frac{1}{13.5}$	$\frac{1}{11.3}$	$\frac{1}{17.5}$	$\frac{1}{8.7}$	$\frac{1}{9.1}$
4 in., 5 ft. 0 in., 1914	160	129	4	[illegible]	$\frac{1}{9.5}$	$\frac{1}{10.5}$	$\frac{1}{12.2}$	$\frac{1}{7.4}$	$\frac{1}{8.9}$
2 in., 5 ft. 0 in., 1914	76	77	4.7	$\frac{1}{9.1}$	$\frac{1}{8.5}$	$\frac{1}{9.1}$	$\frac{1}{8.5}$	$\frac{1}{6.7}$	$\frac{1}{6.1}$
Exp., 5 ft. 0 in., 1914	88	98	4.6	$\frac{1}{7.7}$	$\frac{1}{10.6}$	$\frac{1}{7.4}$	$\frac{1}{11.7}$	$\frac{1}{5.4}$	$\frac{1}{7.7}$
Tw., 5 ft. 0 in., 1914	160	132	4.2	$\frac{1}{7.7}$	$\frac{1}{9.2}$	$\frac{1}{10.3}$	$\frac{1}{12.2}$	$\frac{1}{8.7}$	$\frac{1}{7.5}$
Sq., 5 ft. 0 in., 1914	[illegible]	150	3.9	[illegible]	$\frac{1}{8.7}$	$\frac{1}{11.3}$	$\frac{1}{12.4}$	$\frac{1}{8.4}$	$\frac{1}{8.7}$
Rd., 5 ft. 0 in., 1914	70	115	7	[illegible]	$\frac{1}{8.2}$	$\frac{1}{9.8}$	$\frac{1}{13.4}$	$\frac{1}{7.1}$	$\frac{1}{8.8}$

Failure in bond

CONCLUSIONS AND RECOMMENDATIONS.

Characterictics of Typical New York Cinder Concrete.—(1) The variableness of New York cinder concrete is marked. Other conditions being identical, a difference of 150 per cent in compressive strength may be expected to be shown by two series of specimens, due alone to the quality of the cinders.

(2) Hand mixed cinder concrete handled in the ordinary manner is inferior to the machine mixed product.

(3) The average weight of reinforced cinder concrete, based on actual investigation, was found to be 108 lbs. per cubic foot. It is recommended that this be the minimum value assumed in design.

(4) The crushing strength of standard cylinders of good cinder concrete as used in New York is between 800 and 1,000 lbs. per square inch at 28 days. Poor material will give results as low as 400 lbs. per square inch.

(5) The crushing strength increases for a period of about 6 months, after which it remains practically constant for a period of a year.

(6) The modulus of elasticity, E, under working loads, determined from standard cylinders, is about 1,200,000 lbs. per square inch for average.

Proportions and Mixing.—(1) The assumption that screened cinders will produce better concrete was investigated, with the result that 1:2:5 concrete, made with cinders from which all material less than ¼ in. in diameter had been removed, showed a decrease in compressive strength of more than 25 per cent.

(2) Cinder concrete should be mechanically mixed, for not less than 2 minutes, not leaner than 1:2:5, giving a minimum compressive strength with standard cylinders at 28 days of 800 lbs. per square inch, and should be in a wet to viscous consistency when cast. It should be made from hard, well-burned, vitreous clinkers, free from fine, powdery ash. It has been found from actual test that unburned coal existing to the extent of from 15 to 25 per cent is not necessarily detrimental to the strength of fire-resisting value of such concrete.

(3) Large, irregular clinkers, often 2, 3, or 4 ins. or even larger in diameter, should be thoroughly broken up, by shovels or otherwise, before mixing, as they are sources of weakness in the finished product if allowed to remain intact. This is due, not only to the inherent weakness of the aggregate itself, but also to the difficulty with which the mortar may reach all parts of its porous surface—a condition necessary for maximum density.

Future Regulation.—(1) The safe load of cinder concrete floor fillings should be determined by any one of the three following methods:

(a) Design—Common Theory of Flexure.—For slabs restrained between steel beams, with reinforcement thoroughly anchored, such as continuous mesh with proper cross wires:

Bending moment coefficient, $\frac{1}{20}$.

Extreme fiber stress in concrete, pounds per square inch, 300.

Steel stress, pounds per square inch, 16,000.

Ratio, n, 30.

For slabs simply supported with non-continuous reinforcement:

Bending moment coefficient, $\frac{1}{8}$.

Extreme fiber stress, pounds per square inch, 300.

Steel stress, pounds per square inch, 16,000.

Ratio, n, 30.

Bond stress, pounds per square inch, 40.

(Note that the safe bond stress of 40 lbs. per square inch should be applied to loose bar reinforcement. In the case of mesh the cross wires give sufficient mechanical bond.)

(b) Design—Empirical Formula.—The following formula is to be applied to restrained slabs containing continuous mesh with proper cross wires:

$$w = 3{,}500{,}000 \frac{da}{l^2}.$$

For restrained slabs in which the longitudinal bars are hooked over the beams,

$$w = 2{,}500{,}000 \frac{da}{l^2}.$$

For simple slabs, use the formula,

$$w = 550{,}000 \frac{da}{l^2}.$$

In the application of the formula for simple slabs, investigation should be made of the bond stress when loose bars are used.

In these formulas:

w = total safe load, in pounds per square foot.

d = depth of steel, in inches.

a = area of longitudinal steel per foot of width of slab, in square inches.

l = length of span, in inches.

In the application of these formulas the span should be limited to 8 ft., and the minimum thickness to one-eighteenth of the span. It should also be noted that the empirical formulas are based on tests of slabs reinforced with steel varying from ¼ to ⅜ per cent. For the stresses assumed in the analysis the critical percentage of steel is about 0.32 per cent.

For end span conditions the safe load, as determined by the given formulas, should be reduced to three-fifths of the foregoing recommended values, or the strength of the construction should be increased proportionately.

(*c*) Load Test.—The load test should be conducted on a section of floor system not less than 4 ft. wide and with a span between steel beams equal to the span for which approval is desired. This specimen should be constructed as in actual practice, with material of the same quality as that incorporated in the specimen previously subjected to the standard fire, load, and water tests, and which is thereafter to be used in the system. In all cases the specimen should consist of a test span of normal dimensions and two anchor spans, each of one-half the length of the test span. These anchors should conform to the construction of the test bay in every detail except in length.

In the case of reinforcement manufactured in sheets, which is to be put in with laps between sheets, the lap must come within the middle third of the test span.

The specimen should be tested either by stacking pig iron, bags of sand, or any other available material of sufficient specific gravity, on a platform supported on timbers placed so that the test load will be applied at two points, or loading areas, at the one-third points of the test span. Each loading area should consist of a zone of the slab surface not exceeding 1 ft. in width and of a length conforming to the width of the test slab. A loose sand bed may be provided, not more than 1 in. thick, at each loading area or zone; or the specimen should be loaded similarly in a testing machine, by a calibrated hydraulic jack or by other mechanical means. The construction should be tested at the age of 1 month.

It is recommended that approval be granted for a live load per square foot of not more than one-eighth of the equivalent uniform imposed load necessary to cause the failure of the slab. A factor of safety of 8, on the live load basis, is equivalent to approximately 6 on the total load.

DRAINAGE AND IRRIGATION

Concrete Headgate, South San Joaquin and Oakdale Irrigation District in California.

(Staff Abstract.)

The headgate which diverts and controls the flow of irrigation water from the stream into the main canal is frequently a structure of some complexity. This is particularly true where the headgate must meet the exactions imposed by sudden floods and by waters carrying much sand and silt. In such case the headgate has not only to serve as a control gate but also as a screen for retaining sand and silt and as a barrier to keep flood waters from the canal. The accompanying drawing shows a headgate designed to meet all these requirements.

The headgate illustrated is designed to take 1,500 sec. ft. from the Stanislaus River. This stream has a dry weather flow of about 100 sec. ft., but in floods of recent record a flow of 62,000 sec. ft. was registered. In flood the stream is a heavy silt carrier. Of the 1,500 sec. ft. taken in by the headgate, 1,370 ft. will be delivered to the canal, the surplus being wasted over the spillway or through the sand and waste gate back into the canyon below. As indicated by the drawing the headgate flanks one end of a diversion dam. This dam consists of two arches, with an intervening buttress, having a total crest length of 466 ft., and a maximum height of 78 ft. The headgate proper only is illustrated, and it is built of plain and reinforced concrete on rock foundation.

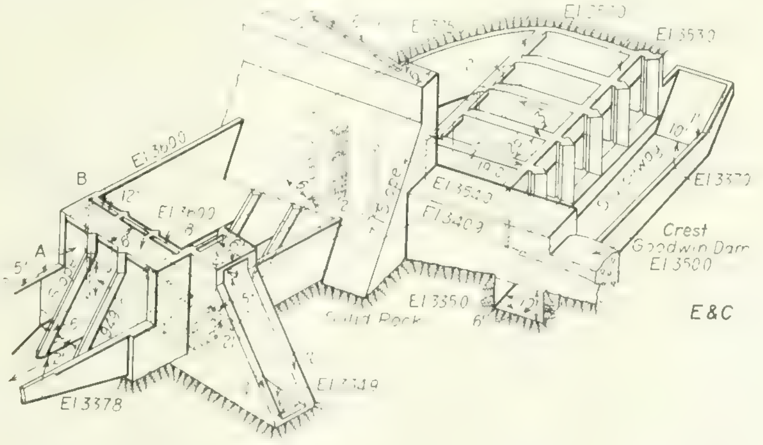


Fig. 1. Showing Headgate for Irrigation Stanislaus River, California.

There are four principal elements in the headworks: First is the head wall, with five openings designed to be closed with stop logs in case of accident to the gates below; water covering the diversion dam more than 3 ft. in depth tops this head wall. Second is a gravity dam placed on a tangent to the curve of the diversion dam, diverging about 16° from a right angle with the center line of the canal. There are three gate openings at right angles to the line of the canal, each 6x9 ft., regulated by massive cast-iron gates raised by screw stems through geared hoists located on top of the gravity dam. The top of the gravity dam is 25 ft. above the crest of the diversion dam and careful estimates show that maximum flood crests will top the diversion dam about 23 ft. Third is an automatic spillway about 30 ft. long just below the gravity dam at an elevation of 1½ ft. below the crest of the diversion dam, and a sand and waste gate just downstream from the spillway. Fourth are three gates, each 6 ft. wide by 9½ ft. high, set in suitable piers at the head of the joint canal, which shapes up after a transition section about 20 ft. long into a concrete-lined channel 10.33 ft. in total depth, 13.5 ft. wide on the bottom, with side slopes of ½ horizontal to 1 vertical. The designed ultimate capacity of the canal will not be reached until some time in the future when the lower bank is raised and lined about 2 ft. higher.

It is expected that the larger portion of silt will be prevented from entering the canal by the sluice-way trough in front of the river openings. The water will be further cleared of sand by the covered ducts below the gravity dam. The floor across the channel in a line 16½ ft. above the lower gate piers slants down 2½ ft. in 4 ft., while curved ribs carrying reinforced-concrete slab covers four ducts for carrying the sand out through the waste gate into the canyon.

The underlying ideas in these headworks are as follows: The velocity of the water through the structure is raised from 5 to 9 ft. per second, with as little commotion as possible, by lowering the floor and curving the outside wall and lower ends of the piers so as to interfere no more than is necessary with parallel filaments of water. The wall is curved on the formula of a cubic parabola. The canal is protected from the entry of flood water by the high gravity section at the dam. The automatic spillway, waste gate, and sand sluice permit the removal of excess water and such sand as passes the upper sluice way. The lower gates accurately determine the quantity of water finally entering the canal.

In all portions of the headworks, depths, widths, and shapes were adjusted as carefully as practicable to prevent losses of head. Assuming the water level in the river to be the crest of the dam at elevation 350 ft., 1,500 sec. ft. of water enters at a velocity of 5 ft. per second, the bottom of the head-wall openings being at elevation 341. Five feet above the lower gates this elevation has lowered 1.42 ft. at the river side and one-half foot less on the bank side. The floor now falls rapidly to a uniform elevation of 338.59 ft. The velocity has increased to 9 ft. per second. The floor from the upper gates falls 0.71 ft. in a distance of 35 ft.

The upper sand sluiceway designed to catch sand, boulders, etc., is at present regulated by stop logs, but it is the plan eventually to install an ordinary vertical sluice gate.

The contract price for concrete work in this heading runs from $14 to $15 per cubic yard on the basis of payment in bonds worth 80 cts., or less than $12 per cubic yard on a cash basis. The total cost will be about $40,000 in bonds. The structure was completed in November, 1912. The floors are made of a 1:3:6 mixture of cement, sand, and gravel, while most of the balance of the structure is made a 1:2½:5 mixture.

The illustration has been redrawn and the description extracted from a bulletin by F. C. Scobey, irrigation engineer, Bureau of Experimental Stations, U. S. Department of Agriculture.

Cost of Topography for Irrigation Work in British Columbia.

(Staff Abstract.)

The methods and cost of making a topographical survey for an important irrigation works in the Western United States were given in our issue of Feb. 25, 1915. The following data add to the data previously given on a class of work for which published costs are not plentiful. The survey embraced an area of about 4,000 acres belonging to the South Kelowna Land Co., F. W. Groves, chief engineer. The tract is situated on benchlands overlooking Okanagan Lake in British Columbia. Okanagan Lake is 1,130 ft. above sea level and the lands of the company extend from the lake shore eastward about six miles, the maximum elevation being 2,100 ft., a range of 970 ft. In a general way this elevation is made up of a series of irregular benches connected by steep slopes, but in detail the ground is very irregular. The topography is the result of glaciation with the usual peculiarities of such action, as U-shaped valleys, cirques, basins or sinks, etc. The surface was covered with heavy timber averaging about 4,000 to 5,000 ft. board measure to the acre and a moderate growth of scrub pine, always most dense just at the height of an instrument and all lines had to be brushed out before sights could be obtained. The nature of the topography made it necessary to take a great deal of detail, both in stadia observations and in sketching, if the resulting maps were to be of practical use in laying out the distribution of water and the roads.

ORGANIZATION OF THE SURVEY.

The writer was given general charge of the survey and was furnished with a staff consisting of three transitmen, each with a crew of three or four men, also, a levelman with rodman, and two draftsmen. A permanent camp was built near the center of the tract, which is about six miles from the town of Kelowna.

FIELD WORK.

"Base Lines" were first laid down with transit and steel tape, hubs being set not to exceed 400 ft. apart. These lines were run around each quarter-section from 50 to 300 or 400 ft. inside the boundaries. The main idea was to place the hubs on commanding points where they could be used as stadia stations, but to keep so close to the boundaries that no intermediate stations would be required between the base and boundary lines. Where the topography of the adjoining quarter-section also was to be taken, the base line was kept close to the boundary line, to serve for both quarters.

The standard of accuracy decided upon was a closing error of not more than 1.5 ft. in a quarter-section and not more than 2.5 ft. in the whole section. Generally this degree of accuracy was reached without trouble but a few of the lines had to be checked over a second or third time. When the hubs had been set, a line of levels was run over them and they were then ready to be used as stadia stations for the topographic work.

The interior stations were established wherever required by carrying stadia traverses and elevations forward as the work advanced. In a few instances measured traverses were carried inside or across the interior square but it was soon found that the additional time spent on them caused an unnecessary expense. In running stadia traverses across the 2,000 to 2,500 ft. between opposite base lines, the transit men were expected to check out within 0.5 ft. in elevation and 2.5 ft. in distance. The elevation usually checked well within 0.5 ft. but the distance errors were generally up to or a little over the limit. Since the maps were drawn to a scale of 200 ft. to 1 in., an error of even 3 ft. in say 2,000 ft. was scarcely noticeable.

The stadia parties were supposed to consist of a transitman, rodman, recorder and axeman, but the parties were often short handed. A start would be made on a base line hub near one corner; a sight and stadia reading would be taken to the next hub forward, with the vernier set to read the bearing of the line of sight, and the vertical angle would be read. This gave a check on the condition of the stadia wires by comparing the measured distance; and a check against a wrong elevation having been recorded for either station.

While this was being done, the axeman would be cutting lanes through the underbrush and the recorder would sketch on the left page of the topography book the shape of contour lines close by the station and would show the position of the station on the sketch. Lines would be cut radially from the station, working around in clockwise direction, taking a stadia shot at each change of slope of the ground.

At right angles to the base line the stadia shots would be taken as far out as feasible, say up to 400 ft., gradually shortening the distance until at the base line the shots would be taken but half way to the next station, say 100 to 200 ft. As each shot was taken the recorder would dot it on the sketch with its number and roughly sketch in the shape of the contours without special effort to get them at the proper interval apart. Usually the transitman would touch up the sketch after completing the observations at a station, walking out the lines to get the details. Very often it would be necessary to establish a substation to map a ravine or draw or other feature.

In planning the stadia work the aim was always to work along the base line in its direction of least slope, and to have the stadia lines running as nearly as possible up or down the slope. When the farther end of the base line was reached the notes would cover a strip roughly 500 ft. wide by one-half mile long. A stadia traverse would then be run in the reverse direction, roughly parallel with this base line and about 500 ft. from it. If the ground was favorable this stadia traverse was run straight through, but if the ground was rough, as was usually the case, the line was zigzaged as much as necessary to get the stadia stations on commanding points. These traverses were always run through and connected to the cross base at the opposite side, and the closing angle was read before any stadia shots were taken from the traverses, to guard against a wrong orientation of the transit when taking stadia observations. The recorder carried a stadia rod and acted as back flag on traverse lines and the stadia distances were read both forward and backward.

When the stadia work was done from stations on a traverse, the lines were expected to be carried out to overlap the shots of the previous belt, as a continual check; any discrepancy in the same topography being instantly apparent when contours were plotted. Owing to the dense underbrush the rodmen were not always able to tell just how far to go and in consequence they generally overlapped too much, probably adding in this way to the cost of the work. From 225 to 250 shots per day per crew of four men was a fair average for all the crews.

REDUCTION OF NOTES.

The stadia elevations and horizontal distances on stadia traverses were reduced on a "Webb Stadia Slide Rule." "Topog" shots were reduced for elevation on an ordinary 10-in. slide rule, if the vertical angle was less than 6°, by multiplying sine of angle by distance; if over 6°, by multiplying double the sine by one-half the distance, or on the Webb rule.

The horizontal distances for less than 8° vertical angle were not computed unless the distance was 250 ft. or more. Horizontal reductions were then made by the draftsman as required, on the Webb Stadia Slide Rule. We tried using stadia charts but the staff objected to them so strenuously that we did not enforce their use. In fact the writer shares the prejudice against them, as he finds their use very hard on the eyes and much slower than slide rules.

The transitmen, with recorders, worked up their own notes, which were then checked by another calculator. The levelman was able to spend about two-thirds of his time on this work. The transitmen also worked up traverse tables of the base line, entered them in full in a large record book and computed the total latitude and departure from an initial point. In the same book the levelman entered the elevation of each hub opposite the station number, in a column provided for that purpose. This record later served as a basis from which to lay out roads and streets and check the subdivision.

PLATTING.

The maps were drawn to a scale of 200 ft. to 1 in. with contours at 5-ft. intervals. Heavy drawing paper was used, each section forming one sheet, which made a convenient size for handling and storing flat. The platting of boundaries and base lines was done by total latitudes and departures taken from the record book. The stadia traverses were not entered in the record book but the latitudes and departures were worked out approximately on a 20-in. slide rule by the transitman to check his field work and the draftsman platted the stadia traverses from these approximate traverse tables.

The stadia shots were platted by drawing a protractor 6 ins. in diameter on a sheet of vellum cloth, about 18 ins. wide by 5 ft. long, then cutting out the center of the protractor circle. The cloth was long enough to permit thumb tacks to be placed beyond the drawing. It was centered and pinned down over the stadia station to be platted where it remained until the platting of that station had been completed and the contours drawn in.

Our only innovation was a scheme for locating the contours. A soft pine board about 10 ins. square was covered with a piece of cross-section paper ruled 20 lines to the inch. At a scale of 200 ft. to 1 in., each horizontal space represented 10 ft., and each vertical space was called 1 ft.; each fifth foot was ruled slightly heavier. At the proper elevation of the stadia station a steel pin was stuck in board to represent the elevation of the station, then pins corresponding to a line of shots were stuck at the proper distances and elevations shown by the stadia notes. A fine thread drawn over these pins gave a profile of the surface and showed where it crossed each contour level. Then with a pair of needle-point dividers the distance from the station to each contour was taken and set off on the map in its proper direction by laying a straight edge from the station to the proper bearing on the protractor described above.

In many cases the position of the contours between points on different lines had to be taken, in which case the position of the two points were first platted on the map and joined by a light pencil line; the dividers were then set to the distance between them and the distance transferred to the pin board. Two pins set at the respective elevations of the shots and joined by the thread instantly gave the position of the contours between. In order that the draftsman might know what points to use in this way the recorder would indicate regular slopes from point to point by drawing a dotted line between them, doing this in the field as the shots were taken.

We had considerable difficulty in obtaining proper pins but finally found that the sharp steel pins with round glass heads that can be bought at any dry goods store answered the purpose well enough. The draftsman must allow for one-half the diameter of the pin in setting off the elevation, going either above or below as the case may be.

RESULTS OBTAINED.

In order to get the platting started early, the four field parties each took at the start a quarter-section of the same section. After two sections had been done in this manner each party was given a half-section, because the notes came into the office faster than the draftsmen could plat them, other work taking a large part of their time. Owing to inclement weather, when field work could not be done, the field men were able to work up their notes about as fast as they were taken. The field work started on the 20th of August, 1910, and completed January 10, 1911. The mapping was started about Sept. 20 and completed in May, 1911, but it did not occupy both draftsmen all of that time.

As fast as the maps were completed, the roads, lateral ditches and pipe lines were projected on them, followed by a tentative subdivision of the area mapped into 10 to 20-acre lots. When the snow had sufficiently gone in the spring of 1911, work was started laying out the roads from projections. The maps stood the test very well. In only a very few instances was it necessary to change the alignment, where rock out crops or caving banks were encountered which had not been noted in the topographical notes. In a word, by every test we have had occasion to apply, the maps have proven correct, except in a single instance where a small gully was overlooked entirely.

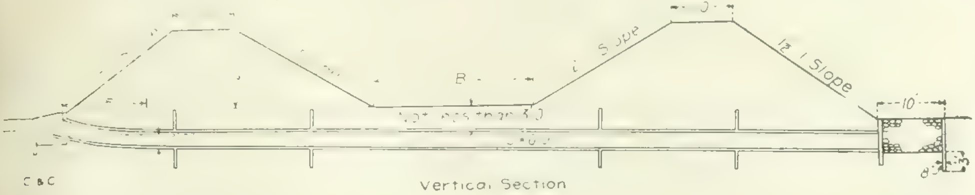


Fig. 1. Lateral Drainage Culvert, St. Mary's Canal, Milk River Project, U. S. Reclamation Service.

COST OF THE WORK.

The following scale of wages was paid, the company furnishing board in addition. The average cost to the company for board was $23.00 per month per man, and in the following costs board is included:

Transitman, av. monthly wages	$125.00 and board ($23.00)
Levelman	80.00 and board ($23.00)
Draftsman	75.00 and board ($23.00)
Rodman and axman	50.00 and board ($23.00)
Recorders	45.00 and board ($23.00)

Cost per acre.			No. stadia shots.		Cost per shot.		
Field.	Dftg.	Total.	Per acre.	Total.	Field.	Dftg.	Total.
$1.085	$0.431	$1.516	$ 8.28	$32,093	$0.131	$0.052	$0.183
			LOWEST COST.				
0.664	0.299	0.96	7.34	4,701	0.090	0.036	0.126
			HIGHEST COST.				
1.850	.607	2.458	11.17	1,285	0.166	0.054	0.22

The cooks wages are included in cost of board. The total cost for 3,875 acres actually contoured was $5,874.78.

All the transitmen had had some experience in topography before coming on this job but it did not appear of much benefit under our complicated conditions. Their average efficiency on the first blocks resulted in a cost of $1.73 per acre with an average of 14 shots per acre for field work, and on the last blocks 93 cts. per acre, with an average of 8 shots, the drop in cost being very regular as they became efficient. The principal fault of inexperience was to take hundreds of unnecessary shots. The same conditions applied to the mapping, the cost per acre of the first two maps being 64 cts. per acre and of the last two, 37 cts. per acre.

In order to determine whether a large or small crew is more economical the writer took one of the regular crews and made the stadia survey of one block, the transitman acting as recorder and the recorder handling an extra rod or axe as circumstances directed. The cost of field work so done was 67½ cts. per acre, with an average of five shots per acre. Then he did a second and apparently similar block with only one man, who acted as both rodman and axeman. While the rodman was cutting brush the writer would sketch, reducing sufficient notes in the field so that the contours could be spotted pretty exactly on the sketches. The cost by this method was 66⅓ cts. per acre, with 7.34 shots per acre. These sketches were of much greater assistance in platting than the others. There appeared to be very little difference in cost between the two systems, but much faster time could be made with the larger crews. Except while engaged on the topography of the above mentioned two blocks the writer's time was spent alternately with the different crews and in the office. His salary was apportioned as a percentage on the other expense. In all the above costs the reduction of notes is included in cost of field work.

To sum up: The writer ventures the opinion that on ground badly broken by glacial action and densely overgrown with scrub pine $1 per acre is a fair estimate of the cost of 5-ft. contour maps complete, provided experienced men can be had. With instrument men otherwise proficient but inexperienced in this work the cost may easily run up to twice that figure.

ACKNOWLEDGEMENT.

The above article is slightly condensed from a paper presented to the Pacific Northwest Society of Engineers by B. P. Little, engineer in charge of the survey.

Standard Lateral Drainage Culvert for St. Mary's Canal, Milk River Project, U. S. Reclamation Service.

(Staff Article.)

Irrigation canal, especially canal along a slope, requires full protection from water draining from the up-hill side. This warning does not refer to permanent stream crossings of the canal but to the minor ravines and washes ordinarily dry but forming channels for considerable flow during prolonged rain. When closed off by the crossing canal embankment pounding occurs unless means are provided for drainage over, under or into the canal. The proper means varies with conditions, but where the volume of flow is considerable a culvert under the canal is the means most frequently adopted and the drawings of Fig. 1 show the standard lateral drainage culvert employed in the St. Mary's Canal of the Milk River Project, U. S. Reclamation Service.

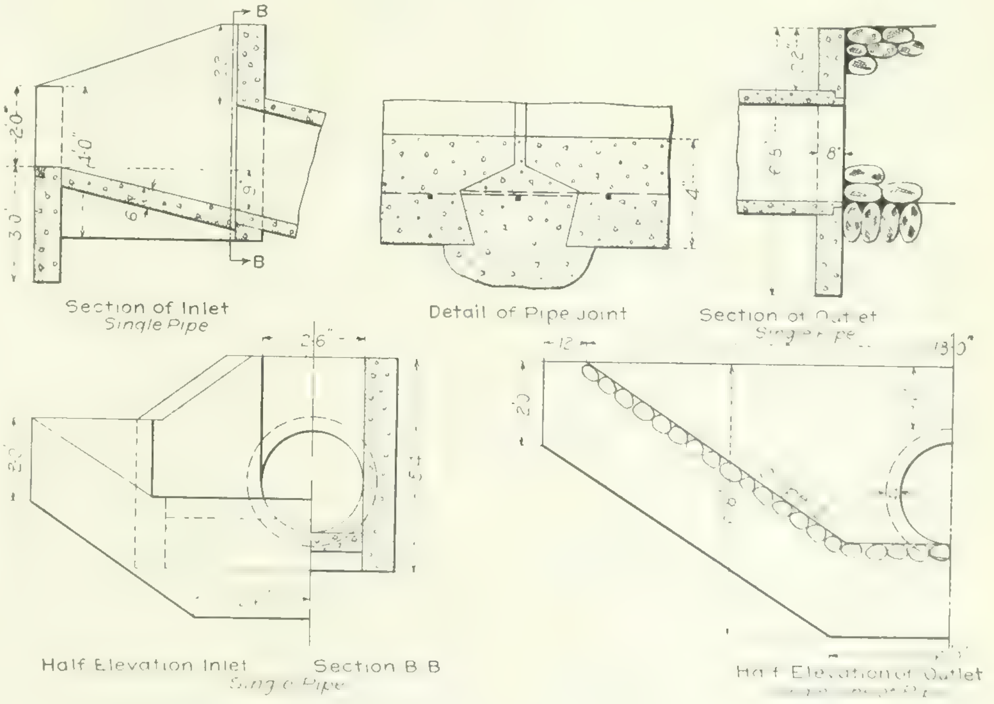


Fig. 2. Details of Lateral Drainage Culvert, St. Mary's Irrigation Canal.

Figure 1 shows in diagram the location of the culvert structure with respect to the canal. This culvert structure consists of one or two lines, depending on the volume of flow, of reinforced concrete pipe terminating in inlet and outlet chambers of the form and dimensions shown by the drawings of Fig. 2. The quantities required for this structure are as follows:

Item.	Single culvert.	Double culvert.
Concrete, cu. yds.	9	15
Paving, sq. yds.	23	28
Concrete pipe, lin. ft.	Variable.	Variable.

The structural features to be noted are the joints and the cut-off walls and pipe collars. The pipe collars are square in elevation and extend 3 ft. outside the pipe diameter and are 8 ins. thick. A 1:2:4 concrete is specified.

The Milk River Project has as Supervising Engineer, H. N. Savage, and as Construction Engineer, Joseph Wright.

College of Engineering, University of Wisconsin.—The fifteenth annual Summer Session of the College of Engineering of the University of Wisconsin will be held at Madison during the six weeks' period beginning June 21, 1915.

Special courses will be given in electrical, steam, and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shopwork and surveying. All courses given in the University Summer Session are open to engineering students.

Special courses have been arranged for manual arts and vocational teachers.

For information address, F. E. Turneaure, Dean, Madison, Wisconsin.

Record in Placing Concrete.—In the construction of the north entrance pier at Balboa, which is connected with the north wall of dry dock No. 1, a gang of men operating a ½-yd. Austin cube mixer, equipped with an elevator and movable chutes, mixed and placed 540 batches of concrete on March 9. In place, the 540 batches measured 275.5 cu. yds. and this was placed in 7 hrs. and 15 mins. actual working time. During the eight hours' work, there were the following delays: Broken chute, 10 min.; repairs to mixer, 20 min.; moving mixer ahead, 15 min.; total delays, 45 min.

The labor cost, including supervision, was $39.91, which makes a unit labor cost for mixing and placing of $0.1448 per cubic yard. All the material was wheeled in wheelbarrows from a point about 100 ft. from the mixer. The average run per hour, actual working time, was 36.33 cu. yds.

BOOK REVIEWS

The Panama Canal. Comprising Its History and Construction, and Its Relation to the Navy, International Law and Commerce. By Reuben E. Bakenhus, Harry S. Knapp, and Emory R. Johnson. John Wiley & Sons, Inc., New York. Cloth; 6x9 ins.; $2.50.

As a studious account of the great isthmian canal this book is for the general reader superior to any other that has come to the editors' attention. Its composition combines the desirable quality of being accurate technically without being difficult for the non-technical reader to understand readily. The three authors have each written a separate part of the book. The history of the development of the canal plan, the route, design and construction of the canal and the sanitation, cost and administration are presented by Mr. Bakenhus, civil engineer corps, U. S. Navy. Captain Knapp's part of the book discusses first the effect of the canal on the navy of the United States and second the position of the canal in international law as determined by the treaties negotiated with foreign countries. The final section of the book by Prof. Johnson relates to the commercial importance of the Panama Canal. This discussion is based on special investigations made by Prof. Johnson and is by the way of being perhaps the most authoritative statement available short of Prof. Johnson's complete report made in 1912 to the Secretary of War. There is less of the personal element and picturesque in the writings of the men named than in previous well known books on the Panama Canal but to the reader desiring a plain account of the great work as an engineering, military and commercial undertaking we commend them.

Engineering Economics.—By Prof. C. L. Fish, M. Am. Soc. C. E. McGraw-Hill Book Co., New York. Cloth; 6x9 ins.; XII + 217 pages; illustrated; $2.

The manuscript of this book has been used by its author for classroom purposes during the last three years at Stanford University, and it is so arranged that the entire subject can be covered in about 30 lessons. The work is essentially a text book for engineering students. As such it is designed to elucidate those principles of engineering economics that relate to estimating first costs, depreciated values, annual costs, and the selection of the most economic plant units.

There are 10 chapters whose titles are: The Problem of Economic Selection; Interest; Sinking Funds; First Cost; Salvage (or Depreciated) Value; Elements of Yearly Cost of Service; Estimating; Basis of Economic Comparison; Procedure for Economic Selection; Examples of Economic Selection. Following these is a good bibliography of books and articles. Then come 30 pages of sinking fund and other interest tables.

From this enumeration it will be seen that the book is the only work of its kind thus far produced for class room use. It might well serve as a companion volume to Prof. Humphreys' "Lecture Notes on Business Engineering," for each book supplements the other. Prof. Humphreys gives particular attention to corporation accounting, financing, etc., whereas Prof. Fish goes into the analysis of costs and their use in selecting the most economic device.

The book is well conceived and admirably executed. It should find extensive use as a text book, particularly now that engineering economics is more generally recognized as being worthy of study as an independent, though co-ordinate, branch of engineering.

A careful perusal of the text of the book discloses no errors of commission, with the possible exception of the treatment of depreciated value. The author begins his chapter on that subject with a nomenclature that departs widely from standard practice. He makes "salvage value" and "depreciated value" synonymous, and, in fact, entitles his depreciation chapter, "Salvage Value." Salvage value always connotes the removal of a plant unit from its existing place of usage. Depreciated value is a broader term, and does not necessarily imply the retirement of an old plant unit. Salvage value is a special case of depreciated value.

The author presents a new depreciation formula which he calls the "equal profit ratios formula." It is regarded by the author as a more general extension of the Gillette depreciation formula. To us it seems that the two formulas are really different expressions of the very same fact. The author says that the Gillette formula does not recognize the element of earnings on capital investment. This is certainly not a correct statement, for the interest rate (which reflects capital earnings) appears in the Gillette formula. The author evidently believes that interest earned in excess of a bond interest rate (say 5 per cent) is essentially different from bond interest. If so, the difference consists essentially of two elements: (1) Insurance against risk, and (2) reward for managerial services. But both of these items—insurance and managerial recompense—are ultimately part of the operating expense. If so, and if they are included in operating expense in the Gillette formula, it should logically follow that the Gillette formula will yield precisely the same depreciated value as does the Fish formula. We have tested this conclusion by several numerical examples and find that the two formulas do yield the same result when each is thus properly interpreted. Prof. Fish's error in regarding the Gillette formula as lacking generality arose from his failure to interpret the profit above interest rate as being a true operating expense, if that profit is of a sort that any good manager can realize. And this proviso is tacitly assumed by Prof. Fish when he assumes a life for the business that exactly equals the life for the plant unit.

Lest this comparatively long comment on one feature of Prof. Fish's book may lead to any inference that the book is not carefully written, we repeat that the work shows an excellent execution of all the subjects that it embraces. Doubtless any one who uses "Engineering Economics" as a text book will supplement it by lectures and by illustrative problems in addition to those given in the text. We heartily concur in the hope of its author as expressed in his preface:

> The book is intended to meet the first needs of the student, and to render effective service in the office. It is hoped that it will facilitate the introduction of formal instruction in engineering economics in the engineering schools, and assist sound engineering practice.

Engineering Office Systems and Methods.—By John P. Davies. McGraw-Hill Book Co., Inc., New York. Cloth; 6x9 ins.; 524 pp.; illustrated; $5.

In addition to data and forms illustrating office systems and methods the book includes: schedules and instructions for the collection of preliminary data for engineering projects; sampling, inspecting and testing engineering materials; and conducting domestic and export shipping operations. It was the author's purpose to follow as nearly as possible the progress of an engineering development. The scope of the book is indicated by the thirteen chapter headings which are as follows: Collection of Preliminary Data for Engineering Projects; Designing and Drafting Systems; Specifications for Engineering Material; Reminders for Obtaining Quotations on Standard Material; Purchasing Office Methods and Forms; Cost Keeping and Estimating; Sampling, Inspecting and Testing Engineering Material; Domestic Shipping; Export Shipping; Progress Charts, Scheduling Systems, Etc.; Indexing and Filing Systems, Etc., for the Engineering Office; Drawing-Office Systems and Methods; Miscellany.

Although the book contains a miscellaneous collection of data gathered from various sources, much of which is of only general engineering interest, a considerable part of the data will be found of value to any engineer who desires to systematize his methods of doing work. The forms and general information on various engineering and allied subjects should prove of special value to office engineers.

Masonry.—By Malverd A. Howe. John Wiley & Sons, Inc., New York. Cloth; 6x9 ins.; 155 pp.; illustrated; $2.

This short text-book is intended to furnish a concise treatment of masonry construction for use in courses which do not provide sufficient time for the study of a more comprehensive treatise. The text includes a description of the materials used, their preparation and arrangement in structures. The six chapter headings are as follows: Natural Building Stones; Artificial Building Materials; Stone Masonry; Brick and Hollow-Tile Masonry; Concrete Masonry; and Railroad Masonry, Brick, Cement, Etc. The book also gives a list of references of books and articles treating this subject.

The book reflects modern practice; its illustrations are well selected, especially those illustrating tools and machines; and it should meet the need for a short text on this subject.

Plain and Reinforced Concrete Arches.—By J. Melan. Translated by D. B. Steinman. John Wiley & Sons, Inc., New York. Cloth; 6x9 ins.; 153 pp.; illustrated; $2.

This book is a translation of the latest (1912) edition of Professor J. Melan's article on arches, published in F. von Emperger's Handbuch für Eisenbetonbau, Berlin. After a brief description of the fundamental principles of arches and a treatment of the stresses in reinforced concrete sections, there are presented algebraic and graphic methods for the design of the various types of arches occurring in practice. The principle of the Melan system of arch construction is fully explained. In making the translation the notation has been modified, for greater clearness, and in the numerical examples the data have been converted from metric to English units.

This translation into English of Professor Melan's work on arches is a valuable addition to the literature on this subject. The approximations and short cuts which amplify the exact treatments will be found of value for preliminary designs.

The Preservation of Structural Timber.—By Howard F. Weiss. McGraw-Hill Book Company, Inc., New York. Cloth; 6x9 ins.; 303 pp.; illustrated; $3.

The author has endeavored to present a book which systematically covers the subject of wood preservation. It is essentially a textbook, the material being taken largely from lecture notes prepared by the author for students at the University of Wisconsin. The scope of the work is indicated by the 20 chapter headings, which are as follows: Introduction; Factors Which Cause the Deterioration of Structural Timber; The Effect of the Structure of Wood upon Its Injection with Preservatives; The Preparation of Timber for Its Preservative Treatment; Processes Used in Protecting Wood from Decay; Preservatives Used in Protecting Wood from Decay; The Construction and Operation of Wood Preserving Plants; (The next eight chapters deal with) "Prolonging the Life of": Cross Ties from Decay and Abrasion; Poles and Cross Arms from Decay and Insects; Fence Posts from Decay; Piling and Boats from Decay and Marine Borers; Mine Timbers; Paving Blocks; Shingles; Lumber and Logs; The Protection of Timber from Fire; The

Protection of Wood from Minor Destructive Agents; The Strength and Electrolysis of Treated Timber; The Use of Substitutes for Treated Timber; and Appendices.

Although the book is essentially a text-book for students in forestry and in engineering schools, its comprehensiveness and the practical character of its contents will be found of value to engineers, foresters and lumbermen.

Design of Steel Bridges.—By F. C. Kunz. McGraw-Hill Book Co., Inc., New York. Cloth; 6x9 ins.; 461 pp. + 52 plates; illustrated; $5.

The stated purpose of the book is to give, in compact form, data on the design of steel bridges of special value to the practicing engineer and to the advanced student, such as the selection and application of the method of calculation best suited to a given case, and practical rules, tables and drawings. The text and the methods of calculation, both graphic and algebraic, have been condensed and cross-referenced to the tables and plates to facilitate ease of application. In the graphic analyses preference has been given to the use of influence lines. The only statically indeterminate bridge trusses considered are those for swing bridges and two-hinged arches. Descriptions are given of several large existing bridges and of a few completely designed long-span bridges as a guide for use in designing similar structures.

The scope of the book is indicated by the seventeen chapter headings, which are as follows: External Forces; General About Reactions and Influence Lines; Moments and Shears in Simple Spans; Stresses in Simple Trusses; Stresses in Bracing of Simple Spans; Types of Bridges and Principal Dimensions; Design of Floor; Beam and Plate Girder Bridges; Simple Truss Bridge; Skew Bridges and Bridges on Curves; Weight of Simple Span Bridges; Viaducts; Elevated Railroads; Movable Bridges and Turntables; Arch Bridges; Long Span Bridges in General and Examples; and Cantilever Bridges. Useful data are also given in the appendixes and in the designs at the end of the book.

The book will be found of particular value to the practicing bridge engineer, and it is undoubtedly one of the most useful works available on the design of simple steel bridges. The numerous designs given in the form of folded plates are especially noteworthy for their completeness.

Tunneling.—Short and Long Tunnels of Small and Large Section Driven Through Hard and Soft Materials. By Eugene Lauchli, C. E. McGraw-Hill Book Co., New York. Cloth; 6x9 ins.; pp. 238; illustrated; $3.

This book is particularly interesting to American readers because of its discussion of certain problems of tunneling which have been most studied in Europe. The importance of geological surveys in connection with tunnel driving, the determination of rock temperatures in deeply overlaid tunnels, and the pressure acting on tunnels driven through soft and cohesionless materials are subjects which have been carefully studied abroad and each is given a special chapter by Mr. Lauchli. The chapters on long and deeply overlaid tunnels, tunnel timbering, lining deep tunnels, vitiation of air and ventilation during construction of long and deep tunnels are also records of European practice in large measure. The author in his subtitle includes short and long tunnels and his text substantially meets his title but it is because the book is the most extensive treatise in English on long and deep tunnels that it holds interest. The author has had another advantage in his writing of being a practical tunnel builder with foreign and American experience. The era of long tunnels is, we believe, yet to come but is surely coming in America and a concise record in book form of long and deep tunneling in Europe which is prominent in its experience with such work is an excellent service to the future of American tunnel engineering.

The volume contains 18 chapters, of which the eight chapters named are the more notable ones. There are, however, chapters on hauling, drilling and excavation, on typical tunneling methods, on siphon and other special tunnels and on headings and tunnels of small cross-section. Costs are given prominent notice in the records of American practice, and there are useful tables on number and spacing of bore holes, areas and dimensions of headings, consumption of explosives, etc. The illustrations are mostly diagrams and line drawings of tunnel sections, drill hole spacing, centers for lining, haulage systems, timbering systems, etc., and are instructive.

Concrete Stone Manufacture.—By Harry Whipple. Concrete-Cement Age Publishing Co., Detroit, Mich. Leather; 4x7 ins.; pp. 255; illustrated; $1.

The concrete stone or concrete building block industry has not fully recovered from the attack of two maladies of youth. These maladies were cheapness and incompetence. In the beginning the idea of low cost dominated all others as a means of promoting building construction of concrete blocks. The talk was not merely that cast concrete was less costly than brick or stone but that it cost only a fraction as much. The result was that most of the blocks made were cheap and that was about all they were. Also another promotion fiction and one largely encouraged by makers of innumerable "block machines" was that the making of concrete blocks was a task that almost any man could accomplish off-hand. These two preliminary errors, first that cast concrete was essentially a cheap material and second that training and plant and business ability were not vital equipment in block making, stunted the growth and very nearly exacted the life of this young industry. It is not argued that all the early block makers were incompetent or that good blocks were made by none. The exact contrary was true. There were competent manufacturers and their product was altogether excellent. If this had not been the case the industry would not have endured and attained the strength that it now possesses. To the reviewer one of the great merits of this little book by Mr. Whipple is that it speaks plainly of these early errors and of the vital need of technical skill, of managerial ability and of adequate mechanical equipment in successful block manufacture.

There is little need at this date to argue the utility of cast concrete or to name its many advantages for much building work. The author therefore devotes his book largely to the following subjects: Location, equipment and layout of block factories; materials, mixtures and manipulation in block making; curing; special molds and patterns; surfaces; shop records and cost keeping; selling; examples of successful plants. There is also a section on building regulations, tests required and typical specifications. The book is closely printed and contains a large amount of text for its size. It is a decidedly useful and welcome addition to the technical literature on concrete products.

Water Works Engineering.—By Fred. C. Uren Castle Litho., Ltd., Bristol, England. Cloth; 7x10 ins.; 270 pp.; illustrated; $2.

The author's endeavor has been to produce a thoroughly practical work at a reasonable price. One sentence from the author's preface is quoted herewith as it is thought likely that many American readers may have had the same early difficulties admitted by the author. He states, of his earliest apprenticeship days: "I had, fortunately or otherwise, access to some bulky expensive works of reference beyond the reach of most students, and one or two of the best books written by college professors whose chief merit lay in obscuring the subject with elaborate engineering formulas that benefited few unacquainted with the calculus." This early experience seems to have made a lasting impression on the author for he has avoided higher mathematics in his treatment of the subject, and gives much attention to fundamental principles and important points of daily practice.

There are 22 chapters on the following subjects: Sources-Storage; Impounding Reservoirs-Masonry Dams; Masonry Dams (cont.); Earthen Dams; Reservoir Accessories; Rivers and Streams-Wells; Well Construction-Well Boring; Geology: Yield of Wells; Service Reservoirs; Raising Water from Wells; Motors for Pumps; Motors for Pumps (Cont.); On Calculating the Dimensions of Pumps and Engines; The Flow of Water in Pipes and Channels; Gaging Water; The Purification and Softening of Water; Distribution and Utilization; Water Mains and Accessories; Service Pipes and House Fittings; Metered Supplies, Waste Detection; Administration and Maintenance; The Law of Water Works.

The book is practical, as the author intended it should be, and will be helpful to all young engineers interested in this line of work. The experienced engineer who prides himself on the completeness of his library will find this book a worthy addition to it. Special attention is given to earthen and masonry dams, geology and well boring, distribution and purification, including the removal of iron and peaty acids.

American Sewerage Practice.—Vol. I.—Design of Sewers.—By Leonard Metcalf and Harrison P. Eddy. McGraw-Hill Book Co., New York City. Cloth, 6x9 ins.; 750 pp.; illustrated; $5.

American Sewerage Practice.—Vol. II. Construction of Sewers.—By Leonard Metcalf and Harrison P. Eddy. McGraw-Hill Book Co., New York City. Cloth, 6x9 ins.; 565 pp.; illustrated; $4

These volumes are the first two in a series of three volumes on American Sewerage Practice. The third volume, Disposal of Sewage, is in preparation.

The 17 chapter headings in the first volume are as follows: The General Arrangement of Sewerage Systems; Flow of Water in Pipes and Channels; Velocities and Grades; Measurement of Flowing Water; Quantity of Sewage; Precipitation; Formulas for Estimating Storm-Water Flow; The Rational Method of Estimating Storm-Water Run-off in Sewer Design; Gaging Storm-Water Flow in Sewers; Sewer Pipe; The Design of Masonry Sewers; Examples of Sewer Sections and the Loads on Sewers; The Analysis of Masonry Arches; Street Inlets, Catch-basins and Manholes; Junctions, Siphons, Bridges and Flushing Devices; Regulators, Overflows, Outlets, Tide Gates and Ventilation; Sewage Pumping Stations. In this volume there is also an introductory chapter on The Lessons Taught by Early Sewerage Works.

The 19 chapter headings in the second volume are as follows: Preliminary Investigations; Engineering Work and Inspection During Construction; Excavation; Machinery for Trench Excavation; Methods of Rock Excavation; Explosives and Blasting; Quantity and Cost of Excavation; Rate of Progress in Building Sewers; The Sheeting and Bracing of Trenches and Tunnels; Sizes of Sheeting, Rangers and Braces; Purchasing, Handling and Laying Sewer Pipe; Jointing Sewer Pipe; Construction of Brick and Block Sewers; Construction of Concrete Sewers; Profiles, Templates, Forms and Centers; Contracts, Specifications and Drawings; Technical Specifications; Operation and Maintenance of Sewerage Systems; Explosions in Sewers.

The authors of this series of volumes have chosen a very broad title—American Sewerage Practice—and one expects a correspondingly broad and thorough treatment. This expectation is realized. The standing of the authors as engineers in this field stamps the series as highly authoritative, and much care has been expended in the collection and classification of the matter presented. The experienced editorial hand of John M. Goodell is everywhere in evidence, and the authors are to be congratulated in having secured his services in the compilation of this highly valuable treatise.

Without in any wise wishing to detract from the credit due the authors for the excellence of these books, it is only right to say that they represent the work of several men. The authors have drawn freely on published articles, papers and reports. Credit is given for information so obtained. The junior members of the firm of Metcalf and Eddy, Messrs. Sherman, Barnes and Fales, who themselves are mature engineers of long experience, have contributed much of value to the building of this monumental work. The authors have also enjoyed a remarkable degree of co-operation from other engineers of high standing in their effort to bring within the scope of these volumes the very best practice now available in this country in the designing and building of sewers. With such resources and facilities as the authors had within themselves and as they have shown themselves able to command, they could not fail to produce a work of the highest merit.

From a physical standpoint the books are pleasing. They are exceptionally well illustrated with half-tones, diagrams, and line drawings of machinery and devices used in connection with the operation and construction of sewerage systems.

Some Consideration Regarding Cast Iron and Steel Pipes. By John Sharp. Longmans, Green & Co., New York City. Cloth, 6x9 ins.; 142 pp.; illustrated; $1.50.

The author observes that steel has been used at times without due regard to the particular working conditions under which it was to be employed, and there has resulted some disappointments, particularly in the use of steel pipes buried in the earth. He has had occasion to make a study of various cases of failure of steel conduits and pipe lines, and of the relative merits of cast-iron pipes under similar circumstances. The book is the outgrowth of those studies.

There are 20 short chapters, and their headings are as follows: Some Notes and Considerations Regarding Cast Iron and Steel Pipes; Physical and Chemical Properties of Cast Iron, Wrought Iron and Mild Steel; Strength and Elasticity of Cast Iron, Wrought Iron and Mild Steel; Transverse Strength of Mild Steel; Resistance of Pipes and Hollow Cylinders to Bursting; Thickness of Pipes and Hollow Cylinders; Thickness of Mild Steel Pipes; Strength of Pipes and Hollow Cylinders Under External Load; Tests on Cast Iron Pipes Under External Loads; The Flow of Water in Pipes and Open Channels; Conditions Affecting the Flow of Water Through Pipes; Corrosion of Steel and Cast Iron; Other Influences Affecting Corrosion; Testing by Embedding in Moist Sand; Internal Corrosion; External Corrosion; Corrosive Effects of Stray Currents of Electricity; Means of Protection from Corrosion; Protective Methods Against Internal Corrosion.

This is a timely book. There has been a great deal of discussion along this line in American water works literature during the past year. It shows evidence of the growing conviction among water works engineers that pipe line materials must be selected with reference to the service requirements and the soils to be traversed, quite as much as with respect to first cost. The chapters on corrosion and the agencies tending to increase or inhibit corrosion are particularly valuable. The book is unquestionably a distinct addition to water works literature.

Land Drainage. By J. L. Parsons. The Myron C. Clark Publishing Co., Chicago. Cloth, 6x9 ins.; pp. 265; illustrated; $1.50.

This volume, being one of the publications of the publishers of ENGINEERING AND CONTRACTING, we quote the author's statement of his plans and purpose in writing it:

> Land drainage at the present time has assumed an important place among engineering enterprises. While the existing literature upon this subject is excellent, the amount is limited, and much of the information that should be available to those connected with the design, construction, maintenance and general administration of drainage enterprises is either not in publication or has not been sufficiently discussed and proven by experience and experiments. The author offers this treatise upon this subject with the hope that it may be of value in the development of the science of land drainage.
>
> To young and inexperienced drainage engineers: Especial efforts have been put forth through the medium of these pages to acquaint you with the problems that you must meet; to impress upon you the importance of accuracy, judgment, honesty and diligence in the investigation and solution of these problems, and to suggest methods of procedure under average conditions and the general principles upon which to base conclusions and plans.
>
> To experienced drainage engineers: The author hopes for a careful and analytical reading of these pages by you and that some of you will be thus incited to take issue with or elaborate upon the questions discussed and thus aid in the formulation of better drainage standards.
>
> To drainage contractors: The author has recognized the facts that contractors have been compelled too often to contend against such unfair conditions as incomplete surveys and reports; the framing of specifications so as to burden contractors with the risks resulting from insufficient plans, and treacherous soils and unfavorable weather conditions, and has pleaded for justice and equity to contractors. Neither have the faults and obligations of contractors been overlooked. Also information is included which will prove useful to contractors, and it is suggested that a general study of the subject of land drainage would better enable contractors to protect their rights and succeed in their business.
>
> To land owners and drainage district officials: The author believes that a general understanding of land drainage science by you would enable you better to distinguish between the efficient and the incapable in employing drainage engineers and to assist and advise with them in the direction of the work which is of such great importance to the agricultural interests of the United States and thus accomplish more effective land drainage.
>
> In conclusion, this treatise has been made as complete as possible for the subjects connected with the successful drainage of agricultural lands by open and closed drains. The author hereby acknowledges a large amount of valuable information which has been gleaned from the reports of the United States Department of Agriculture, from reports of state and other colleges, from the reports of engineering societies, and from engineering periodicals. Specific reference has been made in all cases where important data have been reproduced.

Practical Irrigation and Pumping.—By Burton P. Fleming. John Wiley & Sons, Inc., New York. Cloth, 5x8 ins.; pp. 226.

It is estimated that at least a quarter of a million acres of land in the arid west are irrigated with water provided by pumping, and that the pumping plant investment is nearly $9,000,000. These amounts impress one with the important position reached in irrigation by pumping. The development is already great, and it is still in progress at an increasing rate. Some very large single areas are irrigated by single plants, but for the most part the acreage named above is made up of comparatively small areas, each with its small pump installation receiving power from individual steam or gas engines, or, at an increasing rate of late years, from great commercial central stations by electric transmission. The justification for a book on irrigation pumping is, from these statements, very evident.

The book before us is generally good; its author has had experience in irrigation and writes with this experience to direct him. As a subtitle to his book, he writes: Water Requirements, Methods of Irrigation and Analyses of Cost and Profit. These terms are all virtually true, but pumping for irrigation is the real subject of the book. Beginning with estimates of water requirements of different crops the text covers in turn, wells and well sinking, pumps and pumping machinery, prime movers, central stations and costs and profits. The treatment is brief, but generally covers the main subjects with sufficient fullness for the engineer's needs. Design of pumping machinery for irrigation is a manufacturer's task as the irrigation pump business now exists.

Construction of Masonry Dams.—By Chester W. Smith. McGraw-Hill Book Co., New York. Cloth; 6x9 ins.; pp. 279; illustrated; $3.

This small book on dam construction strikes a new note. It gives no space to dam computations and very little space to descriptions of dam structures. It is a practical study, comparison and criticism of masonry dam construction methods. Not the least important of its contents are the forecasts of probable future methods and the facts and reasoning presented in evidence that increased speed and economy of masonry dam work will come from change from cyclopean or rubble concrete to all-concrete construction. There is an idea in this which merits study and the argument and facts presented by Mr. Smith facilitate study. This happens to be so because the author has had exceptional experience on very large masonry dam work where data on progress, performance and costs were collected and recorded with unusual care.

The chapter headings are: Exploring the Site; Temporary Works for Stream Diversion; Preparing the Foundation; Masonry Construction; Quarrying; Face Work; Miscellaneous Features; Plant and Power; Installation Required and Power Consumption; Assembling Materials, Crushing and Mixing; Transportation of Materials; Probable Future Methods; Estimates of Cost; Partial List of Existing Dams with Descriptions and Costs. In one way the most valuable chapter of the book is that on estimates of costs. This chapter discusses the conception and development of a project, lists and explains the estimates required at various stages, schedules the items entering into estimates, gives very detailed costs of the Roosevelt Dam and figures of plant costs, costs of repairs, erection, etc., tells how to prepare bids. The book is a monograph on masonry dam construction methods and costs and is a distinct addition to engineering data and discussion.

Working Data for Irrigation Engineers.—By E. A. Moritz, C. E. John Wiley & Sons, Inc., New York. Cloth. 6x9 ins.; pp. 395; illustrated; $4.

A compilation of tables, diagrams and formulas used by the irrigation engineer has been needed. In this book are contained some 65 numbered tables and 46 diagrams applying in hydraulic and structural computations of the kind that the irrigation engineer has to perform. Some of these data are original with the author who is an engineer of the U. S. Reclamation Service, others are from the records of the service and others, mostly of a general nature, are from miscellaneous sources. In preface to the tables and diagrams and their text explanations, there is a discussion of the various features of irrigation engineering such as water supply, precipitation, measurement of water, duty of water, surveys and design of structures. This illustrative text is contained in the first three chapters. Chapter VII reprints typical specifications and discusses the requirements of specifications for irrigation work. Chapter IV gives hydraulic tables and diagrams; Chapter V gives structural tables and diagrams, and Chapter VI gives various general tables, formulas and data. It will be seen from the contents that the book is a manual and data book for designers. The author has produced a very useful volume for the branch of engineering in which he is engaged.

At a recent meeting of the American Association of North China a resolution was passed asking American manufacturers of machinery to follow the practice of British manufacturers in sending machinery to Chinese technical schools and universities for their use, as a means of advertising American machinery and bringing it into favor with the Chinese students.

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Calls attention to the value of quoted articles as abstracted in E. & C. and explains system of crediting adopted by this journal. E. & C., April 28, 1915; ⅔ col.

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Comments on the high cost of developing territory by railway construction, as undertaken by the Canadian Government. Points out the similarity to our own Alaskan project, and warns against probable results. E. & C., April 28, 1915; ¾ col.

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Editorial discussion of the changes made in shaft design by the advent of concrete as a lining material. E. & C., April 28, 1915; 1½ cols.

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Editorial comment on need of standard field signal code for engineers and surveyors and announcement of activity of Ohio Engineering Society in this matter. E. & C., April 28, 1915; ¼ col.

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Editorial comparing the engineer, whose ethics forbid self-advertisement, with leaders in other fields who have pushed themselves forward. E. & C., April 28, 1915; ⅔ col

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Describes the four divisions into which this new water department is subdivided, and tells in detail of the procedure in the General Administration Division, the head of which bears the title of Business Manager. E. & C., April 28, 1915; 2½ cols.

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Discusses the plan of laying brick flat on a very thin reinforced concrete base as a means of reducing cost of brick pavement. Gives results of tests and comparative costs. E. & C., April 28, 1915; 3 cols.

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Describes construction methods and gives cost data of work on three sections of a sand clay object lesson road in North Carolina. E. & C., April 28, 1915; 1½ cols.

ROADS: Gravel; Construction and Maintenance.

Methods of Constructing and Maintaining Gravel Roads 376

Outline of gravel road construction and maintenance methods in relation to Ohio conditions, but also to conditions in most of the Mississippi basin states. Discusses selection of gravel, loose gravel and water bound gravel construction methods and maintenance. E. & C., April 28, 1915; 3 cols.

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Piling Building Material in City Streets ... 377

Letter commenting on a former article on the charging of rent for space used by builders for stock piles. Describes the extent to which this nuisance has been carried in that city and shows photograph. E. & C., April 28, 1915; 1 col.

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Some Details of the Exterior Wooden Framing of the Tower of Jewels, Panama-Pacific International Exposition, San Francisco, Cal 377

Describes and illustrates the exterior wooden framing of the 435-ft. Tower of Jewels, Panama-Pacific International Exposition. Also gives working drawings of selected parts of this structure. The framing is exceptionally heavy, and involves the use of some interesting framing details. The steel frame of this structure was described and illustrated in our Jan. 20, 1915, issue. E. & C., April 28, 1915; 8 cols.

CONCRETE, CINDER: Tests of.

Results of Tests of Cinder Concrete Floor Slabs with Conclusions and Recommended Methods of Design 379

Gives the results of a series of tests of reinforced cinder concrete floor slabs made with typical New York materials, the tests being made at Columbia University. Also gives discussion of the tests with recommended formulas for use in design. E. & C., April 28, 1915; 9 cols.

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Describes and gives diagram showing headgate for controlling water from Stanislaus River, California. E. & C., April 28, 1915; 2 cols.

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Gives cost data and describes some of the methods of making a topographical survey of an irrigation project in British Columbia. E. & C., April 28, 1915; 4 cols.

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Iron and Steel Products.—Business man in Italy wishes to get in communication with American exporters of steel plates, frames, beams and angles. He solicits correspondence in English, giving full detail as to prices, terms, discounts, etc. No. 16426. [For address see first paragraph.]

Building Material.—Government of Central American has let a contract to an American for the construction of a reinforced concrete building to cost about $40,000. The contractor will be in need of cement, builder's hardware, etc. No. 16427. [For address see first paragraph.]

Steam Cranes, Contractors' Machinery, etc.—An industrial bureau in Europe desires to obtain an agency for the sale of American machinery. It is especially interested in steam cranes, rolling stock, material for contractors, and machinery in general. No. 16435. [For address see first paragraph.]

Power Plant.—It is understood that a concession for an electric power and light plant for a town of 7,000 inhabitants in Latin America will be let to an American corporation in the near future. It is stated that the corporation now controls a number of public utilities. The power plant will probably be operated by steam at first and later by water power. No. 16436. [For address see first paragraph.]

Motor Trucks.—Firm of wholesale grocers in Canada wishes prices and full information relative to 2-ton motor trucks. Prices should be quoted f. o. b. destination. No. 16469. [For address see first paragraph.]

Steel and Iron.—A large importing firm in Spain wishes to secure immediately prices on iron bars, round and square, plates, tires, calks for horseshoes, hoops, iron window frames, stair rails, grills, etc., T bars, and structural iron. Correspondence should be conducted in Spanish. No. 16470. [For address see first paragraph.]

Water Supply and Sewerage Systems.—Date for submission of bids for the water supply and sewerage systems for the cities of Athens and Piraeus, Greece, has been extended for 3 months. Bids were to have been opened on April 12. Plans, etc., can be examined at the Bureau of Foreign and Domestic Commerce or its branch offices.

INDUSTRIAL NOTES

The Richardson-Phenix Co., Milwaukee, Wis., has purchased the patents, good-will and manufacturing rights of the Osborne "No-Kut" valve and is now carrying a complete line of the various size valves in stock.

The Bucyrus Co., of South Milwaukee, Wis., has moved its Southern sales office from Birmingham to New Orleans, La. Mr. E. L. Byron, Southern Sales Manager, who is well known throughout the South, will remain in charge, and will have associated with him Mr. R. S. Byron. His office will be 1105 Hennen Bldg.

The Rocmac Road Department of the Philadelphia Quartz Co. has established a branch office in Anderson, Ind., with offices in the Union Building. Rocmac in the Indiana territory is being represented by Brooks E. Miller. M. T. Calef, Road Engineer for the Rocmac Road Department, has recently opened an office in Harrisburg, Pa., Room 203 Trustee Bldg, No. 8 North Market Sq.

NEW CATALOGUES

Batch Mixers—Paper, 6x9 ins.; 12 pp. Raber & Lang Mfg. Co., Kendallville, Ind.

Booklet 16, giving details of construction and operation of the Bull-Dog Batch Mixer, Type B. Table of sizes and capacities, specifications and price list are included. Illustrated.

Concrete Mixers.—Paper, circular. Ideal Concrete Machinery Co., 1342 Monmouth avenue, Cincinnati, Ohio.

Shows views of the Ideal Cincinnatus Mixer, gives comparative cost data, specifications for No. 7 machine, and price and lists the various equipment.

Air Compressors.—Paper, 6x9 ins.; 32 pp. Ingersoll-Rand Co., 11 Broadway, New York City.

Form No. 3015, complete treatise on subject of portable air compressing outfits for the contractor, mine operator, factory manager and others employing air tools. Illustrated.

Scraper—Paper, 9x6 ins.; 14 pp. The Baker Manufacturing Co., 506 Stanford Avenue, Springfield, Ill.

Describes the Maney four-wheeled scraper. Shows various types and views of operations on grade reduction or road construction work. Also shows cuts of extra parts and gives dimensional data.

Wire Rope Fastenings.—Paper, 4½x5½ ins.; 18 pp. American Hoist & Derrick Co., St. Paul, Minn.

The February-March issue of "The Crosby Clipper." This number describes the erection of a big reinforced concrete reservoir at Tuscaloosa, Ala., and use of "Crosby" clips in its construction. Also describes some interesting bridge work. Illustrated

Wire Rope.—Paper, 3¼x6¼ ins.; 12 pp. Wright Wire Company, 79 Hammond street, Worcester, Mass.

Points out the value of wire rope in modern construction operations and the particular advantage of Excelsior elevator ropes made by the Wright Wire Company. Gives list of buildings in which they are used and instructions for ordering. Illustrated.

Air Washer.—Paper, 6x9 ins.; 8 pp. Spray Engineering Co., 93 Federal street, Boston, Mass.

Bulletin No. 151, devoted to the subject of washing and cooling air for steam turbine generators. Describes the use of Spray air washers and coolers, gives temperature tables, diagrams of installation and views of operation.

Drills—Paper, 6x9 ins.; 8 pp. E. J. Longyear Co., 710 Security Bank Building, Minneapolis, Minn.

"Modern Prospecting" is the title of Bulletin No. 7, issued by the contract drilling department of the company. Describes and illustrates the work of Longyear diamond core drills and the "Longyear Service" in the prospecting field.

Assessments for Improvements—Paper, 6x9, ins.; 48 pp. Universal Portland Cement Co., 208 S. LaSalle Street, Chicago.

"Local Improvements by Special Assessment in Illinois," contains brief outline of procedure, references to court decisions and forms as they might be applied to concrete paving improvement. The manual is published with a view to assisting officials to avoid errors and litigation in making local improvements.

Expanded Metal Lath—Paper, 6x9 ins.; 52 pp. NorthWestern Expanded Metal Co., 901 Old Colony Building, Chicago.

"Kno-Burn" expanded metal lath is the subject of this pamphlet, which points out the advantages of metal lath in general and of "Kno-Burn" in particular. Gives information and data on protective coatings, specifications and construction details of partitions, ceilings, ornamental plastering, exterior plastering or stucco, overcoating and corner beads, etc. Illustrated.

CATALOGUE REVIEWS

Atlas Publications.—Paper, 6x9 ins. and 5¼ x 7 ins., respectively. Atlas Portland Cement Co., 30 Broad Street, New York City.

The Atlas Portland Cement Co. publishes two little monthly pamphlets which are of interest to all engineers and contractors or others who use cement or concrete. One of these is known as "The Contractor's Atlas," and consists of "practical ideas for the building contractor." The March number of this publication contains articles on "Concrete Bungalows at High Lake, Ill."; "Concrete Ice Houses," and "Structural Tones and Counter Tones." These are illustrated by half-tones, diagrams, and small sketches, evidently by the staff cartoonist.

The other magazine goes by the name of "The Atlas Almanac," and purports to be a "calendar of cement progress." It is, if anything, a little more elaborate than the "Atlas," and is written up in an attractive, though loquacious, style. The March number consists of a description of an imaginary trip through "a few of" the Atlas plants. This is illustrated by photographs of the many quarries, mills, shops, stock houses, and some of the interiors, machinery, etc., and is also brightened by the little thumb-nail sketches, which are not the least attractive feature of both papers.

Oxy-Acetylene Process.—Cloth, 6x9 ins.; 134 pp. Vulcan Process Co., 2430 University avenue, Minneapolis, Minn.

The third edition of the Vulcan Textbook on Welding and Cutting Metals by the Oxy-Acetylene Process, revised and up-to-date, has recently been published. The book aims to give a short, clear and practical explanation of the theory and practice in this field, without including unnecessary technical material. Chapters on chemistry, physics and the nature and composition of metals are of an elementary nature and in the simplest language, giving sufficiently explicit explanations to make clear the operation and application of the oxy-acetylene apparatus. The nature and effect on metals of all gases used in autogenous welding, why some welds are a failure and others a success, how to base charges for welding work, theory of cutting and use of torch, are some of the subjects treated. The book contains 64 illustrations of plant and operations, and a number of tables giving cost data, quantities and pressure, consumption of gas, and other useful information. It is compiled by Mr. C. H. Burrows and a free copy is furnished each purchaser of a Vulcan welding plant. Regular price $1.50 post prepaid.

Centrifugal Pumps—Paper, 6x9 ins.; 298 pp. De Laval Steam Turbine Co., Trenton, N. J.

Catalogue "B," describing De Laval high efficiency centrifugal pumps, their characteristics, design, manufacture, testing, selection and adaptation to various uses. Single-stage and multiple stage types for all capacities and all heads are shown. Special chapters are devoted to speed-reducing gears and turbine-driven water works pumps. The catalogue is divided in 13 parts the subjects of which follow: History and Perspective; Selection of Centrifugal Pump; Pump Characteristics; Testing De Laval Pumps; System of Manufacture; Details, Design and Construction of Single-Stage Pumps; Multi-Stage Pumps; Turbine and Pump Speeds; Speed Reduction Gear; Motor, Belt and Gear Drives; Waterworks Pumps; Common Applications; Data and Specifications. The catalogue is extensively illustrated with photographs of typical installations and of the various types of pumps. Tables, charts and diagrams accompany the text, giving data on tests, capacities, etc.

CURRENT NEWS

The Doings of the Week.

Continued improvement in business and finance has been shown during the past week. Practically all branches of industry report gains. The export trade showed some falling off, but the balance for April will be large. There has been an enormous absorption of securities in the past few days. Bank clearings last week disclosed a small gain over the figures for the same period last year. Cotton showed greater activity, copper metal sales, foreign and domestic, increased, and the lumber trade made steady progress. The railways are having less difficulty in financing, and as a result many companies are about to come into the equipment and supply market. In fact it is reported that purchases aggregating nearly $50,000,000 already have been authorized. In the construction field there has been no slowing up of activity during the past week. Many large contracts were placed and much new work reached the call for bids stage. County and road district highway improvements, in particular, make an especially good showing this week. A considerable amount of bridge work also is being advertised. In the municipal field many construction undertakings are being advertised. Smaller cities are particularly active at this time in taking bids on their improvements. Street paving and waterworks and sewerage construction are offering many opportunities. Many good-sized government river and habor contracts are now ready for bids. In the steel and iron industries there has been increased activity. Plants outside of the U. S. Steel Corporation are now operating at 85 per cent to 100 per cent capacity. This is due in the main to war orders rather than to domestic demands. The Steel Corporation continues to operate at about 75 per cent capacity. Demands for structural material are increasing. Bookings for March, according to the Bridge Builders and Structural Society, amounted to 110,000 tons or 64 per cent of the fabricating capacity of the country. This was the best record since last July. For the first three months of this year the average was about 51,000 tons.

Railways.—While no particularly large construction contract appears to have been let last week, there have been many encouraging factors. The fact that the railways are buying once again leads to the conclusion that they also will take up their construction programs. In the east there are at least three big jobs that are about ripe and it would not be surprising if contracts for them were let any time in the near future. The Union Station Co., which is in charge of the erection of the new $65,000,000 terminal at Chicago, has asked bids on another large contract in connection with this development. The work advertised calls for the building of trunk sewers in Canal, Monroe and Clinton Sts., concrete retaining walls and curb wall in Canal St., and curb walls in Monroe St. Among the contracts reported recently are the following: H. W. Nelson Co., Chicago, for bridge fills for Illinois Central R. R., about 400,000 cu. yds. in all; Henry & McFee, Seattle, Wash., a $250,000 contract for snow sheds for Great Northern Ry.; A. R. Canaday, Deerfield, Kan., and Woodward & McCall, Culver, Kan., grading for Salina Northern R. R., a new 80-mile line projected from Salina to Osborne; Litchfield Construction Co., New York City, at $1,937,509, and Inter-Continental Construction Corp., New York City, at $2,744,263, subway contracts in New York City.

Roads and Streets.—Several large road jobs are being advertised in the south and southwest states. Collins County, Texas, opens bids June 7 on 125 miles of macadam, gravel or concrete surfacing; Capital County, Mississippi, is asking proposals on gravel road construction to cost about $150,000; St. Mary Parish, Louisiana, is asking bids on 50 miles of gravel or shell surfaced highway. California has awarded several state highway contracts and is calling for bids on work costing about $145,000. New York is advertising 19 repair contracts and last week awarded about $250,000 worth of this kind of work. Counties in New Jersey are now taking bids on numerous highway jobs. Perhaps the largest of these is the work for Bergen County. This calls for the improvement of Lafayette Ave. and Teaneck and other roads.

Bridges.—A number of fair-sized bridge contracts came up for advertising during the past week. The county supervisors at Eureka, Cal., open bids May 11 on work to cost about $63,000; the County Clerk at North Platte, Neb., is asking bids on a state aid bridge to cost about $45,000; the Commissioners of Floyd County, Ga., open bids May 21 on three large bridges—two reinforced concrete structures and a steel truss bridge. A fair amount of small bridge and culvert construction for various counties is now ready for bids.

Drainage and Irrigation.—No particularly large undertakings in either the drainage or irrigation fields appear to have reached the call for bids stage during the past week. The Mecklenburg Drainage Commission of Charlotte, N. C., is asking for proposals on about 300,000 cu. yds. of dredge ditches. The U. S. Reclamation Service, Provo, Utah, is asking bids on about 30,000 cu. yds. of excavation and 3,400 cu. yds. of concrete. Bids are being taken on a 175,000 cu. yd. levee job at Waxahachie, Tex., and a 90,000 cu. yd. ditch and levee job at Edinburgh, Tex.

Water Works.—Many small municipalities are calling for bids for constructing water works or for improvements to existing systems. F. H. Nakielski, Milwaukee, Wis., at $34.92 per lin. ft., was low bidder for the 5,600 ft, water tunnel for Milwaukee. The Schaw-Batcher Co., Sacramento, Cal., was awarded contract at $593,529 for extending water mains for Sacramento. Paris, Ill., is calling for bids on water works improvements; and Osseo, Minn., and Riverside, Wash., are asking proposals for complete systems.

Sewerage.—The Sewerage Commission of Milwaukee, Wis., is readvertising the contracts for intercepting sewers on each side of the Milwaukee River. Huntington, N. Y., is calling for bids on a sewer system requiring 15 miles of sewers and sewage treatment works. Siloam Springs, Ark., is asking proposals on about 10 miles of sewers, and Pana, Ill., opens bids April 30 on a sewage treatment plant. The Passaic Valley Sewerage Commission, Newark, N. J., is calling for bids on another section of the Passaic Valley intercepting sewers.

Rivers and Harbors.—Government river and harbor work is beginning to offer many construction opportunities. The U. S. Engineer at Detroit, Mich., is advertising several good-sized undertakings, one of them calling for the masonry for the fourth lock at Sault Ste. Marie, Mich. Work on which bids are now being taken by the U. S. Engineer at Kansas City, Mo., includes 13,350 lin. ft. of standard 3-row timber dike and 17,000 ft. of standard revetment. This work is divided into five contracts. The city of Dunkirk, N. Y., is asking bids for the construction of a public wharf. The Levee Board at Clarksdale, Miss., opens bids May 12 for facing about 138,000 sq. yds. of levee with a 3-in. plain concrete slab.

Few Jobs in Alaska.

The press dispatch stating that the Alaska Engineering Commission already had received 40,000 applications for jobs and had only 100 places to fill probably exaggerates the situation. Nevertheless there have been so many reports of an impending stampede of labor in search of work on the government railway that the Commission has issued a warning that no large number of men would be needed this year. The construction this season, for the most part, will be done by stationmen and there are plenty of these on the coast. Experience in work of this sort, long hours and hustling all the time, are necessary if a stationman is to make more than a living wage. The Commission itself will employ only a few engineers and these will be men experienced in railroad building. The Federal appropriation for the Alaskan railway for the fiscal year is only $2,000,000. Two railroad contracts let in the states in the last month calls for larger expenditures than this amount. There are few opportunities for work in Alaska at the present time, and anyone going there looking for a job would do well to have grub stake large enough to insure the purchase of a return ticket.

Standard Boiler Specifications.

One of the little troubles of the contractor is the ununiformity of state laws for boiler inspection. It is exasperating to find that the boiler on the hoisting engine, perfectly good in one state, is decrepit and dangerous in the adjoining commonwealth. But relief is in sight. The joint committee of the American Boiler Manufacturers' Association and the National Tubular Boiler Association has approved the steam boiler specifications formulated by a committee of the American Society of Mechanical Engineers. Practically all the boilermakers of the country will therefore operate under a standard code. Boiler inspection companies also will get in line and draw their specifications to conform to this code. As a result, contractors operating in more than one state will in the future be saved much inconvenience and expense.

Labor Troubles at Pittsburgh.

Spring and trouble in the building trade usually arrive about the same time. Last week it was Chicago, now it is Pittsburgh. In the latter city the bricklayers are asking an increase in pay. They get 70 cts. an hour and want 75 cts. They also insist that they shall set the promenade tile regardless of the Roofers' Union and that the employers shall recognize the Building Laborers' Union. The employers consider the demands unreasonable in face of present conditions and intend to resist. As a result a walkout is threatened which would tie up more than $20,000,000 worth of building work now under construction. Compulsory arbitration of labor disputes would save disinterested parties, usually the chief sufferers from strikes, from having their neutrality violated.

Gouging the Railways.

Every time a state legislature convenes bills are introduced for gouging the railways. Two particularly vicious pieces of legislation are now before the Illinois legislature. One of these limits the length of trains to 50 cars; the other specifies the number of men that may be employed upon a switch engine while engaged in switching cars. Both bills were introduced by labor interests who justify the measure on the grounds of efficiency and safety. Long trains, they claim, are a source of inconvenience to the public because they "block the street crossings, hold up fire departments, and delay doctors responding to calls." The sponsors also claim that with shorter trains there would be a quicker movement of freight. This is class legislation of the worst kind. Should such a law be enacted the cost of hauling would be greatly increased and the millions spent by the railroads for grade reductions, for curve elimination and other betterments, and for heavier equipment will have been wasted.

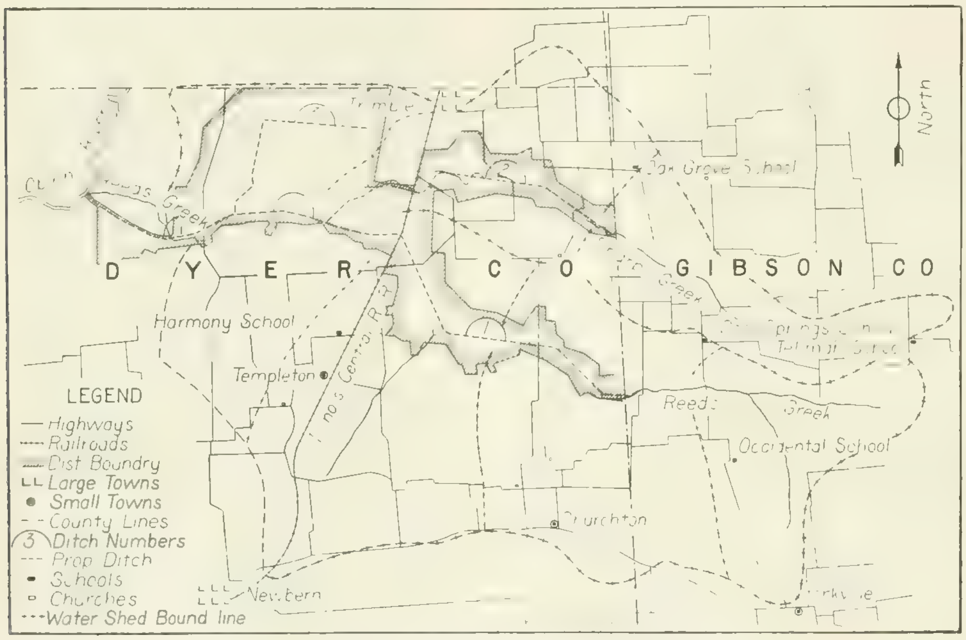
DRAINAGE LETTING IN DYER COUNTY, TENN.

Work to Be Done in Reed's Creek District.

635,000 Cu. Yds. of Floating Dipper Dredge Excavation.

Bids will be opened May 14 at Dyersburg, Tenn., by the Directors of Reed's Creek Drainage District of Dyer County, Tennessee, for the construction of an important drainage system in the northwestern part of Tennessee. This district lies about 100 miles north of Memphis and is crossed by the main line of the Illinois Central R. R. The Morgan Engineering Co., Memphis, Tenn., made the surveys of the territory and designed the reclamation system.

The boundaries of this district include about 6,000 acres of fertile bottom lands. The overflow waters from Reed's Creek and Sharp's Creek cover all the land several times each year, and a part of the acreage is so low and swampy that the water stands over during practically the entire year. At the present time only 25 per cent of the district is cultivated. Those lands that are cleared are unfit for profitable cultivation. On some of the lands that are in cultivation, only about one-half a crop can be made on account of the waterlogged condition of the soil. These overflow waters become stagnant and thus endanger the health of the community. As the district is situated in the low valley bottoms, the soil is very rich and productive. Soil borings taken along the line of the ditches show a blue clay subsoil with a thick covering of black loam top soil.



Location of Ditches in Reed Creek Drainage District.

The plan which has been adopted for the reclamation of this territory consists of three open ditches, having a total length of about 15 miles. The main ditch follows down the valley of Reed's Creek. It ranges in size from a 14-ft. bottom width with ½:1 slopes, to a 35-ft. bottom with 1:1 side slopes.

A second ditch traverses the Sharp's Creek bottoms. This will have 14-ft. or 18-ft. bottom widths and ½:1 side slopes. The third ditch is planned to drain a low piece of country and will have a 14-ft. bottom width and ½:1 slopes. The berms will be 10 ft. wide in all cases.

The fall in these ditches varies from about 7 ft. per mile at the heads of the valleys to about 1 ft. per mile near the outlets. The average cuts will vary from about 7 ft. to 10.5 ft. The total yardage to be excavated is about 655,000 cu. yds. This can be done best with floating dipper dredges. The excavation work has been estimated to cost 8 cts. per cubic yard, including clearing the ditch right of way. The total cost will be nearly $60,000.

Road Repair Lettings by New York Highway Commission.

Bids were opened April 20 by the State Highway Commission of New York on 20 contracts for the repair of public highways by state aid. The work, in general, consisted of resurfacing or the application of bituminous materials. The total cost on the basis of the low bids being accepted will be about $250,000. There was considerable competition on the work and for none of the jobs were there less than six bidders. On repair contract No. 705, for Road No. 365, Guilderland, Guilderland Center, in Albany County, there were 17 bidders. On many of the contracts there was little difference of opinion regarding the prices for the work and as a consequence the bids were well bunched.

On several contracts the figuring was especially close, there being a difference of only a few dollars between the totals of the low man and his nearest competitor. On Repair Contract No. 705, Alonzo Schaupp of Guilderland put in a bid of $8,286; the next lowest bid amounted to $8,338, a difference of $52. The following tabulation shows the high and low bids and the number of bidders on each contract. The names of the three low bidders and the bidding prices will be found under Roads and Streets elsewhere in this section.

Repair Contract No.	Miles.	High bid.	Low bid.	Number bidders.
705	1.9 *	$10,305	$ 8,286	17
695	5.73†	10,939	9,911	8
694	1.07†	2,884	2,291	8
707	7.34*	38,887	30,435	11
691	1.00†	2,275	1,942	6
706	3.64*	26,991	20,961	7
611	1.72*	6,606	5,471	12
698	2.21*	10,517	8,655	11
699	2.50*	12,314	9,595	12
700	3.09*	11,590	9,755	8
697	9.07†	12,026	9,971	10
709	2.46*	13,124	11,927	6
708	3.79*	23,629	20,193	15
692	8.49†	7,493	5,600	8
702	5.72*	24,804	21,324	10
696	1.50*	13,878	12,446	7
704	3.82*	18,823	16,343	7
710	4.12*	24,049	19,907	8
703	7.01†	3,793	3,000	10
711	1.28*	9,752	8,573	7

*Resurfacing. †Surface treatment.

[1] No. 265-Deposit and No. 5338-A, Windsor-Deposit. [2] Also Nos. 318, 319 and 675. [3] Also Road No. 443.

The next letting for repair contracts will be held on May 11. At that time bids will be opened on 19 contracts. Of these, 11 provide for N. C. T. cold applications, four provide for C. O. applications, one for H. O. application, one for Bit Mat "A" application and one for Bit Mat "A" application, L. C. T. cold application and C. O. application.

Surveys Made for 44-Mile Scenic Highway in Mt. Rainier National Park, Washington.

The Federal Government has had surveys made for a highway in the Mt. Rainier National Park and Rainier National Forest, State of Washington, that calls for an estimated expenditure of over $610,000. No definite action has been taken, however, toward the construction of the road, and it probably is a development of the future. The surveys were authorized in June, 1913, and were completed last year.

The route as surveyed extends from a point on the government road southerly and southeasterly along the south side of the Tartoosh Range and down Skate Creek Canyon to its crossing with the Cowlitz River. From this point it runs northeast and north along the east side of the Cowlitz and Ohanapecosh to Boundary Post No. 40 on the southern boundary line of the National Park, near Hot Springs. From here it extends north and northeast across the southeastern part of the park and in the forest preserve to a point in Rainier Pass, 2 miles east of the boundary line of the park. Of the whole route 5¾ miles would be above an elevation of 4,000 ft. The total length is 44 miles. The route is divided into three sections, the lengths and estimated costs being as follows:

	Length, miles.	Est. cost.
Longmire Springs to Cowlitz River	15.34	$200,827
Cowlitz River to Hot Springs	11.95	140,537
Hot Springs to Rainier Pass	16.73	268,803

These estimates are based on an 18-ft. road with grades not greater than 5 per cent except in five cases, where they would vary from 5 to 6 per cent over a total length of 2.7 miles. About 564,863 cu. yds. of excavation would be required in the construction of the highway. This would include considerable hardpan and several solid rock cuts, and the work would be heavy and expensive.

The highway would require 15 bridges estimated to cost $46,700. The piers and abutments would be of rubble masonry and local stone. The locations of the structures and their lengths are as follows:

Location.	Length, ft.
Misqually River	160
Johnson Creek	70
Cowlitz River	180
Lake Creek	60
Coal Creek	64
Purcell Creek	40
Clear Fork Creek	60
Summit Creek	84
Hot Springs Creek	60
Ohanapecosh, No. 1	94
Ohanapecosh, No. 2	30
Rock Falls Creek	20
Dewey Creek	40
Rainier Creek, No. 1	20
Rainier Creek, No. 2	20

A $640,000 Filtration Plant for Wheeling, W. Va.

The proposed filtration scheme for Wheeling, W. Va., has been advanced another step toward the construction stage. On April 20 the city council passed an ordinance providing for an election on May 15 to vote on a bond issue of $640,000 for installing the plant. At a preferential election last July the citizens voted in favor of putting in a Smith slow sand filtration system.

The plant is to have a capacity of 20,000,000 daily, and the filter beds will be connected with the valve chambers and auxiliary pumping station by ten 24-in. supply lines. The cost of the plant and supply line is estimated at $430,000. The plan of improvement includes a valve chamber and auxiliary pumping station with four 10,000,000-gal. centrifugal pumps, a covered concrete reservoir of 5,000,000 gals. capacity, and a 36-in. pipe line from the reservoir to the present city pumping station. The total estimated cost is as follows:

Sites, right of way, etc.	$ 20,000
Plant and supply lines	430,000
Valve chamber, pumping station and pumps	60,000
Concrete reservoir	60,000
Pipe line	70,000

BUILDING CONSTRUCTION BY U. S. TREASURY DEPARTMENT.

Appropriations for 1915-1916 for Post Offices and Other Structures.

Many millions of dollars are provided in the sundry civil expenses bill, approved March 3 last, for the erection of public buildings for the Treasury Department of the United States. The appropriations provide for the purchase of sites, commencement, continuation or completion of several hundred buildings. Most of these are post offices or post offices and court houses, but in some of the larger cities the sums provided are for extensions or remodeling of existing buildings, or for structures other than those used for postal services. For instance the $300,000 appropriation for Baltimore, Md., is for the continuation of the immigrant station at that city, the $350,000 for Pittsburgh, Pa., is for the completion of the laboratories for the Bureau of Mines and the $1,500,000 appropriation for Washington, D. C., is for the continuation of the building for the Department of the Interior. The construction work under the appropriations in the bill will be carried out under the direction of the Supervising Architect, Treasury Department, Washington, D. C. The appropriations for the fiscal year ending June 30, 1916, are as follows: ,

City.	Amount, Thousand dollars
Alaska:	
Juneau	75†
Alabama:	
Jasper	1*
Mobile	70*†
Opelika	40†
Arizona:	
Globe	1*
Arkansas:	
Arkadelphia	55*†
Eureka Springs	16†
California:	
Bakersfield	1*
Berkeley	20*†
Chico	35*†
Grass Valley	10*†
Hanford	15*†
Oakland	51
San Luis Obispo	71*†
Willow	20*
Colorado:	
Denver	200*†
Greeley	25*†
La Junta	10†
Connecticut:	
Danbury	55†
Greenwich	50*
Middletown	1*
Naugatuck	25*
New Haven	100*†
Putnam	10†
Rockville	1*
Seymour	10*
Stamford	100*†
Delaware:	
Smyrna	10*†
District of Col'bia:	
Washington	1,500†
Florida:	
Bartow	1*
Live Oak	20†
Palatka	18†
Pensacola	30*†
St. Petersburg	25*†
Georgia:	
Augusta	50*†
Bainbridge	15*†
Barnesville	1*
Cartersville	5*†
Moultrie	1*
Quitman	20†
Thomasville	46*†
Washington	6*
Hawaii:	
Hilo	50*†
Idaho:	
Coeur d'Alene	55†
Illinois:	
Beardstown	27†
Canton	30*†
Collinsville	36*†
East St. Louis	95*
La Salle	35*†
Mt. Vernon	8*†
Princeton	50*†
Robinson	45*†
Savanna	1*
Sycamore	15*†
Taylorville	10*
Urbana	10*
Indiana:	
Evansville	75*
Gary	50*†
Huntington	10*
Newcastle	15*†
Portland	18*†
Seymour	28*†
Valparaiso	5*
Washington	1*
Iowa:	
Charles City	1*
Maquoketa	1*
Washington	10*
Kansas:	
Arkansas City	35*†
Chanute	12*†
Garden City	45*†
McPherson	20*†
Osage City	12*†
Winfield	14*†
Kentucky:	
Ashland	30*
Fulton	35*†
Georgetown	45*†
Jackson	35*†
Middlesboro	65*†
Shelbyville	10*
Winchester	20*
Louisiana:	
Alexandria	40*
Jennings	25*†
Lafayette	10*†
Minden	20*
New Orleans	250*†
Maine:	
Bangor	10*†
Caribou	1*
Gardiner	65†
Rumford	1*
Maryland:	
Baltimore	300†
Hagerstown	30*†
Massachusett	
Attleboro	30*
Boston	350*†
Greenfield	75*†
North Attleboro	50*†
Waltham	20†
Minnesota:	
Anoko	10*
Lake City	20*†
Little Falls	10*
Montevideo	1*
Michigan:	
Albion	10†
Cadillac	15*†
Detroit	25
Holland	55*†
Ishpeming	30*†
Muskegon	30†
Three Rivers	10*†
Ypsilanti	35†
Mississippi:	
Canton	30*†
Grenada	25*†
Laurel	40†
Tupelo	40*†
Missouri:	
Chillicothe	80†
DeSoto	5*†
Excelsior Springs	20*†
Kansas City	250*
Kirksville	30*
Moberly	20*
Webb City	20†
Montana:	
Bozeman	30*†
Kalispell	15*
Miles City	118*†
Missoula	50*
Nebraska:	
Alliance	1*
Aurora	1*
Chadron	1*
Falls City	10*
Lincoln	135†
Nevada:	
Goldfield	60*†
New Hampshire:	
Concord	18*†
New Jersey:	
East Orange	1*
Hackensack	1*
Millville	25†
Morristown	80*†
Orange	20*†
Plainfield	80*†
New York:	
Batavia	40†
Glens Falls	45*†
Gouverneur	35†
Hornell	30*
Mt. Vernon	20†
New Rochelle	15*†
Port Jervis	10*†
Poughkeepsie	40*†
Salamanca	20*
Saranac Lake	25*
Syracuse	180†
Utica	180†
Waterloo	20*
Yonkers	250*†
North Carolina:	
Burlington	1*
Gastonia	15*†
Kinston	20*†
Rocky Mount	30*†
Rutherfordton	5
Shelby	1*
Tarboro	25*†
Waynesville	21*
Wilmington	200†
Wilkesboro	30†
Wilson	15*†
North Dakota:	
Mandan	11*†
Minot	20*†
Valley City	15*
Williston	5*†
Ohio:	
Alliance	20*†
Elyria	20*
Logan	20*
Middletown	50*
Newark	50†
Sandusky	80*
Sidney	10*
Steubenville	40†
Tiffin	70*†
Van Wert	25*
Oklahoma:	
Ardmore	95*†
Blackwell	20†
El Reno	75*†
Lawton	152*†
Oklahoma City	111*
Tulsa	15†
Oregon:	
Albany	10*†
Medford	20*†
Pendleton	73*†
Portland	50†
Roseburg	1*
The Dalles	60*†
Pennsylvania:	
Bedford	50*†
Carnegie	35*†
East Pittsburgh	40†
Harrisburg	75*†
Huntingdon	15*†
Monongahela	23†
Pittsburgh	350*†
Reading	40*†
Ridgway	25*†
South Bethlehem	1*
Sunbury	20†
Tamaqua	27*
Tarentum	1*
Titusville	15*
Rhode Island:	
Nar'gansett Pier	39*†
Newport	150†
South Carolina:	
Camden	6*†
Columbia	1*
Marion	1*
South Dakota:	
Redfield	1*
Tennessee:	
Chattanooga	30*
Covington	6*†
Cookeville	40*†
Fayetteville	15*†
Humboldt	1*
Jellico	30*†
McComb	1*
Maryville	10*
Nashville	200*
Shelbyville	5*†
Winchester	15*†
Texas:	
Amarillo	133*†
Belton	10*
Brenham	20†
Bryan	1*†
Corpus Christi	70*†
Cuero	20†
Ennis	43*†
Longview	20*†
Nacogdoches	20*
Navasota	15*
New Braunfels	20*
Stamford	1*
Uvalde	35*†
Vermont:	
Brattleboro	50*†
Virginia:	
Hampton	20*†
Lynchburg	25*†
Norton	25*†
Pulaski	1*
Wytheville	25*†
Washington:	
Aberdeen	1*
Ellensburg	10*
Everett	85*†
Wenatchee	1*
Vancouver	10*
West Virginia:	
Huntington	100*
Martinsburg	20*†
Moundsville	10*†
Wellsburg	30†
Williamson	1*
Wisconsin:	
Antigo	1*
Delavan	10*†
Fort Atkinson	30†
Madison	200*
Merrill	35*
Milwaukee	40*†
Neenah	1*
Sparta	23*†
Wyoming:	
Buffalo	1*

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*For commencement †For continuation
*†For completion.

Bids on 1,150 ft. of Bridges at Rome, Ga.

A good sized bridge letting is now being advertised by the Commissioner of Roads and Revenues of Floyd County, Georgia. The work calls for the construction of three bridges in the city of Rome. One of these will be located at 2nd Ave. and will be a reinforced concrete arch structure of a total length of about 376 ft. It will have a 40 ft. roadway and two 8 ft. sidewalks. A reinforced concrete arch bridge also will be constructed at Broad St. This will have a total length of about 407 ft. with a 40 ft. roadway and two 8 ft. sidewalks. At 5th Ave. a steel truss bridge on concrete substructure will be erected. It will have a movable channel span with a channel clearance of 100 ft. It will have a total length of 367 ft., a 37½ ft. roadway and two 8 ft. sidewalks. Kieffer Lindsey, Rome, Ga., is County Engineer. The Consulting Engineers are Greiner & Whitman, Baltimore, Md., and W. C. Spiker, Atlanta, Ga. Bids will be received by the County Board of Commissioners of Roads and Revenues, Rome, Ga., until noon, May 21.

Underground Transportation Development for Boston, Mass.

Studies for a future treatment of the transportation problems of Boston, Mass., have been submitted to the Legislature by the Public Service Commission. The main feature of the tentative plan is the establishment of a traffic center in the Faneuil Hall district, and the erection of a market and storage building above the proposed station at this point. Freight and suburban passenger traffic would converge at this location. There would be 5 or 6 tracks through the station, with loading and unloading platforms between them. There also would be a track yard capable of storing about 40 freight cars and 18 trolley freight cars.

The plan provides for the linking by means of subways of the north station and the south station and would give these terminals short and direct connection with the Boston, Revere Beach & Lynn R. R. and with the docks in East and South Boston. The scheme is an elaboration of previous propositions for a tunnel betwen the two stations. It takes in all lines entering the city and welds them into circuitous lines that give a free flow of traffic and transfer possibilities with docks and railroads. It is estimated that it would cost $30,000,000, this cost not including certain important features, to carry out the plan.

Bids Asked on 700 ft. Bridge at North Platte, Neb.

A 700-ft. state aid bridge is to be constructed over the North Platte River at a point about 2 miles east of the town of North Platte. Designs have been prepared by the state engineer, Lincoln, Neb., for a concrete bridge and for a steel bridge. The latter design provides for a low truss steel structure composed of seven 100-ft. skew spans, 20-ft. roadway, concrete floor, with concrete piers resting on steel piles and concrete abutments also supported on steel piles.

The design for the concrete bridge calls for a reinforced concrete structure of the balanced arch type made up of two 60-ft., two 65-ft., two 70-ft., two 75-ft., and two 80-ft. arches. The roadway will be 20 ft. in width and the structure will have a 50° skew. The concrete piers and abutments will rest on piles. In connection with the work there will be approximately 25,000 cu. yds. of fill and 3,000 cu. yds. of surfacing.

Bids on the alternate designs for the construction of the bridge will be received until noon, May 21, by C. W. Yost, County Clerk, North Platte, Neb.

Sea Wall, Sewers, Paving for West Palm Beach, Fla.

The city of West Palm Beach, Fla., is calling for bids on a number of municipal improvements. These include a sea wall, sanitary sewers and additional street paving. The latter work includes 40,000 sq. yds. of macadam, 29,900 sq. yds. rock surfacing and 5,544 cu. yds. of grading. The sea wall will be a reinforced concrete structure, the principal quantities involved being as follows:

Reinforced concrete, cu. yds.	1,350
Steel reinforcement, tons	73.44
Anchor bolts, nuts, etc., lbs.	11,460
Round piling, [illegible] lin. ft.	[illegible]
Fill, cu. yds.	[illegible]
Sidewalk, sq. yds.	[illegible]

The sewer work includes 16,600 ft. 8 in., average depth 4.6 ft.; 3,360 ft. 10 in., average depth 4½ ft.; 1,315 ft., average depth 4 ft. The J. B. McCrary Co., Atlanta, Ga., is the engineer. Bids will be received until noon, May 7, by A. M. Lopez, City Clerk, West Palm Beach, Fla.

Increased State Aid Highways in Wisconsin.—An increase in state aid highway construction is desired by towns in Wisconsin. At town meetings held this month an increase in state aid of 87 per cent over what was received for 1915 was asked. The figures for 500 towns show that these places voted for $324,400 in 1914 and for $603,100 in 1915.

1,800,000 Cu. Yds. of Dredging at Toronto, Ont.—The Toronto Harbor Commissioners, Toronto, Ont., in connection with their scheme of harbor improvement will expend about $400,000 this season on the reclamation of park lands on the island and on the western water front. This program calls for reclaiming by dredging land lying east and west of Wards Island in the bay. This will call for the pumping of 757,321 cu. yds. of material. On the western city front working from the Humber east so as to deposit the material behind cribs already placed in connection with the western breakwater it is proposed to pump 1,096,400 cu. yds. of material. This is the maximum amount of work which the commissioners propose to do as the city's share of the improvement during the present year.

Bids Asked on Bridge to Cost $63,000.—Bridge construction to cost about $63,000 is now advertised for bids by the supervisors of Humboldt County, California. The improvements provide for two cable suspension bridges and a concrete structure. The latter will have two spans and a total length of 60 ft. It will be constructed over Salmon Creek and will cost about $9,000. One of the cable bridges will be erected over the Eel River at Scotia to replace a similar structure washed out last February. The bridge will have a total length of 700 ft. and will cost about $45,000. The other suspension bridge will be constructed over the Klamath River at Weitchpec. It will cost about $9,000. Bids on the three bridges will be received by the County Supervisors, Eureka, Cal., until May 11. A. J. Logan, Eureka, Cal., is County Surveyor.

Bids Asked on 48 Miles of Highway Work in Ohio.

The State Highway Commission of Ohio, as noted briefly in our last issue, is now asking for bids on 31 contracts for highway improvements. The work covers about 48 miles of road. Of this amount, 24 miles are to be surfaced with waterbound macadam, 10 miles with brick and 13 miles with cement. There also will be about 4 miles of glutrin-bound macadam. Two of the contracts call for work for Bureau of Maintenance and one contract provides for the construction of a bridge. Details of the contracts are given in Table I. The work on which proposals are asked includes constructing the bridges and culverts, grading roadway and paving. Bids on the 31 contracts will be received until 2 p. m. April 30, by Clinton Cowen, State Highway Commissioner, Columbus, O.

PERSONALS

Mr. Fred M. Baldwin has been appointed superintendent of water works at Flint, Mich., succeeding Mr. William L. Fisher, resigned.

Mr. M. T. Calef, road engineer for the Roemac Road Department of the Philadelphia Quartz Co., has recently opened an office at 203 Trustee building, Harrisburg, Pa.

Mr. C. W. Cochran, engineer maintenance of way, Cairo Division, Cleveland, Cincinnati, Chicago and St. Louis railways, has been appointed engineer of maintenance of way on the Cleveland-Indianapolis Division with headquarters at Galion, Ohio.

Mr. H. A. Perkins has been chosen as city engineer of Leavenworth, Kas. He has had 27 years of experience in bridge, railroad, city and government work. During that time he has located about 1,500 miles of railway in Kansas, Oklahoma and Texas. He was for a time chief engineer of the Beaver Valley & Northwestern in Oklahoma, also chief engineer of the Medicine Valley & Northwestern in Kansas.

Mr. E. F. Bridges has been appointed as manager of the Oskaloosa Vitrified Brick Co. of Oskaloosa, Iowa. Mr. Bridges has been city engineer of Oskaloosa since 1911, and prior to that was for a time foreman in charge of paving construction at Burlington, Iowa. In 1908-1909 he was city engineer of Oskaloosa. His earliest engineering experience was that of transitman and locating engineer for the Interurban Railway at Des Moines. During the year of 1907 he was computer for the Mississippi Central Railroad.

Mr. John E. Bowe, formerly commissioner of street cleaning of the Borough of Richmond, New York, has been appointed assistant commissioner of public works of that Borough. Mr. Bowe was deputy commissioner of the Department of Water Supply, Gas and Electricity of the city in charge of the Richmond office, from 1908 to 1914. During his period in office privately owned and operated water companies were taken over by the city and properly organized. Since 1914 Mr. Bowe has been commissioner of street cleaning.

Mr. F. C. Herrmann, consulting engineer, 1104 Merchants' Exchange building, San Francisco, has been appointed chief engineer of the Modesto Irrigation District of California. He will have charge of the reconstruction and enlargement of the main canal system, replacement of timber structures with permanent structures with 2,000 second-feet capacity, and enlarging the reservoir. The total cost of this work will be about $800,000. Mr. Herrmann was irrigation engineer with the U. S. Irrigation & Drainage Investigation in 1905-7. He was chief engineer of the California Development Co., in 1907-10, and chief engineer for the Spring Valley Water Co., of San Francisco from 1910 to '14. Since the beginning of 1914 Mr. Herrmann has conducted a consulting engineering practice with offices as above. He is a member of the American Society of Civil Engineers.

Mr. Edmund A. Bonney has been appointed supervising engineer for the New York State Highway Commission. Mr. Bonney entered the State Engineering Department in 1904 as chainman, working through the various grades of rodman, highway inspector, draftsman, chief draftsman and assistant engineer, until 1912, when he resigned to enter contracting work. He is co-author with Mr. G. Harger of the "Handbook for Highway Engineers," used as a textbook in Colgate and Cornell Universities.

Mr. John Gaitenby has been appointed superintendent of the filtration plant at Evanston, Ill., succeeding Mr. C. G. Gillespie, resigned. Mr. Gaitenby was constructing engineer for the Norwood Engineering Co. of Florence, Mass., designers and erectors of filters, paper mill machinery, etc., for 12 years. Mr. Gaitenby's early experience was acquired in the paper mills of the east, where he learned the practical details of his work. He then took up the engineering course of the International Correspondence School, and in 1903 entered the service of the Norwood Co. as constructing engineer.

Mr. R. M. Clayton, who recently resigned as head of the engineering and construction department of the city of Atlanta, Ga., after 33 years' service in that position, has opened an office at 210 Temple Court building in Atlanta, as consulting engineer. He will make a specialty of water works and purification plants, sewerage and sewage disposal, highway and street paving and municipal work of all kinds. Mr. Clayton is a member of the American Society of Civil Engineers, the American Water Works Association, and the Engineering Association of the South.

OBITUARIES

Maurice A. Vielé of the engineering firm of Vielé, Blackwell & Buck of New York City, died in that city April 10. Mr. Vielé was a graduate of Massachusetts Institute of Technology, and was formerly assistant engineer with the Croton aqueduct commission. The firm, which he founded in 1906, has been connected with some of the largest hydro-electric development projects in the country.

TABLE I.—DETAILS OF HIGHWAY IMPROVEMENTS FOR LETTING APRIL 30 BY STATE HIGHWAY COMMISSION OF OHIO.

County	Road section.	Road.	Township.	Type.	Length, miles.	Width pavement, ft.	Width roadway, ft.	Estimated cost.
Champaign	Sec. L	Urbana-Sidney	Salem	Concrete	1.00	14	26	$13,381
Defiance	Sec. C	Hicksville-Defiance	Mark	W. B. macadam	4.03[1]	16	26	36,963
Erie	Sec. M	Milan-Elyria	Florence	W. B. macadam	1.00	16	26	15,764
Fulton	Sec. E	Wauseon-Morenci	Dover	W. B. macadam	1.05	14	24	9,176
Greene	Sec. R	Dayton-Chillicothe	Silver Creek	W. B. macadam	2.76	14	26	19,793
Harrison	Sec. M	Cadiz-Carrollton	Archer	W. B. macadam	1.59	12	26	14,775
Harrison	Sec. N	Steubenville-Cambridge	Cadiz	W. B. macadam	.42	12	26	4,953
Highland	Sec. H	Milford-Hillsboro	Liberty	W. B. macadam	2.50	14	26	15,819
Knox	Sec. H	Columbus-Wooster	Clinton	Brick	2.05	14	26	44,211
Medina	Sec. L	Medina-Norwalk	York	Concrete	1.29	10	16	16,802
Medina	Sec. M	Ashland-Medina	Harrisville	Concrete	2.09	16	26	25,319
Monroe	Sec. H	Caldwell-Woodsfield	Summit	Brick	1.00[2]	14	26	22,324
Monroe	Sec. G	Malaga-Alledonia	Sunsbury	Brick	1.17	14	24	25,124
Paulding	Sec. G	Paulding-Van Wert	Paulding	W. B. macadam	2.01[3]	14[4]	24	12,001
Paulding	Sec. F	Paulding-Woodburn	Paulding	W. B. macadam	1.96	14	24	17,256
Perry	Sec. M	Logan-New Lexington	Salt Lick	Brick	1.66	16	26	46,428
Portage	Sec. N	Akron-Youngstown	Palmyra	Concrete	1.73	12	26	21,237
Portage	Sec. M	Ravenna-Parkman	Freedom	Concrete	3.16	12	26	39,233
Putnam	Sec. H	Van Wert-Ottawa	Monterey	W. B. macadam	1.97	16	26	7,063[5]
Richland	Sec. M	Mansfield-Shelby	Jackson	W. B. macadam	1.54	12	26	11,692
Richland	Sec. N	Mansfield-Wooster	Madison	W. B. macadam	2.95	12	26	25,467
Ross	Sec. K	Chillicothe-McArthur	Scioto	Concrete	1.52	16	26	13,305[6]
Ross	Sec. L	Chillicothe-Lancaster	Green	Brick	1.00[7]	16	26	14,837
Ross	Sec. M	Columbus-Chillicothe Western	Union	Brick	1.00	16	26	16,569
Stark	Sec. G	Akron-Canton	Plain	Brick	1.57	16	26	30,837
Summit	Sec. K	Akron-Cuyahoga Falls	Portage	Brick	.47	20	30	13,231
Trumbull	Sec. N	Warren-Sharon	Vienna	G. B. macadam[8]	2.50[9]	14	26	22,855
Trumbull	Sec. M	Youngstown-Warren	Weathersville	G. B. macadam[10]	1.83[11]	14	26	15,259
Bureau of Maintenance and Repair								
Huron	Sec. O	Oberlin-Norwalk	Norwalk	Concrete	1.28	16	26	17,634
Trumbull	Sec. A	Youngstown-Conneaut	Kinsman	Brick	.18	16	26	3,702

[1] Alternate bids will be received on paving with concrete; estimated cost $51.776. [2] Grading roadway for 1.3 miles; paving for 1 mile. [3] Alternate bids on concrete, estimated cost $24,067. [4] 14-ft. and 16-ft. roadway, 24-ft. and 26-ft. [5] Estimated cost item No. 1; estimated cost item No. 2, $7,387. [6] Estimated cost item No. 2; estimated cost item No. 1, $4,000. [7] Alternate bids on concrete, estimated cost $13,800. [8] Glutrin bound macadam, rolled slag foundation. [9] Alternate bids on sandstone foundation; estimated cost, $20,796. [10] Glutrin bound macadam, sandstone foundation. [11] Alternate bids on crusher run foundation; estimated cost, $17,510.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette　C. S. Hill　C. T. Murray　S. C. Hadden　C. W. Malcolm　C. R. Thomas

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A Series of Twelve Articles on the Valuation of Water Works Properties.

In this issue we publish the first in a series of twelve articles on water works valuation. These articles, written by Halbert P. Gillette, Editor-in-Chief of Engineering & Contracting, will be published at the rate of one a month. The titles of the twelve articles are as follows:

(1) Inventorying a Water Works Plant.
(2) Estimating Accrued Depreciation; Inspection and Tests vs. Life Formulas.
(3) Appraisal of Reservoir Site Value.
(4) Appraisal of Water Right Values.
(5) Appraisal of "Development Cost" or "Going Value" and "Franchise Value."
(6) Appraisal of "Overhead Costs."
(7) Appraisal of "Working Capital."
(8) Detailed Appraisal of a Water Works in a City of 25,000.
(9) Prorating the Plant Value to Different Uses.
(10) What is a Fair Rate of Return on Money Invested in Water Works Properties?
(11) Some Disputed Points in Water Works Valuation.
(12) Sources of Information and Bibliography.

While numerous short and long articles and papers on water works valuation have heretofore been published in this journal and elsewhere, the series here announced is the first of its kind. The articles will contain many specific suggestions on water works valuation procedure not previously published.

The subject matter of this series is obviously of vital interest to the owners and managers of privately owned water works properties. The valuation engineer will likewise find the articles of immediate help in his work. The regulation of municipally owned plants is sure to come, and officials of such works who expect or hope to remain in the water works business should take advantage of the opportunity here announced to obtain a thorough grounding in this subject. Even where "home rule" is in force new rate schedules should be drafted on a properly made valuation of the water system as a basis. In a word, the series of articles here announced will be of direct interest and utility to all water works engineers and operators.

Most of our readers know the writer of these articles as the author of the "Handbook of Cost Data," "Rock Excavation," "Earthwork" and other books on construction methods and cost and are aware that, since the time when he served as chief engineer of the Washington Railroad Commission, he has become one of the high authorities on valuation subjects. During the past ten years he has had charge of the appraisal of more than $600,000,000 worth of public utility properties. Although Mr. Gillette has written many separate appraisal articles based on his wide experience, this is the first *series* of articles on valuation that he has produced.

Procedure Adopted in New York to Secure the Passage of a Satisfactory Building Code.

On account of the multiplicity and diversity of interests involved it has, in the past, been found practically impossible to frame a building code, the requirements of which would be equally fair to all parties affected. Ordinarily building codes have been framed by a small committee, and then have been brought up for passage without affording opportunity for full discussion of the merits or defects of their provisions. As definite action upon the code as a whole was called for, it was usually impossible to secure adequate discussion by those vitally interested. On account of the methods employed in framing and adopting such codes it is not to be wondered at that building departments and city councils are continually being petitioned to permit infractions of certain provisions of such codes. As is generally known, New York has for years been a center of strife due to various attempts to secure the passage of an adequate building code, and it has only recently been possible to secure progress toward this end by adopting new methods of procedure.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

About a year ago R. P. Miller was appointed engineer for the aldermanic committee, and under his direction the building code is being revised, section by section, with the object in view of introducing each section as a separate ordinance. Opportunity for full discussion is afforded as the tentative drafts of the revised sections are first published, comment is then invited, the amended section is introduced as an ordinance, a public hearing is held, and finally the ordinance is either passed or recommitted.

Final action has already been secured on those sections which refer to partition walls and fences, to plumbing, and to fire limits and suburban limits. Other sections which have been revised and introduced in the Board of Aldermen include those pertaining to: materials, wood construction, iron and steel construction, working stresses and loads, and elevators, the latter having been recommitted. On April 1 a public hearing was held on iron and steel construction and on wood construction, and on April 8 another hearing was held to consider working stresses and loads. Sections which have been tentatively revised include those referring to: reinforced concrete, light and ventilation, exits, classification of buildings, and excavations and foundations; these sections, however, have not been introduced as ordinances.

It will be noted from the above that definite progress is now being made, and it is reasonably certain that all obstacles will be overcome by the procedure adopted and that a satisfactory code, covering essential building requirements, will soon be in force. Those in charge of framing and securing the passage of building codes in other cities should investigate fully the methods now being used in New York before attempting to secure the adoption of comprehensive building codes in their entirety.

Locating Deposits of Sand Suitable for Use in Water Filters.

In Engineering & Contracting of March 17, 1915, we published an account of the use of Mississippi River sand as a filter medium in Moline and Rock Island, Ill. The experience of the two cities has been the same; river sand has been in use for two years with results which indicate its permanent use. At Moline the river sand supplanted a well known bank sand from Minnesota at a net saving per cubic yard of sand ready for use of $5.26.

The results at Moline and elsewhere in the use of river sand as a filter medium, when considered in connection with the unmistakable trend toward the filtration of all surface supplies, indicates the desirability of making sand surveys in the various states for the purpose of locating deposits of sand suitable for use in water filtration. Engineers on large filtration projects can doubtless be depended upon to investigate the relative economic advantages of local and remote sand deposits, but for the smaller projects the engineer is likely to think of filter sand as a commodity for purchase through well established market channels. It is for the benefit of the latter class of works that the co-operation of state agencies is here suggested.

Engineers should urge state geological departments to locate and map all the deposits of sand within the several states which are suitable for the use here under discussion. In some states the state water survey experts will doubtless be glad to co-operate with the geological department in making these filter sand surveys.

Fargo Referendum Abolishes "Free Water."

Water works men, the country over, will be interested to learn that the first use of the referendum in the State of North Dakota was at Fargo, on April 6, at which time a new water works ordinance was passed by popular vote after the Board of City Commissioners had refused to pass it. The ordinance, which is published in the water works section of this issue, provides for the abolition of "free water," creates a water works fund and subsidiary funds, including a depreciation fund, and makes illegal the use of this water fund for other than water department expenditures. Since it is generally believed that the great difficulty with respect to a referendum is to get the voters to understand the question at issue, the result of the vote at Fargo is reassuring to friends of direct legislation. That the voters on that particular day, were not in a mood to endorse everything is shown by the fact that the proposed bond issues for a city market, a municipal abattoir and garbage incinerator all lost by small margins. Water Commissioner Robert Blakemore was re-elected, although some of the other city officials up for re-election were defeated.

Some of the local conditions leading up to this referendum are of sufficient general interest to warrant their review at this time. Fargo has a City Commission of five members: the president and the commissioners of water, streets, finance, and police and fire. The city is proud of its Commission; all the Commissioners are men of energy, ability and unquestioned integrity. Failure of the Commission to agree on the passage of the water ordinance was not due to personal antagonism. The difficulty arose out of the division of the city government into revenue and non-revenue producing departments, and out of the natural tendency of men not to show but to shift the true expense of their department upon another department having an independent source of revenue. Water Commissioner Blakemore was unable to bring his fellow Commissioners to his viewpoint with reference to water fianances, and so appealed directly to the people, with the result already stated.

Under the conditions which have existed in Fargo the City Commission has in a sense been a water board of five members, four with official interest in water finances adverse to that of the Water Commissioner. Thus the Fire Commissioner needs water under high pressure for fire-fighting purposes. This pressure entails a considerable expense in hydrant maintenance and repairs to broken and leaky mains. All this expense has been borne by the water department, thereby enabling the Fire Commissioner to minimize his annual expense for fire protection.

The Street Commissioner also was aided in making a showing of economy in his department, for he secured free the water needed in street cleaning and sprinkling and for sewer flushing. His department also makes use of the fire hydrants.

The President of the Commission and the Finance Commissioner have been interested in keeping down as low as possible the tax levy for general expenses. By having the old water works fund to draw upon it was possible to keep the general tax levy low, although this procedure worked an injustice upon those paying for water for domestic and manufacturing purposes.

Under the new order of things, since the passage of the water ordinance, the other departments will have to pay for water used and for the readiness of the water department to serve them. The true expenses will be more clearly defined in all departments. It will no longer be possible to reappropriate money from the water works fund for general municipal expenses.

"Free water" has played such a prominent part in loose and misleading forms of municipal accounting, thereby retarding the efficiency and economy movement, that we are always glad to see a city abolish it. The Fargo experience is of interest, as it shows that where the subject is properly agitated, as it was in that city, the people can be made to see the point.

The Fatigue Element in Production: An Example.

The effect upon production of increasing or decreasing the number of hours worked per day or per week is a subject which is now receiving considerable attention. The tendency to fix by legislation the length of the working day probably would not be so pronounced if employers understood better the effect of fatigue upon the efficiency of labor. The need for definite data on this subject is great, as much of the discussion has been based on sentiment or hypothesis. Some pertinent facts have been brought out by an investigation of this subject by the Cleveland Hardware Company, and reported in the *Iron Age*. The general conclusion drawn from the results of this investigation, which involved a working day both longer and shorter than eight hours, was that the most satisfactory results were accomplished by limiting the men to an eight-hour day. As the character of the work is an essential factor in any investigation made to determine the importance of the fatigue element, the following data on the results of this investigation are pertinent:

Until about two years ago the work in the drop forge shops of this company was done in two shifts, each shift working 60 hours per week—which is usual practice. The day men worked 10 hours per day, six days per week, while the night shift worked 12 hours per day, five days per week. The day men were allowed to work over-time 2 hours per day, thus keeping the forge shop in operation continuously. On Jan. 1, 1913, orders were issued prohibiting any employe from working more than 60 hours per week. With practically the same men and equipment the output during 1913 was the largest in the history of the company. The results were so satisfactory that it was decided to reduce a day's work to 8 hours, and this was gradually done in the various departments in 1914, until all of the employes, with the exception of those in some of the repair departments, are now on an 8-hour schedule. Practically all shop employes, with the exception of the die makers, are on piece work, and the piece work prices were not changed with the shortening of the working hour. In general, the employes are doing as much work in the forge shop and in the press room, and are earning as much, in 8 hours as they previously did in 10 hours.

The above data are by no means conclusive, and the kind of work reported is rather strenuous, but the results accomplished in this particular case emphasize the need of data applicable to various working conditions. In many lines of work it is important that the men be given sufficient time to recuperate, and the increased effort put forth during shorter working hours is more than compensated by the benefits derived from longer rest periods. Moreover, the possibility of being able to give employment to a greater number of men, working in shifts, is an important factor in certain kinds of work. We believe that employers would do much toward solving their labor and production problems if they would give more attention to the fatigue element, by making similar investigations of their particular problems.

WATER WORKS

Design and Methods and Cost of Constructing the Los Angeles City Trunk Line, Connecting Aqueduct to Distribution System.

Contributed by Burt A. Heinly, Secretary to
William Mulholland, Chief Engineer, Bureau
of Water Works and Supply, Los
Angeles, Calif.

The Los Angeles Aqueduct, by means of which streams flowing down the eastern face of the Sierra Nevadas are collected and carried 233 miles across the Mojave Desert and through several mountain ranges, terminates 25 miles northwest of Los Angeles. The system that connects the aqueduct with the city and provides the means of storage, regulation and distribution of the aqueduct's daily flow of 258,000,000 gals. is of an importance second only to the aqueduct itself. It comprises five prospective or already constructed reservoirs of a total storage of 64,228 acre-feet, a cascade of spectacular engineering construction, 7,975 ft. of open conduit, 4,951 ft. of covered conduit, 5,254 ft. of tunnels and 106,974 ft. of inverted steel siphons and penstocks ranging from 40 ins. to 72 ins. in diameter. Known as the City Trunk Line, for which bonds to the amount of $1,500,000 were voted in 1913, this system was constructed and placed in operation during the latter portion of last year. The appropriation made no provision for the work of constructing the larger reservoirs nor for the 350 miles of steel pipe lines which will gird and criss-cross the San Fernando Valley below the outlet of the aqueduct in every direction to provide an irrigation and domestic supply. For this purpose, alone, the district to be benefited has voted a bond issue of $2,660,000 for the installation of the distribution system. This article gives in outline the general plan of the Trunk Line with emphasis on the more important phases of construction.

THE CASCADES.

The Los Angeles Aqueduct terminates at the outlet of a tunnel whose southern exit opens forth from the steep southern face of the Santa Susana mountain range onto a projecting spur or ridge at an elevation of 1,461 ft. above sea level. The face of the cliff was cut back 20 ft. to solid rock and a bulkhead of concrete 3 ft. wide at the base, 2 ft. wide at the top and 13½ ft. high was built. This is shown in Fig. 1. In this bulkhead two cast steel, hand operated sluice gates, each 4x5 ft., on bronze bearings and lifted by 2¼-in. screws, are installed for the control of the aqueduct flow. From this point for a distance of 1,037 ft., the construction follows the summit contour of the hogback making in this distance a descent of 167 ft. The first 49 ft. comprises 11 steps, each of 2-ft. elevation and 4-ft. tread with a 4½-ft. concrete wall on each side to prevent overflow, as shown in Fig. 1. From the base of the steps the water is carried to the foot of the ridge in a concrete canal ranging from 19 ft. wide and 4 ft. deep at the summit to 71 ft. wide and 6 ft. deep at the base. This is shown in Fig. 2. The whole structure has the one object of simulating a mountain stream in freshet and the results attained make it one of the attractions of the section. The first 720 ft. of this canal has a drop of 1.4 to 24 per cent; the last 220 ft. has a 30 per cent drop, the bed of the canal being strewn with boulders which project from 4 to 6 ins. above the concrete, thus changing the swiftly moving flow of water into a foam-churned torrent. While the aesthetic idea is uppermost, there is a utilitarian object in the thorough aeration of the water.

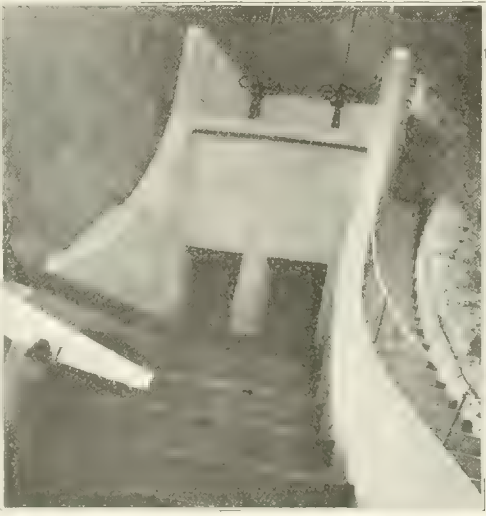


Fig. 1. Close View of Outlet Structure of the Los Angeles Aqueduct, Showing Bulkhead, Gates and Top Steps of Cascade.

At the base of the cascades the water enters an open concrete lined conduit of a capacity of 20,000 miner's inches (258,000,000 gals. per 24 hours of flow). A section of the open conduit is shown in Fig. 3. The high momentum gained from the descent of the cascades is arrested by the 63° angle of intersection of the cascades with the conduit and the water enters straightaway of the latter as a comparatively slow running and unagitated stream. The cascades were constructed at an average cost of $3 per lineal foot for excavation and $12.48 per lineal foot for concreting.

OPEN CONDUIT.

The open conduit has a length of 7,975 ft. with a capacity of 20,000 miner's inches. The grade varies from 1 to 2.58 per cent and the velocities from 15.6 to 22.3 ft. per second. $n = .014$ in Kutter's formula. The conduit is 4 ft. wide at the bottom and 15 ft. wide at the top with a 6-in. invert and with side slopes of 1½ to 1; the walls being carried to a free board of 15 ins. Excavation was in a heavy dobe clay and was done with scrapers at a cost of 70 cts. per foot which included trimming. The concrete lining is 6 ins. thick of a 5½ mix, the gravel being washed and brought from a stream one-half mile distant at a cost of 50 cts. per cubic yard. A view of the concreting is shown in Fig. 4. No forms were used. Every 12½ ft., 2x6's were laid and as the concrete was delivered from above by a No. 11 Austin Cube mixer it was screeded off by a screed held on the 2x6-in. guides, which were then removed, the spaces filled and the mass trowelled to a smooth surface. The cost of concreting was $2.80 per lineal foot. With a force of 20 men, the average rate of progress was 150 ft. per day. This open conduit lies in the bed of the Upper San Fernando Reservoir site, where when additional storage is required, a reservoir of 23,000 acre-feet will be constructed.

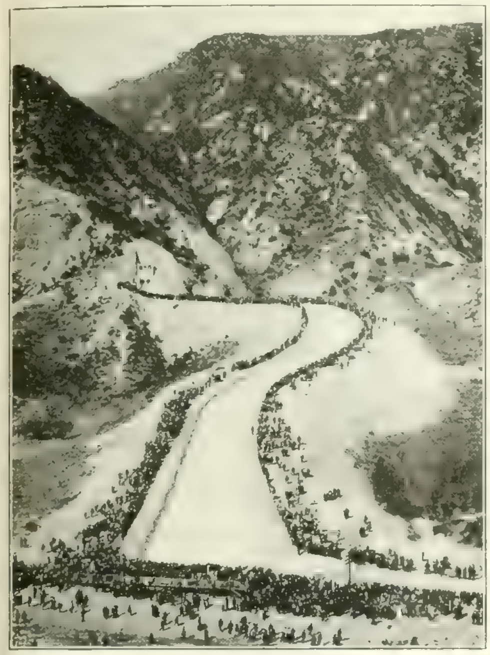


Fig. 2. General View of the Cascades at the Outlet of the Los Angeles Aqueduct.

COVERED CONDUIT AND TUNNELS.

At the dam site of this prospective reservoir, the form of construction assumed is that of covered conduit, shown in Fig. 5, and tunnel, shown in Fig. 6, which follows the high water line on the west side of the Lower San Fernando Reservoir. With the two tunnels aggregating 1,575 ft., this section has a length of 6,426 ft. At the end of the open conduit, 5,000 miners inches will be by-passed into the Lower San Fernando Reservoir, so that the capacity of the covered conduit section is 15,000 miner's inches. From this section, also, the Chattsworth Conduit with a capacity of 11,500 miner's inches will lead off eleven miles to the westward, serving as a trunk line for diversion of irrigation water to the valley beneath or for winter storage at its terminus in the proposed Chatsworth reservoir with a capacity of 25,000 acre-feet. The conduit has a slope of 0.0005 with $V = 4.8$ ft. per second; $n = .014$ Kutter's formula. The hydraulic grade of the conduit at its upper end is 4 ins. above high water elevation of the reservoir and 1 in. at the lower end. Excavation was in a soft sandstone overtopped with clay and was accomplished with a Model "40" Marian shovel, electric equipped with a 1¼-cu. yd. dipper, at a cost of 48 cts. per lineal foot. The average progress per day was 60 ft. No shooting was required.

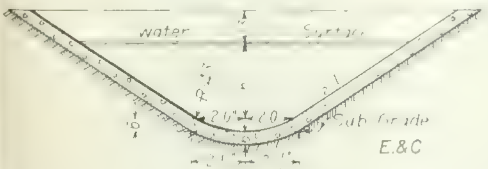


Fig. 3. Section of Fernando Open Conduit of Los Angeles City Trunk Line.

HYDRAULIC PROPERTIES OF SECTION

Slope.	h.	Area.	W. P.	R.	C.	V.
0.0258	2.25	17.95	12.31	1.46	115	22.30
0.0217	2.36	19.15	12.70	1.51	[illegible]	20.90
0.0147	2.62	22.11	13.64	1.62	117	18.10
0.010	2.90	25.78	14.66	1.74	[illegible]	[illegible]
0.016	2.56	21.43	13.43	1.60	117	[illegible]
0.015	2.60	21.90	13.52	1.62	117	18.25

In all cases N in Kutter's formula taken as 0.014. Capacity of all sections equals 400 cu. ft. per sec.

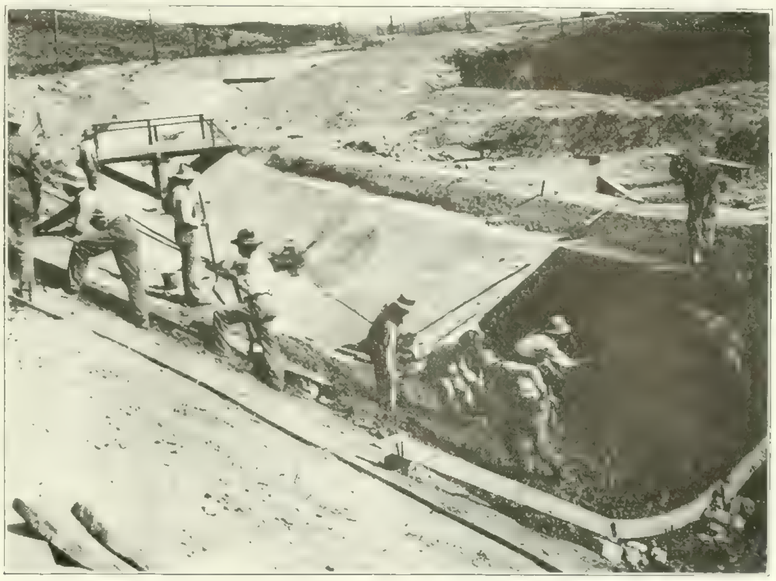


Fig. 4. View of Concreting Operations on Fernando Open Conduit Section of Los Angeles City Trunk Line.

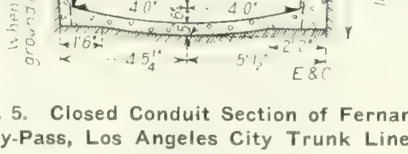

10-3"
9'3"
W.S.
When conduit projects above original ground carry face vert. to solid ground
Plain Rods 2'cc
R=16.3'
7.1'
Sub grade
Steel Rods 9"cc
Plain Rods 1'cc
Batter 1 to 12
8'-0"
Make face vertical entire length of conduit on downhill side
4.0'
4.0'
1'6"
4.5¼"
5'1½"
2'2"
E&C

Fig. 5. Closed Conduit Section of Fernando By-Pass, Los Angeles City Trunk Line.

Construction Quantities. Per lineal foot of conduit for normal section. Excavation, 3.11 cu. yds.; concrete in conduit, 0.54 cu. yd.; concrete in cover, 0.203 cu. yds.; steel in cover, 17.66 lbs.; steel in walls, 14.08 lbs.

Hydraulic Properties: Slope, 0.0005; capacity, 303.7 cu. ft. per sec.; velocity, 4.785 ft. sec.; area, 63.48 sq. ft.; wetted perimeter, 22.30; R, 2.847; N, 0.014; C, 126.86.

The covered conduit section, Fig. 5, is similar in design to Aqueduct covered conduit sections but is smaller. The depth is 8 ft. 1 in. and the width 8 ft. at the bottom to 9 ft. 3 ins. at the top, with a batter of 1 to 12. On the reservoir side of the conduit, the outer face of the lining was made vertical. Side walls are of a minimum thickness of 6 ins., the bottom 9 ins. and the cover from 6 ins. at the sides to 7 ins. at the center. Reinforcement of sidewalls on the hill side is of ⅝-in. plain rods spaced 2 ft. center to center, and on the reservoir side, ⅝-in. rods spaced 1 ft. center to center. The cover is reinforced by ⅝-in. square twisted rods, placed 9 ins. center to center, and is designed to carry a load of 300 lbs. to the square foot with a factor of safety of 4. A 5½ to 1 mix was used for the cover and a 6 to 1 mix for side and bottom. The cost of finished conduit amounted to $8.90 per lineal foot.

The two tunnels, Fig. 6, one of 875 ft. and the other of 700 ft. which are located about midway in the conduit, were driven through an indurated gravel and clay, comprising an ideal material in which practically no timbering was required. The work was done by hand at a cost of $7.50 per foot. Making and placing of forms cost $1 per foot and the concreting $6.50 per foot, making this work cost complete, $15 per lineal foot. The tunnels have a slope of .0009, with $V =$ to 5.8, $n = .014$ Kutter's formula. The sidewalls are on a batter

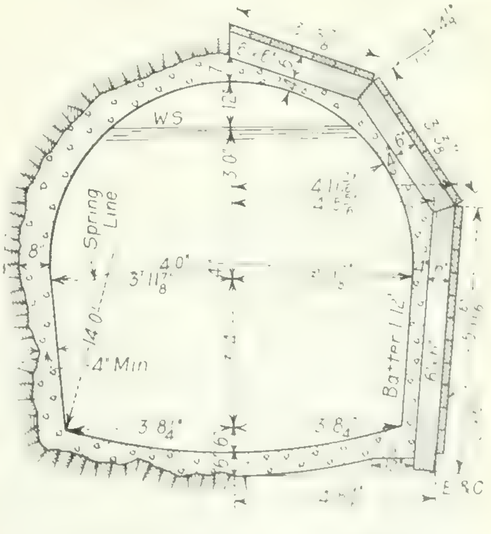


Fig. 6. Tunnel Section of Fernando By-Pass, Los Angeles City Trunk Line.

Construction Quantities.—Per linear foot of tunnel normal section. Excavation (timbered) 3.10 cu. yds., (untimbered) 2.73 cu. yds.; concrete, (timbered) [illegible] (untimbered) 0.69 cu. yds.; timbers, 15 B. M.; spreaders, 5 B. M. [illegible] B. M. [illegible] B. M.

Hydraulic Properties: Slope [illegible] capacity, 302.5; velocity, 5.784; area, 52.30; wetted perimeter, 21.65; R, 2.416; N, 0.014; C, 124.075.

of 1 to 12 inwards, the top is semi-circular and the bottom has a 6-in. invert.

At the lower end of the covered conduit there is a waste wier with a crest width of 40 ft. capable of discharging the full capacity of the conduit into the Lower San Fernando Reservoir, the flow being regulated and diverted either into the reservoir or on into the inverted steel siphon of the City Trunk Line by means of radial balanced gates.

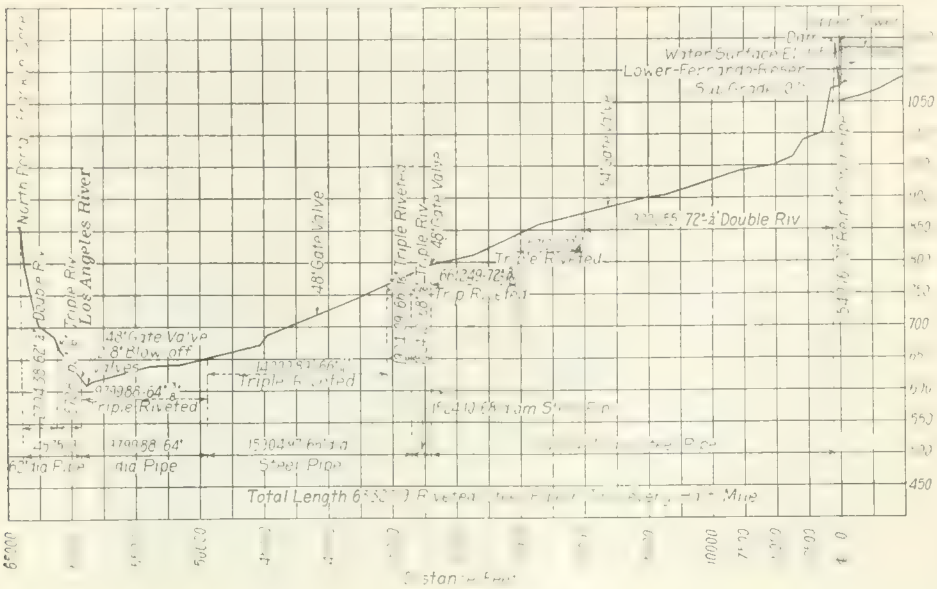


Fig. 7. Profile of the San Fernando Inverted Steel Siphon, Los Angeles City Trunk Line.

The covered conduit connects with a gate tower in the reservoir by means of a monolithic concrete pipe of 6 ft. internal diameter, 170 ft. long designed for a maximum head of 57 ft. The pipe has a shell of 12 ins. of a 4½ to 1 mix, reinforced circumferentially by ¾-in. rods placed 7½ ins. center to center. The gate tower is so designed that it may not alone deliver water from the conduit but also by means of the gates with which it is furnished, draw upon the reservoir in case of interruption of the Aqueduct flow.

LOWER SAN FERNANDO RESERVOIR

Only a word is here possible concerning the Lower San Fernando Reservoir. The dam comprising a total fill of 2,700,000 cu. yds. has been constructed by the hydraulic fill process and is one of the most extensive to be built by this means. It has a width at the base of 720 ft., a crest length of 2,060 ft. and a height of what is to be ultimately 140 ft. Work was begun in 1911 and was discontinued temporarily, to give time for settlement, on Jan. 1, 1915, at which time the fill amounted to 2,100,000 cu. yds., and had been carried to a height of 90 ft. Filling of the reservoir, which with the dam to a height of 140 ft., has a capacity of 23,000 acre-feet, was undertaken January 15, to provide an assured supply for this season's irrigation.

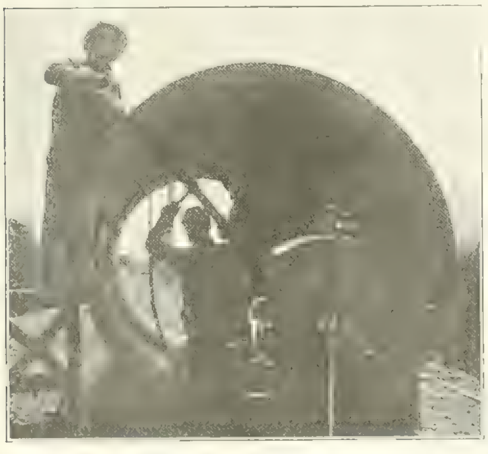


Fig. 8. View Showing Field Riveting on San Fernando Siphon of the Los Angeles City Trunk Line.

THE SAN FERNANDO INVERTED STEEL SIPHON.

At the gate tower begins the San Fernando inverted steel siphon by which more than half the full flow of the aqueduct is carried across the San Fernando Valley a total distance of 63,327 ft. under a maximum working head of 260 ft. to the crest of the Santa Monica mountain range which hems the valley on the south. This siphon, a profile of which is shown in Fig. 7, comprises the most difficult and expensive part of the City Trunk Line. It required 8,260 tons of steel for its fabrication and is a noteworthy example of pipe line construction and design.

The siphon at its inlet is designed for a capacity of 11,500 miner's inches which with the trunk lines and irrigation laterals leading from it, is reduced to 7,500 miner's inches at the point where it makes delivery into the Franklin tunnel near the crest of the Santa Monica range. By shutting all diversion gates, this flow at the outlet is capable of being increased to 9,000 miner's inches. From an inside diameter of 72 ins. at the inlet, the siphon, as diversions are made, is gradually reduced to 62 ins. The inlet elevation at the San Fernando gate tower is 1,075 ft. above sea level with hydraulic grade at 1,134. The elevation of the outlet is 854 ft. above sea level. With the steep slope of 4 ft. to 1,000, the siphon carries the high velocity of 8 ft. per second.

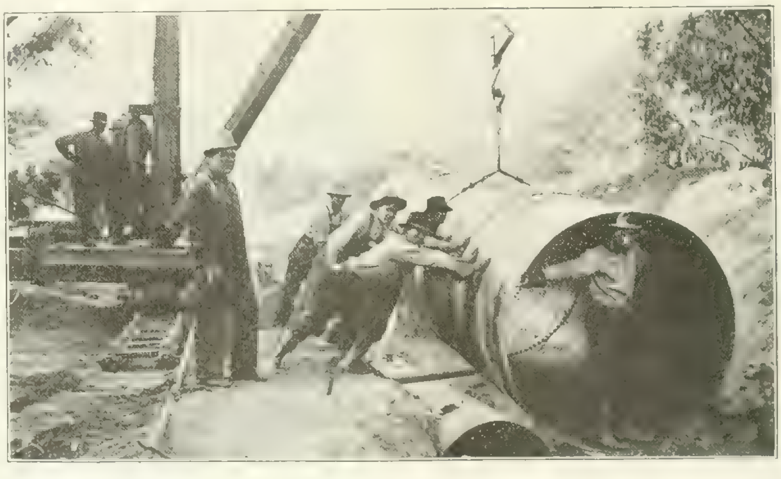


Fig. 9. View of Stiff Leg A-Frame Derrick, On Track, Swinging a Section of 68-in. Steel Pipe into Trench, Los Angeles City Trunk Line.

On account of the high expense, the line was not designed for full static pressure but is constructed for full pressure up to the maximum hydraulic grade line with a maximum safety of 4. This is equivalent to 15,000 lbs. per square inch maximum pressure on the net section.

Single sheet construction is used throughout, the design and fabrication following the methods employed on the 21 steel siphons of the Los Angeles Aqueduct. The line was designed and built of lap joints of alternate inside and outside sections, the plates being 69 ins. long. All rivets were cone headed: ⅝-in. rivets were used on the ¼-in. and 5/16-in. plates with 11/16-in. open holes; and ¾-in.

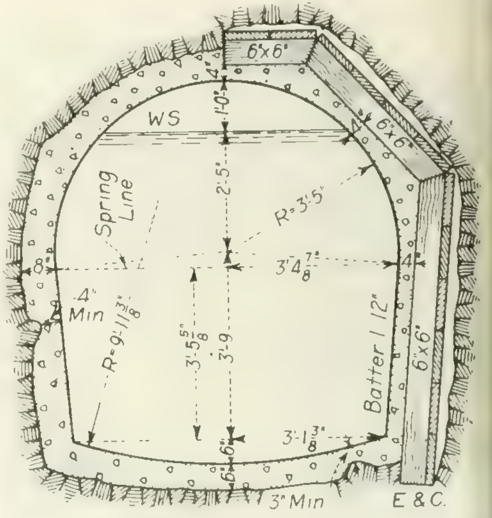


Fig. 10. Franklin Tunnel Section of Los Angeles City Trunk Line.

Construction Quantities.—Per linear foot of normal section: Excavation, (timbered) 2.82 cu. yds., (untimbered) 2.31 cu. yds.; concrete, (timbered) 0.80 cu. yds., (untimbered) 0.66 cu. yds.; timbers, 13.80 B. M., lagging, 48 B. M.; shoulder braces, 7 B. M.

Hydraulic Properties.—Hydraulic slope, 0.0009, 0.001, 0.0011 or 0.0012; area, 41.63; wetted perimeter, 19.24; hydraulic radius R, 2.163; $\sqrt{R}$, 1.47. For slope of 0.0011, C = 122.19; velocity = 5.96 ft. per second; discharge = 248.11 cu. ft. per second.

TABLE I.—DATA ON STEEL IN SAN FERNANDO SIPHON.

Length, ft.	Diameter, ins.	Thickness, ins.	Longitudinal riveting.
19,200.55	72	1/4	Double
5,710.00	72	1/4	Triple
6,612.49	72	5/16	Triple
1,524.10	68	5/16	Triple
1,904.09	66	5/16	Triple
14,000.89	66	3/8	Triple
9,799.88	64	3/8	Triple
1,870.81	62	5/16	Triple
2,704.38	62	1/4	Double
63,327.19			

rivets for the ⅜-in. plate with 13/16-in. open holes. Riveting followed the Hartford Boiler Standard specifications with the efficiency of the joints having a maximum of 72 per cent.

The steel for both plates and rivets was all made by the basic, open hearth process, the quantities, diameters, riveting, etc., being shown in Table I.

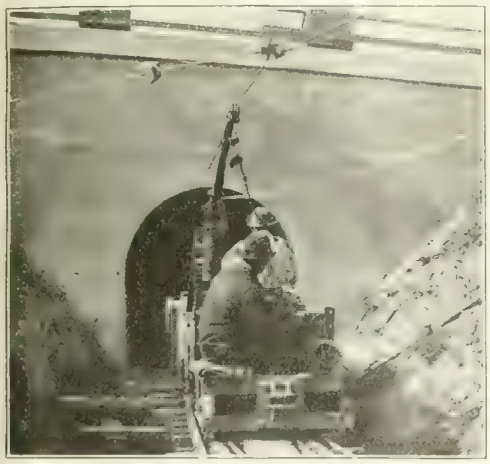


Fig. 11. South Portal of Franklin Tunnel of Los Angeles City Trunk Line. Tunnel Passes Through Crest of Santa Monica Mountains. Shows Type of Electric Locomotive Used on Construction.

As the time was an important element, the work was divided so that a local contracting firm did part of the work, and the city the remainder. The contractor's part consisted in delivering at trench side, 19,200 ft. of 72-in. and 4,575 ft. of 62-in. in 24-ft. sections with rivets for circular seams. The city purchased the remainder of the steel from an eastern factory in plates rolled to true cylinders, beveled, sheared and scarfed.

The gates used were of Rensselaer manufacture, double disk, single gear type, with heavy bevel gear, bronze trimmed and operated by hand, designed for working pressures ranging from 150 to 225 lbs. The large, regulating shut-off gates were designed for the nearest commercial size larger than one-half the diameter of the pipe. These comprise a 54-in. gate with 12-in. by-pass, 4 miles from the inlet, and at intervals of about 3 miles, three 48-in. gates with 8 in. by-passes. These gates are for shutting off any section of the line on which an accident might occur or for cleaning. At intervals of one-half mile, 6-in. gates are provided for the irrigation laterals, a number of which are now under construction, and at the Los Angeles River crossing, two 8-in. blow-off and one 6-in. drain valves are installed. These are capable of adding a flow of about 50,000,000 gals. to the flow of the river which can be taken up farther down stream by the collection works of the Los Angeles river supply system. Every one-half mile manholes with reinforced manhole plates are constructed and on the low sides of shut-off gates, 10-in. saddles are constructed to provide for air valves.

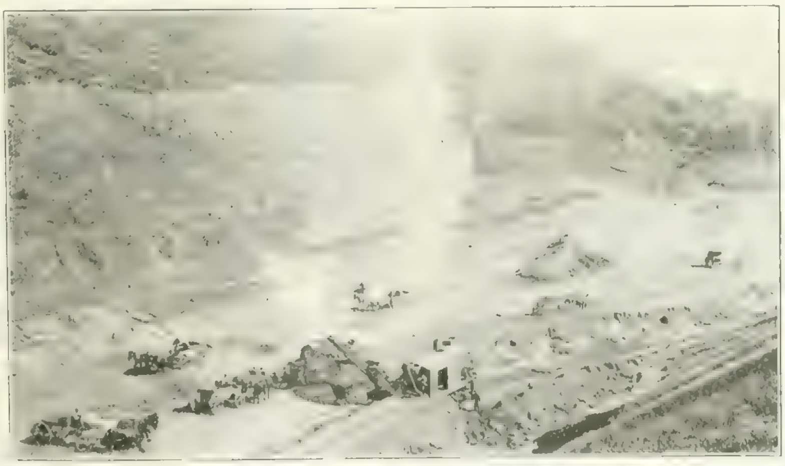


Fig. 12. View Showing Construction of the Lower Franklin Reservoir, Los Angeles City Trunk Line.

The work of construction, as is the rule of the Los Angeles Water Department, was accomplished by its own laboring force under the direction of its own engineers.

The excavation was done with two Model 40 Marion steam shovels of ¾-cu. yd. and 1¼ cu. yd. capacity. Each was equipped for this particular kind of work with an extra long boom 25 ft. in length. The aim was to have the top of the pipe a minimum of 3 ft. below the surface of the ground. This made the depth of ditch range close to 9 ft., the width being as narrow as the shovel could dig, or from 10 to 11 ft. Excavation was in an ideal formation of sandy loam that stood without cribbing excepting in a few instances. Shovel crews in an eight hour day accomplished from 85 to 190 lineal feet, the average cost of trenching ranging from 25 to 30 cts. per foot. Shovel runners were paid $150 per month; cranemen, $115; firemen, $75 per month, and pitmen $2.50 per day. The shovels worked 6 days per week, the crews overhauling the shovel on the seventh without allowance for overtime. Backfilling was with Fresnos at the rate of 150 ft. per day for each gang, teamsters being paid $2.50 per day. The cost of this item averaged 18 cts. per running foot.

As stated, the contractor was required to deliver the pipe in 24 ft. sections at the side of the trench. He found it cheaper to rivet into single sections in his shop, then rivet four sections into a tank, or 24 ft. length of pipe, on the ground, air being sold to him for this purpose by the city. With the city it was necessary to unload the nested, unriveted plates and do all the work of riveting, both circular and longitudinal at the side of the trench, as shown in Fig. 8. For this purpose the equipment comprised three compressor stations situated at points near the inlet, middle and outlet of the siphon with air lines of 2-in. and 4-in. inside diameter standard screw pipe. The longest delivery was one of 26,000 ft., through 4-in. pipe. Air compressors used were one Clayton 2-stage tandem of a capacity of 200 cu. ft. of free air per minute under 100 lbs. pressure, driven by a 75 hp. Westinghouse motor, and two 2-stage Ingersoll Rand No. 10 Imperials, each of a capacity of 700 cu. ft. of air per minute under 100 lbs. pressure driven by 100 hp. General Electric motors. Transmission lines of the Southern California Edison Co. in the vicinity were tapped to supply the energy.

From three to five gangs were employed on the city's riveting. Each gang comprised a riveter at $3.50, a caulker at $4.00, a heater at $3.00, a bucker-up at $2.75, a sticker at $2.50 and sometimes an additional helper at $2.50 for an 8-hour day. The gangs worked under a bonus system, compiled at 10-day intervals, amounting to $1.75 per 100 rivets for all over 500 driven in 8 hours. This was divided proportionately among the gang, the riveter foreman who received $150 per month not participating. A rivet that on a tap of the inspector's hammer showed any vibration was rejected and had to be cut out and replaced on the gang's own time. There are defects in the bonus system but if watchfulness is exercised, the city has found that in this line of work, the spirit of co-operation, enthusiasm and personal endeavor can be developed to a high degree. Under this system one gang would rivet from 12 to 15 rings into 4-piece sections in a day. In the trench, 10 round seams was a day's work.

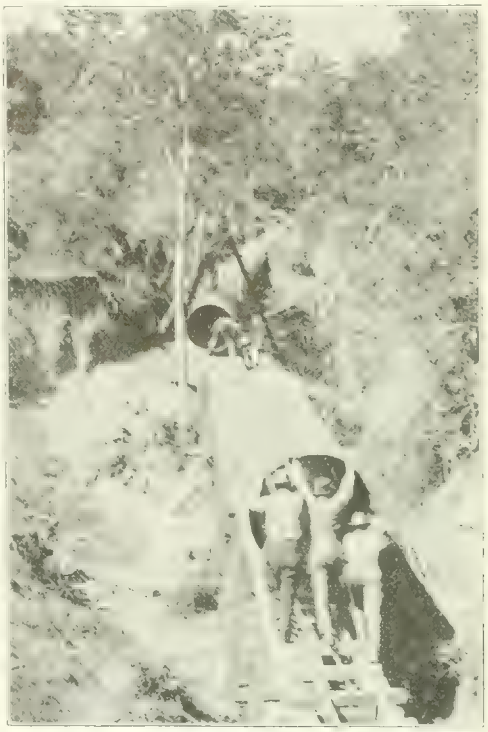


Fig. 13. View Showing the Laying of the 52-in. Penstock Down the Franklin Canyon, Los Angeles City Trunk Line.

After some experimenting, it was found that the quickest and most satisfactory method of fabrication was to rivet the plates into four ring sections or tanks. This made the work of riveting much easier and swifter and reduced the number of bell holes. The "tanks" were hoisted to position in the trench by a stiff-leg A-frame derrick set on wheels and movable rails, as shown in Fig. 9. Riveting in the trench progressed at the rate of 125 ft. per

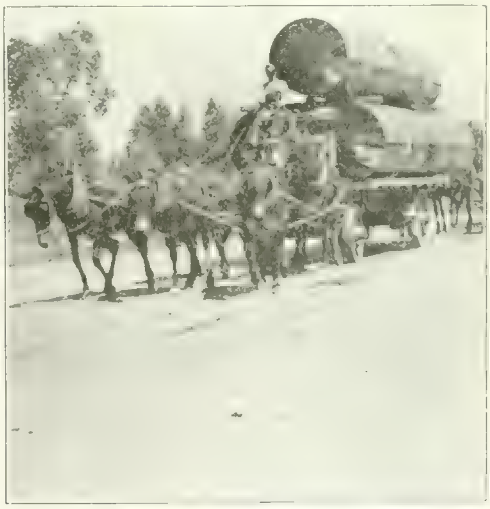


Fig. 14. View of the Hauling of Sections of the 52-in. Penstock to the Trench.

day. Large angles and transitions were shop made but on small bends, no special construction was required, the plates being simply cut and beveled. On curves where the radius was equal to or larger than a 6° railroad curve, it was found that the situation could be handled by a little reaming of the rivet holes. The pipe was all laid with the longitudinal seams uppermost, as shown in Fig. 9, as it has been found by experience that most of the leaks occur where the three thicknesses of steel come together and they are thus made easy of access for recaulking.

In painting, coal gas and water gas tars were used. A coating of the latter which is much thinner than coal tar and of high penetrating qualities was first applied and then on succeeding days, two coats of coal tar both inside and out. No heating was required in the summer months but was necessary with the approach of autumn and winter temperatures. Painting was done at trenchside with brushes. After the pipe was laid, another coat was applied to all round seams and to any abrasions. Comparison of expense with patented preparations is to be noted from the fact that coal tar cost 11 cts. per gallon and gas tar 10 cts. per gallon laid down on the ground in carload lots. The department after having had three years of tests of these materials on the exposed aqueduct siphons finds them an effective substitute for the higher priced coatings.

The transitions at both ends of the siphon consist of blocks of heavily reinforced concrete, covering the pipe to a depth of 2 ft. on all sides for a lineal distance of 8 ft. which serve as anchorages to hold the pipe in place.

FRANKLIN TUNNEL.

The Franklin Canon tunnel shown in section in Fig. 10, 3,781 ft., was the most difficult and expensive piece of excavation on the job as it was in a much contorted and broken stratified formation where heavy timbering was necessary almost throughout. The tunnel has a capacity of 12,405 miner's inches with a velocity of 5.96 ft. per second. The slope is .0011 and $n = .014$ Kutter's formula. Completed, the tunnel has a width of 6 ft. 9¾ ins. and a height of 7 ft. 8 ins., with a semi-circular top and a 6-in. invert at the bottom. Side walls are on a batter of 1 to 12.

Excavation was carried on from both ends, the tunnel being holed 2,600 ft. from the south portal. The breakage was 8x9½ ft. In timbering, 6x6-in. timbers set three segment, 4½ ft. centers with a 6-in. lean-back at the top of the post on each side, were used. All the work was by hand with three shifts employed, the cost averaging about $20 per foot. When concreting was undertaken, the power lines had been brought to the north portal for the pipe work and these were run through to the south portal and electrical equipment from aqueduct salvage was installed. The type of electric locomotive used is shown in Fig. 11. The lining is 6 ins. thick at the bottom with 4 ins. for sides on timbered sections and 8 ins. for untimbered sections, of a 6 to 1 mix and was completed at a cost, including forms, of $7 per lineal foot.

The tunnel empties into a small regulating reservoir of 128 acre-feet with a high water elevation of 850 ft. above sea level, formed by an earthen dam with a clay core wall to bed rock, thrown across the canon to a height of 46 ft. and having a yardage of 34,840 cu. yds.

From the gate towers of this reservoir, a steel penstock 52 ins. in diameter of ¼-in. steel and 6,100 ft. in length leads down Franklin Canon to empty into the Lower Franklin reservoir now under construction, as shown in Fig. 12. The outlet elevation of the penstock is 575 ft. which gives a fall between the two reservoirs of 275 ft. Construction followed the same methods described for pipe work in the foregoing with the exception that inasmuch as the survey follows the floor of the canon as shown in Fig. 13, there are many small angles; 8, 10, and even up to 15° angles were handled by butt strapping instead of with shop made bends. This was accomplished by laying the pipe in its permanent position and putting on the butt straps, made tapering to unite the ends. This meant only one additional row of rivets, avoided heavy cost and prevented much delay. From the fall in this canon, the city will ultimately develop 2,500 hp. of electrical energy whenever the time becomes opportune for the installation of the plant. The method of hauling the 52-in. penstock to the line is shown in Fig. 14.

The Lower Franklin Reservoir, when the dam of 272,000 cu. yds. is raised to its full height of 100 ft., will have a capacity of 1,100 acre-feet and will provide regulation of the flow from the proposed power plant as well as storage for entry into the city's domestic distribution system. At the present time, such flow as is required is by-passed through the bottom of the reservoir to the gate tower at the lower end. From this point, a 68-in. steel pipe of ¼-in. metal is constructed cityward a distance of 4,354 ft., whence it will radiate into three or more smaller trunk lines. One will extend southward to the populous summer and winter resorts that line the Pacific to the south and southwest of Los Angeles; and a second extending north will skirt the foothills of the beautiful and wealthy suburban community of Hollywood.

At the present time only one of these three prospective lines has been constructed and is in operation. This is a 40-in. steel pipe line of ¼, ⅜ and 5/16-in. extending 32,428 ft. due easterly from the end of the 68-in. main to form a junction with the Los Angeles domestic system at Third and Western Avenues. It has a daily capacity of 25,000,000 gals. and in conjunction with the Los Angeles River system with its daily capacity of 65,000,000 gals. daily assures the city, within its present area, of a stable and adequate supply.

The building of this great trunk line system has been overshadowed and almost lost sight of in the engineering achievement of aqueduct construction but in many respects it is no less remarkable than that larger and more spectacular effort which gave it birth.

The Valuation of Water Works Properties.

I. Inventorying a Water Works Plant.

By Halbert P. Gillette.

An *inventory*, as the term is here used, is a tabular statement of the quantities of each class and size of plant units. A *plant unit* is an element of the plant to which a unit price or unit cost can be applied. Thus a cubic yard of rock excavation or a lineal foot of pipe of given size, or a pump, of given description, is a plant unit.

Those who have had little experience with appraisals of public utilities are likely to think that such work differs little from the "stock taking" of a merchant or manufacturer. Hence the common, though erroneous inference that almost any engineer is competent to appraise a utility plant.

While it is true that the counting, measuring and classifying of plant units is ordinarily a matter requiring no great experience, it is equally true that the estimating of unit prices, overhead costs, accrued depreciation, and "going value" or "development cost" are matters of considerable complexity and therefore requiring a wide range of experience and study. Even the relatively simple, though often slow, process of taking an inventory should not be left without the advice of an experienced appraiser. With such advice a small company can usually undertake the making of an inventory of its plant, using its own employes almost entirely for the purpose. In this manner the cost of an appraisal can be kept down. It will be my object to indicate, in a general way, what a small water company should do in order to secure an inventory of its plant without employing outside engineers for that part of the appraisal work, save in an advisory capacity.

The first step should be to adopt a general classification of plant accounts under which the various classes of plant units are to be listed. In a few states the public service commissions prescribe such plant accounts. However, the plant accounts thus prescribed are often not sufficiently detailed, and are never fully complete for appraisal purposes. A water works company should, of course, so appraise its property that it can ultimately group the items in accordance with the accounts prescribed by the public service commission of the state in which the company operates. The Wisconsin Railroad Commission publishes a 140-page pamphlet of "Uniform Classification of Accounts of Water Utilities," prescribing, in great detail, both the capital accounts and the operating accounts for all water works properties in Wisconsin.

The following is a summary of the "Construction and Equipment Accounts" by that commission. I have prefixed reference numbers for convenience:

PLANT ACCOUNTS PRESCRIBED BY WISCONSIN RAILROAD COMMISSION.

1 Intangible capital.
  1a. Organization.
  1b. Franchises.
  1c. Rights, licenses, etc.
2. Land.
  2a. Lands used in operation of property
  2b. Pumping station land.
  2c. Source of water supply land.
  2d. Reservoir, tank and standpipe land.
  2e. General office land.
  2f. Stores department land.
  2g. Utility equipment land.
3. Buildings, fixtures and grounds used in operation of property.
  3a. Steam power pumping station buildings, fixtures and grounds.
  3b. Hydraulic power pumping station bldg., fxt. and grd.
  3c. Electric power pumping station bldg., fxt. and grd.
  3d. Gas power station bldg., fxt. and grd.
  3e. Boiler plant bldg., fxt. and grd.
  3f. Gas producer plant bldg., fxt. and grd.
  3g. Source of water supply bldg., fxt. and grd.
  3h. Reservoir, tank and standpipe bldg., fxt. and grd.
  3i. Distribution bldg., fxt. and grd.
  3j. General office bldg., fxt. and grd.
  3k. Stores department bldg., fxt. and grd.
  3l. Utility equipment bldg., fxt. and grd.
4. Pumping station equipment.
  4a. Steam power pumping sta. equip.
  4b. Hydraulic power pumping sta. equip.
  4c. Electric power pumping sta. equip.
  4d. Gas power pumping sta. equip
  4e. Boiler plant equipment.
  4f. Gas producer equipment.
5. Collecting aqueducts, intakes and supply mains.
6. Purification system.
7. Transmission mains.
8. Distribution mains.
9. Services.
10. Hydrants.
11. Meters.
12. Fire cisterns, basins, fountains and troughs.
13. General office equipment.
14. Stores department equipment.
15. Utility equipment.
16. Miscellaneous equipment.
17. Miscellaneous construction and equipment expenditures.
18. Salaries during construction.
19. Office supplies and expenses during construction.
20. Stationery and printing during construction.
21. Law expenses during construction.
22. Injuries and taxes during construction.
23. Insurance during construction.
24. Taxes during construction.
25. Interest during construction.
26. Discount on bonds during construction.
27. Miscellaneous expenditures during construction.

Under "Current Asset Accounts" the commission prescribes the following:

Cost.
Notes and bills receivable.
Accounts receivable.
Interest and dividends receivable.
Materials and supplies.
Miscellaneous current assets.

If the foregoing items are compared with those that I am about to give it will be seen that an arrangement and classification of accounts for a balance sheet statement, such as the above is, may not serve the purpose very well for an inventory and appraisal. The following is a classification of accounts that I have used in appraising water works properties in states whose commissions prescribed no detailed capital account statement:

AUTHOR'S INVENTORY AND APPRAISAL ACCOUNTS

1. Supply intakes, dams and reservoirs.
2. Supply lines.
3. Pumping equipment.
4. Purification system.
5. Standpipes, tanks and distributing reservoirs.
6. Distributing mains.
7. Services.
8. Hydrants and fire system.
9. Meters.
10. Paving over pipes.
11. Buildings, fixtures and land improvements.
12. Tools and instruments.
13. Teams and vehicles.
14. Furniture.
15. Telephone and signal apparatus.
16. Miscellaneous construction and equipment.
17. Wells.
18. Land and easements.
19. Water rights.
20. Organization, promotion, franchise, license and patent right costs.
21. Engineering and inspection.
22. Business management.
23. Legal costs.
24. Insurance and damages.
25. Taxes during construction.
26. Interest during construction.
27. Contingencies, omissions, waste and incidentals.
28. Brokerage fees.
29. Stores and supplies.
30. Working cash capital.
31. Development cost.
32. Construction uncompleted.

Note, for example, that Item 10, "Paving Over Pipes," is kept separate. It is often a disputed point whether a company is entitled to include in its valuation any allowance for pavement laid over its pipes by the city and not actually paid for by the company. The Supreme Court of the United States, in the Consolidated Gas case, has held that the cost of all pavement over mains should be included in a rate-making valuation, regardless of who paid for such pavement. Several commissions, notably that in Wisconsin, have thus far refused to follow the Supreme Court ruling. It therefore becomes desirable to set up "Paving Over Pipes" as a separate item, and, furthermore, to subdivide the pavement into (1) that known to have been laid by the company, (2) that known to have been laid by the city, and (3) that about which there is doubt as to who laid it.

Other differences will be noted between my list of accounts and that of the Wisconsin Commission, the most important of which are my accounts numbered 17, 19, 27 and 31.

Item 19, "Water Rights," has no counterpart in the Wisconsin Commission Classification unless it be "Source of Water Supply Land." The Wisconsin Commission has allowed water right values in hydro-electric power cases, and now that the U. S. Supreme Court has ruled, in "The San Joaquin and Kings River Canal and Irrigation Co. case" (April 27, 1914), that water right values must be included in a rate-making valuation, every commission must recognize this element of value wherever it exists. In a subsequent article of this series I will discuss water right valuation in detail. Overhead charges (Items 20 to 28) will also be discussed in a later paper, and two other articles will be devoted to "Working Capital" and "Development Cost."

Having selected a plant account schedule, assign numbers to each of the accounts and sub-accounts; or use a combination of numbers and letters to designate each account and sub-account. This greatly facilitates reference and cross-reference, beside saving time and space in writing and typing. Next select a date at which the inventory is to close, making the date the last day of some month, and, if convenient, the last day of the last quarter or last half of a year. Enter this appraisal date on all summary sheets, together with the name of the company.

A fairly complete map or maps of the water works system should be prepared, or existing maps should be brought up to the date of the appraisal. The appraisal map should be filed as part of the appraisal and should not subsequently be altered. In other words, the appraisal map should not be used as a working map. If many maps are needed to cover the entire system, then prepare a small "key map" on which will appear the number of each map sheet. An appraisal map should show locations of supply pipes, mains, services, hydrants, valves, etc. The size and kind of each pipe should appear on the map, also its age, if known. Of course all street names should appear, and the class of pavement should be designated. Since several copies of the appraisal will be required, it will be necessary to trace and blueprint the appraisal map. With this in mind, do not use colored inks nor tints to designate things, but make all lines and letters with India ink. This at least must be done on the tracings.

The map, if carefully made as it should be, will serve to give lengths of pipe by scaling. In this connection let me caution against scaling from the blue prints unless a correction factor is applied for shrinkage of the blue print. I have known instances of scaling from blue prints that resulted in a loss of 2 per cent of the true length of pipe, due to the shrinkage of the print upon drying out. It should be added also that a correction should be made for the slope of the ground in hilly sections, for all maps are based on horizontal measurements. Map shrinkage and ground slope corrections may not be large percentages, but still run into a good many dollars on the final total.

Before a map can be brought up to date it will be necessary to make a "field inspection" of the location of pipes, class of pavement, class of excavation, etc. Field notes are preferably entered in a field notebook, instead of being entered directly on a map, although there are exceptions to this general statement. The records of field notes are subsequently transcribed to the map. Record in the field book the date and name of appraisal, also the names of those who made or assisted in making the field inspection.

One of the most important of the facts entered in the field book is the classification of the excavation. Excavation is usually classed as follows:

Earth
Hardpan
Quicksand
Loose Rock
Solid Rock.

In the note book is entered the estimated percentage of each of these classes between certain streets. Where the earth itself varies considerably in toughness, a further subclassification of earth may be noted, as Tough Clay, Gravel, and Sand. For these classifications it is generally necessary to depend largely upon the memory of the most experienced man in the employ of the company, which can be checked by inquiry among local contractors, particularly sewer contractors. Occasionally it pays to dig some test pits and to drive rods into the ground. Special note should be made of any excavation in very wet ground.

On large appraisals it is customary to prepare printed "forms" or "blanks" upon which are entered all the inventory data. On a small appraisal this is not necessary. In fact, an inventory of considerable size can be well made without the use of a single printed "form," but typewritten forms are usually desirable. A "form" for an inventory for water mains may have a number of columns headed thus:

1. Street.
2. From.
3. To.
4. Distance.
5. Pipe diameter.
6. Class of pipe.
7. Specials.
8. Age of pipe.
9. Classes of excavation.
10. Percentage of each class.
11. Trench depth.
12. Class of pavement.
13. Age of pavement.
14. By whom laid.
15. Number of services.

A similar "form" for services may be prepared.

After entering all the inventoried data on "forms" or in tables that facilitate addition of columns to get totals, check each inventoried item of the distribution system by the aid of the map of the system. To do this provide a special blue print, or preferably a white print, of the distribution system; and cross off each part or item on this print corresponding to each item on the "forms" or in the inventory tables of pipe quantities, etc. By using cross-hatching (parallel lines drawn close together) section after section of the print is crossed off as checking progresses, until the entire print is cross-hatched. Any failure to have entered any pipe lengths, etc., in the "forms" or tables will show up on the print as an area that has not been cross-hatched. Other methods of checking the accuracy and completeness of the inventory might be suggested, but to do so would considerably lengthen a paper that is already quite long.

Whether a quantity survey of the buildings is desirable will depend largely upon their value and the completeness of the records relating to their actual cost. Usually it suffices to estimate inexpensive buildings by applying a cubic foot price to the total volume, or by securing the rough estimate of an experienced building contractor.

If the company has kept "work orders" or the like, it is wise to make a complete index of them. Rule a series of columns, and enter in the first column the number of the work order. In the second column enter the date. Let the remaining columns be serially numbered to correspond with the numbers of the plant accounts. Then look through each work order carefully and enter check marks in the blank opposite the number of the work order and under the plant account number corresponding to the classes of construction recorded in the work order. Thus if a given work order contains work on services, make a check mark in column No. 7 (Services).

By this method the subsequent looking up of work order data is greatly facilitated, but, what is perhaps more important, items of plant will be discovered that would otherwise be overlooked.

I am insistent upon a careful analysis of all the accounting records, even those relating to operating expense, as far back as records are available. Such an analysis invariably discloses items of plant cost that have escaped those who have made the inventory. For example, a railway spur to a coal yard did not appear in an inventory, and the manager of the plant was positive that the spur had been built by the railway at its own expense. Being familiar with railway practice in such matters I doubted whether the railway had paid for more than the "steel" and the ties. My doubt was justified when our analysis of the accounts disclosed that the company had spent $5,000 for grading and bulkheading in connection with the spur.

While, as previously stated, nearly all the work of gathering the data for an inventory can be done by men not particularly experienced in such work, it is wise to have them act under the direction of an experienced appraiser. Moreover, I think an appraisal engineer should himself be a competent accountant, capable of understanding accounts that have been incorrectly kept, and familiar with the details of many different systems of corporation accounts. It is astonishing how frequent are the omissions of items of value where only a field inventory has been made, unchecked by an analysis of accounting records.

New Water Works Ordinance Adopted by Referendum at Fargo, N. D.

(Staff Abstract.)

The essential provisions of the new water works ordinance adopted at Fargo, N. D., on April 6 by a referendum, are here given. The Board of City Commissioners had previously refused to pass the ordinance. Editorial comment on the referendum, and the circumstances leading up to it, is made elsewhere in this issue.

Briefly, the ordinance requires the city of Fargo to provide, annually, by a general tax as for other municipal expenses, a sum based upon the number of city fire hydrants; to pay such sum into the water works fund in payment for services rendered and water used, donated or wasted by the city in extinguishing fires, sprinkling streets, flushing sewers, supplying parks, fountains, city buildings, construction of public improvements, public charities and other municipal uses. The ordinance creates a water works fund and other subsidiary funds therefrom, designates officials and provides regulations with reference thereto. The essential sections follow:

Be It Ordained by the Board of City Commissioners of the City of Fargo, North Dakota, or
Be It Ordained by the People of the City of Fargo, North Dakota (as the case may be).

Section 1. (Municipality Shall Provide BY Taxation for Water Used, Wasted or Donated By It.) The Board of City Commissioners shall annually provide by appropriation and uniform tax levy, on property subject to their jurisdiction, such sum or sums hereinafter designated per hydrant (or more, if in their judgment more is necessary) to defray the cost and expense (including maintenance and depreciation) incident to and caused by reason of the general and special uses by the city of the water works, filtration plant, fire hydrants, and distribution system in supplying water to its municipal buildings, its public parks, fountains, donees (as a charity, or for semi-public use without income or profit), for sprinkling streets, flushing sewers, construction of public improvements and extinguishing fires, for the next succeeding fiscal year.

Section 2. (The Sum to be Provided.) The determination of the sum or sums herein provided and hereby ordained as necessary for the purposes in section one designated and provided shall be computed upon the following basis, per fire hydrant, according to the class or classes under which the Board of City Commissioners, by ordinance or resolution, shall determine and provide with respect to the annual municipal uses, waste and donations of water; and the sums per hydrant shall be cumulative if any such water takings shall be in more than one class.

Class 1. Use of water for extinguishing fire under a required pressure not greater than 50 lbs. per square inch, not less than the annual sum of $24 per hydrant for each and every fire hydrant within the corporate limits of the city; or

Class 2. Use of water for same purpose under a required pressure greater than 50 and not greater than 75 lbs. per square inch, not less thn the annual sum of $36 per hydrant for each and every fire hydrant within said corporate limits, or

Class 3. Use of water for same purpose, under a required pressure greater than 75 and not greater than 100 lbs. per square inch, not less than the annual sum of $48 per hydrant for each and every fire hydrant within said corporate limits, or

Class 4. For supplying water to city buildings, parks, fountains, street drinking bubblers, public or semi-public places without income or profit, or as charity, sprinkling city roads and streets, flushing sewers and streets, under a required normal pressure not exceeding 40 lbs. per square inch, not less than the annual sum of $20 per hydrant for each and every fire hydrant within said corporate limits, or

Class 5. For granting permission to, or allowance of, any person, firm, or corporation to use fire hydrants (with meter attached) not less than the annual sum of $3 per hydrant and for supplying water to contractors (with or without meter) for public construction work upon buildings, street paving, sidewalks and improvements, or tamping ditches, not less than the annual sum of $5 per hydrant for each and every fire hydrant within said corporate limits.

Section 3. (Creating Water Works Fund.) All such sums as provided for in Sections one and two shall, together with all sums collected as water rents or rates for water, and incidental service in supplying water to the inhabitants, and any unexpended balances remaining in the "Operation and Maintenance" and "Extraordinary Emergency" funds of the previous year, be paid into, and credited to, a special fund to be kept and known as "The Water Works Fund," and the money so paid and credited to such fund shall not be used, reappropriated or dissipated for any purpose, except as hereinafter provided.

Section 4. (Water Works Fund, How Used.) The water works fund so constituted as provided by Section three shall furnish the funds, by reappropriation; 1st, for and from which shall be paid the operating and maintenance costs and expenses of the water works, sedimentation and filtration plant each year, including such sum as may be necessary for temporary use as a revolving fund for the purchase and re-sale of meters and other water works and service connection supplies; 2nd, for and to credit of a proper and adequate depreciation account whenever the commissioner in charge of such water works, after investigation and consultation with the city engineer, shall determine that such depreciation account can be reasonably required as hereinafter provided; 3rd, for and to the credit of an extraordinary emergency fund to meet any unforeseen and extraordinary casualty that may happen to and disable any portion of such water works, sedimentation and filtration plant or distribution system.

Section 5. (Depreciation Fund, Who Decide and How Used.)

(1) The city engineer, commissioner of water works, superintendent of filtration plant, and chief engineer of power plant of the water works shall constitute a board to ascertain and determine what are the proper and adequate rates of depreciation of the several classes of property of such water works utility. The rates shall be such as will provide the amounts required over and above the expenses of maintenance, to keep such property in a state of efficiency corresponding to the progress of such water utilities generally. The auditor of the city, under instruction and direction of the commissioner of water works, shall conform the depreciation account to such rates so ascertained and determined by said board. Such board may make changes in such rates of depreciation from time to time as it may find to be necessary.

(2) Such board shall also prescribe rules, regulations and forms of accounts regarding such depreciation which the commissioner of water works shall carry into effect.

(3) The city commission shall provide for such depreciation in fixing the rates, tolls and charges to be paid by the public.

(4) All moneys thus provided for shall be charged to and set aside out of "the water works fund," credited to and carried into a depreciation fund in manner hereinbefore provided. The moneys in this last mentioned fund may be expended in new constructions, extensions, or additions to the property of such water works utility (the distribution system provided for by special improvement taxes excepted), provided always, such sums are duly charged to the construction account and the same credit to this fund is maintained; or invested, and if invested, the income from the investment shall be credited to and carried in the depreciation fund. This fund and the proceeds thereof shall be used for no other purpose than as provided in this section and for depreciation.

Section 6. The money or securities representing any unexpended or unappropriated balance in the water works fund of the city at the time of the adoption of this ordinance shall be immediately absorbed by, and transferred to the credit of, such accounts as are described in, and in the manner and to the extent provided by the second and third provisions of Section 4 of this ordinance and shall be proportioned, estimated and computed back for the period when the rates, tolls and charges contained the surplus which by this section is contemplated, and to the extent of the credit in such water works fund appearing.

Water Works Publicity Measures Employed at Terre Haute, Indiana.

(Staff Abstract.)

The average customer of the water department or water company has very little idea of the difficulties which water works men must meet in supplying water. It is reasonably certain that if customers knew something of such problems that water works men are compelled to solve they would be more charitable in their criticism and would pay their bills with better grace. Here, as elsewhere, it is good policy to take the public into your confidence and let them know what you are doing. The present article describes, very briefly, the publicity measures employed by the Terre Haute Water Works Company of Terre Haute, Indiana, as given by Mr. Dow R. Gwinn, president and manager.

NEWSPAPER ADVERTISING.

The best publicity medium in a community is the newspaper. While I would not confine my publicity work to newspapers, I believe that the major part of the money spent along this line should be used for newspaper advertising. We have contracts with our daily papers for a 1-in. advertisement for every day in the year, so that the company is always represented in every issue of each of the daily papers published in the city. We have about 40 different ads which are used for this purpose, alternating from day to day, and when the entire lot is used they commence over again. Eight examples of these short advertisements follow:

(1) Give Up the Back-Breaking Pump—Use Filtered Water. (2) City Water in Terre Haute is Purified by Scientific Methods in Charge of an Expert. It Is Tested Every Day. (3) Filtered Water Kitchen Sink—6-Room House—1½ Cts. Per Day. (4) Don't Be Tied to the Pump. Get City Water in the Kitchen. (5) Good Morning! Have You Used Filtered Water This Morning? (6) Pure Filtered Water Bath Room in 6-Room House, 3 Cts. Per Day. (7) The Good Landlord Puts City Water in Kitchen and Keeps His Tenants. (8) The Public Be Pleased. We Strive to Make City Water Service as Near Perfection as Possible.

Sometimes we use a half page; sometimes we use a whole page, and on one occasion we used a double page, when we used a large cut showing how well water is contaminated from privy vaults. We pay special attention to the headlines, some of which are as follows: "The Public Be Pleased." Come on In, the Water's Fine. Don't Be Tied to the Pump. Get on the Water Wagon. Fix Up the Old House. We have used quite a number of cuts and on several occasions used a large cut running across the page, showing the park at the pumping station and a portion of the buildings, with the headline: "The Home of Pure Filtered Water."

We have used some posters, but, as stated, believe that the best results can be obtained by advertising in the newspapers.

CIRCULARIZING.

About four years ago we did considerable circularizing. First, we went through the street index in the local directory and checked off the addresses of all who were using city water and found that there were over 4,000 premises along the lines of our mains that were not using water from us. We then prepared a half dozen circular letters, which were printed on the mimeograph and the addresses were put on with the typewriter. The typewriter ribbon corresponded very closely in shade and color to the ink used by the mimeograph and the letters had the appearance of being typewritten. These letters were mailed to more than 4,000 people and were accompanied with a circular on colored paper, with attractive type and, in some cases, with cuts. The letters were sent out about a week or ten days apart. I remember that one man came in and said that he had received three of our letters and was ready to put in city water. He was the head of a large institution which uses $250 to $300 worth of water a year.

In my opinion, one of the best things that we sent out in connection with these circular letters was a pamphlet entitled "An Important Trial," which purported to be the trial of Mr. City Well and Mr. Privy Vault. It was gotten up in legal style and attracted a good deal of attention.

VISITS TO PUMPING STATION.

In addition to the publicity work already mentioned we believe that a good way of getting the public familiar with what we are doing is to have them visit our pumping station. Working along this line, we engaged a landscape gardener, spent hundreds of dollars for trees and shrubbery, fixed up a tennis court for the use of the public, and really have a very beautiful park at our pumping station. We invite the public to use our tennis court and to have picnic lunches at the plant. On several occasions we have invited the local medical society to visit the plant and have served supper. We have also had the Young Business Men's Club, the Manufacturers' Club and also the city officials. Some of the teachers in the public schools have taken their classes to the plant, and Prof. Bruce, who has charge of the Chemistry Class at the State Normal, makes a point of taking each of his classes to the pumping station and gives them a talk on the purification of water.

Accepting an invitation from the Manufacturers' Club, I gave them a talk on the Methods of Testing Meters, the Purification of Water and Results Obtained. I had a number of charts showing the daily average bacteria in the river water and in the filtered water, and also the reduction in cost of water to residence consumers who were on meters.

COMPETITION WITH SHALLOW WELL SUPPLIES.

In Terre Haute, where water can be secured from the ground at a nominal expense, it is necessary to educate the people to show the advantages of using water under pressure, and also the danger of contamination of water taken from the ground on account of the large number of privy vaults. One day a man came in the office and wanted water for sprinkling purposes. I suggested that he also should take the water for domestic use, but he quickly replied that they had a good well, the best one in that part of the city, that people came from several blocks around there to get water from his well. I asked him if he had ever had the water analyzed, and he said no, that the water was all right; it was clear and nice and cold and it was not necessary to have it analyzed. I offered to furnish him with a barrel of salt, free of cost to him, if he would put it in the privy vault, and then if the water from the well became salty he would know where some of it was coming from. He refused to accept the proposition, and when I pressed him for a reason he said it might spoil his well.

PUBLICITY WORK PAYS.

The average water works man will want to know if advertising the water works business pays, and in reply will say that when I came to Terre Haute, 14 years ago, the company had about 2,000 customers, after being in the business for 27 years. We now have about 7,000 customers and the gross earnings are more than double what they were 14 years ago. Of course, all of this increase is not due to advertising, for we have made a point of serving a very high-grade filtered water. We have an unusually good plant and are getting fine results in the way of bacterial reductions. We have a laboratory and make daily examinations of the filtered and unfiltered water. Good water and good service attract business, but I believe that advertising is a material help in developing business.

ACKNOWLEDGMENT.

The foregoing matter is from the discussion by Mr. Gwinn of a paper entitled: The Practical Value of Publicity to the Water Works Man, read before the recent annual meeting of the Illinois Section of the American Water Works Association by the editor of this section.

BRIDGES

Substructure Features of a Bridge Over the South Canadian River in Oklahoma and Erection Procedure Adopted.

(Staff Article.)

The Chicago, Rock Island & Pacific Ry. has recently started the replacement of a long pile-trestle bridge across the South Candian River, at Geary, Okla., which involves some difficult substructure work. The two steel spans which are included in the present contract have lengths of 200 ft., and are of the riveted through Pratt-truss type. As the trestle at the western end of the bridge is not to be replaced at this time, the present substructure work includes the construction of two piers and one abutment. Figure 1 is a general elevation of the structure showing profiles of the subsoil strata. It will be noted by referring to this drawing that at the low water stage the river is confined to a comparatively narrow channel, but at times of high water it occupies a wide area. At the location of piers Nos. 2 and 3 the river bed consists of quicksand. To secure a suitable foundation material it was necessary to extend the piers, by means of caisson foundations, to shale, which was encountered at a considerable depth below the river bed. The bridge was designed for Cooper's E-55 loading, with impact as required by the Rock Island Lines' specifications. The assumed dead loads for the superstructure were: Steel, 2,500 lbs. per linear foot of span; and track, 500 lbs. per linear foot of span.

It has not yet been decided what type of construction will finally be used to complete the bridge. This cannot be settled until the effect has been observed of some bank protection work which is being put in about three miles up the river for the purpose of changing its course. As the rock stratum dips rapidly toward the west end of the bridge the construction of piers for this part will be much more expensive than for the two spans now being constructed. It is estimated that it will ultimately take about 1,000 ft. of permanent construction to relieve the condition existing at this site. Taking the costs and present railroading conditions into consideration, doubt is expressed by those in charge of this work as to whether it will be a paying proposition to put in more permanent work than is to be constructed at this time.

CAISSONS AND PIERS.

As noted in Fig. 1 the distance from the bed of the stream to the shale stratum at pier No. 1 is 23 ft., while at pier No. 2 this distance is 36 ft. The caissons for both piers extend into the shale a distance of about 11 ft. The tops of the caissons are about 3.5 ft. below low water level.

Caissons.—The same type of construction is used for both caissons, although their dimensions differ somewhat. The caisson for pier No. 1 has a total width of 14 ft. 6 ins., a length of 37 ft., and a height of 29 ft.; while that for pier No. 2 has a width of 15 ft. 6 ins., a length of 37 ft., and a height of 44 ft. The sides of the caissons consist of 1¾x11½-in. sheeting, braced at about 3-ft. intervals with longitudinal and transverse girts and cross braces. The working chamber of each caisson has a height of 7 ft. 3½ ins., the cutting edge being heavily reinforced with steel plates. Each caisson is equipped with two air locks. To sink the caissons and to form a suitable foundation they are to be filled with concrete.

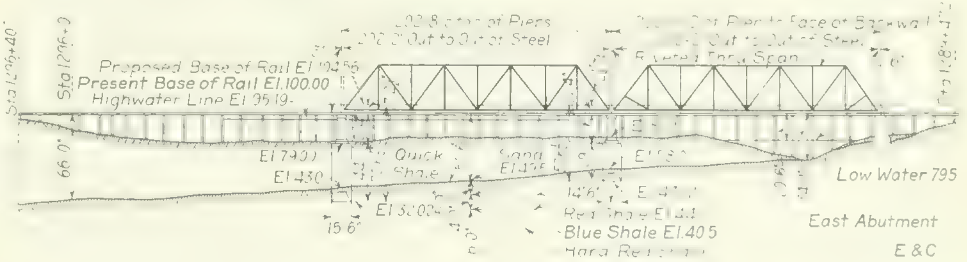


Fig. 1. General Elevation of South Canadian River Bridge Showing Type of Structure and Subsoil Conditions.

The construction details of the caissons are fully shown in Fig. 2. The manner of forming and bracing the sides and ends of the caissons is shown in Figs. 2 (a), (b), (c), (d) and (f). These drawings also show the arrangement of the tie rods and of the bars used for concrete reinforcement. The construction features of the cutting edge and of the roof of the working chamber are shown in Figs. 2 (a), (c) and (e). The timbers in the flat portion of the roof are 11½x11½ ins. in section, these timbers being sheeted with planks 2¾x9½ ins. in section. The sloping sides of the roof are formed of 5¾x11½-in. timbers, the corners being reinforced with 18x5/16-in. bent plates. The system used in bracing the caisson consists of horizontal frames placed at about 3-ft. intervals, the details of these frames being shown in Figs. 2 (a), (b), (c) and (f). Each course of wall timbers is fastened to the course beneath it with ¾-in. x 20-in. drift bolts, spaced about 5 ft. on centers and driven into holes 1/16-in. less in diameter than the drift bolts, the holes being bored to the full length of the bolts. The roof sheeting is fastened to the timber with 7x⅜-in. boat spikes; all strut cleats are fastened with 7x⅜-in. boat spikes; while the exterior sheeting is held in place with 6x5/16-in. boat spikes.

Piers.—Each pier, the footing of which is centered on the top of its caisson, has a total height of 21 ft. 4 ins. The dimensions of the footings are 9 ft. 10 ins. x 34 ft. 10 ins. x 2 ft. thick. The pier shafts have semi-circular ends, as shown in Fig. 2 (h). The various drawings of Fig. 2 give complete pier details, and indicate the arrangement of the reinforcing bars in the coping and in the pier shafts. A 1:3:5 concrete mixture is specified for all parts of the piers except the bridge seats, where the proportions are 1:2:4.

The total volume of concrete in pier No. 1 and its caisson is about 709 cu. yds., while that in pier No. 2 is about 1,055 cu. yds. The total weight of the reinforcing steel in pier No. 1 and its caisson is 7,255 lbs., and in pier No. 2, 9,581 lbs. A bill of material for the steel reinforcement in each pier is given in Table I.

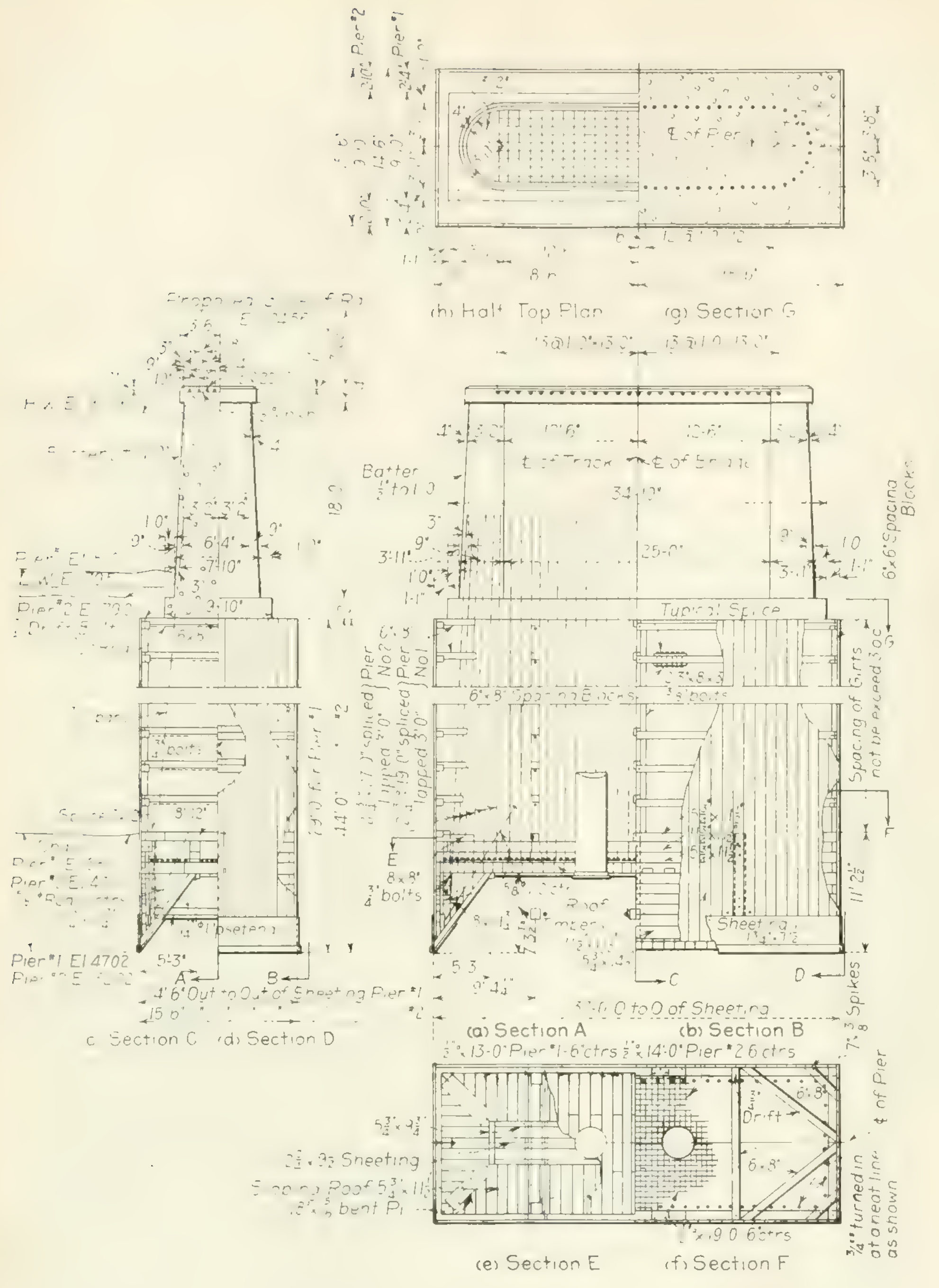


Fig. 2. Details of Piers and Caissons for South Canadian River Bridge, Geary, Okla.

TABLE I.—BILL OF MATERIAL OF STEEL REINFORCEMENT IN PIERS NOS. 1 AND 2.

No. of bars.	Size, ins. sq.	Length, ft. ins.	Location.
		Pier No. 1.	
10	½	20 0	Bridge seat.
27	½	6 6	Bridge seat.
144	¾	19 0	(Vertical.)
72	½	13 0	Top of caisson.
54	½	19 0	Top of caisson.
Total weight, 7,255 lbs.			
		Pier No. 2.	
10	½	25 0	Bridge seat.
27	½	6 6	Bridge seat.
144	¾	27 0	(Vertical.)
72	½	14 0	Top of caisson.
58	½	19 0	Top of caisson.
Total weight, 9,581 lbs.			

Abutment.—The concrete abutment is to be founded on shale, which outcrops at its site. The gravity type of section is used for this abutment, the only parts reinforced being the bridge seat and the back-wall. Figure 3 (a) is a cross section of the abutment at the center line of the track, and Fig. 3 (b) is an elevation of the abutment. These drawings give the principal dimensions and show the type of section adopted. The abutment proper has a width at the top of footing of 28 ft. 10¾ ins., and a width at the coping of 27 ft. 2¼ ins. The downstream wing-wall, which makes an angle of 45° with the face of the wall, has a length of 25 ft. 7⅝ ins.; while the upstream wing-wall has a length of 35 ft., and makes an angle of 30° with the face of the abutment. The size and shape of the back-wall, together with the dimensions and arrangement of the reinforcement in the bridge seat and back-wall, are shown in Figs. 3 (a) and (b). The abutment contains about 590 cu. yds. of concrete, including the old footing. The total area of the footing is 963 sq. ft., and the maximum pressure on the foundation, 9,500 lbs. per square foot. The abutment contains 430 lbs. of reinforcing bars. A 1:3:5 concrete mixture is specified for all parts of the abutment except the bridge seat and back-wall, where the proportions are 1:2:4.

CONSTRUCTION PLANS AND PROCEDURE.

As outlined by the railway company, the construction program contemplates the use of temporary girder spans on pile bents to replace portions of the pile trestle at the pier and abutment sites, these spans providing sufficient clearance to permit the construction of the substructure without interference with traffic. Figure 4 illustrates the use of this temporary construction at the east abutment and at piers Nos. 1 and 2. For the east abutment a 28-ft. 1-in. deck plate-girder span is used; for pier No. 1 a 49-ft. 3-in. span is used; and for pier No. 2 a 50-ft. span will carry the track during the construction of the bridge. These girder spans are old bridges, which were formerly in use on other parts of the line.

Figure 5 shows side and end elevations of the pile-bent supports for the temporary girder spans at pier No. 1, and cross sections of the

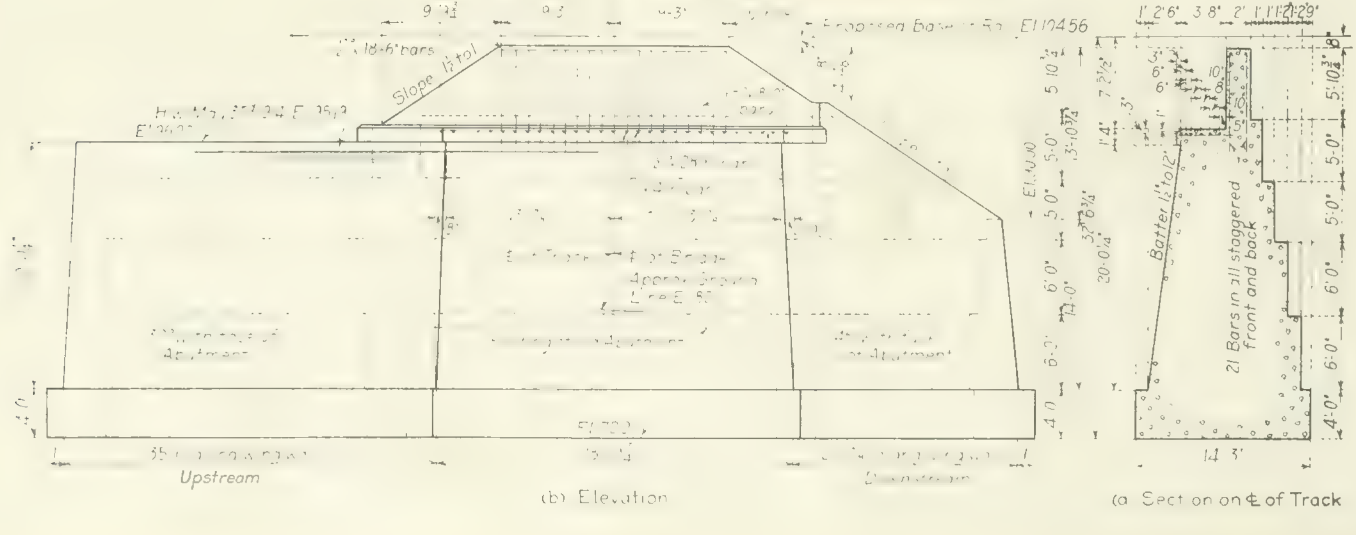

Upstream
(b) Elevation
(a) Section on ℄ of Track
Slope 1½ to 1
Batter 1½ to 12
21 Bars in all staggered front and back

Fig. 3. Elevation and Cross Section of Abutment for South Canadian River Bridge.

track construction at this pier. These drawings give all the details for this part of the work. The bents used for the east abutment are duplicates of that shown in Fig. 5. The blocking used at the abutment differs slightly, however, as the temporary girders are spaced 7 ft. on centers. The bents and blocking used at pier No. 2 are of similar construction to that shown in Fig. 5, although the details differ somewhat; for example, the temporary girders at pier No. 2 are spaced 5 ft. 6 ins., on centers, the pile caps are 12x12 ins. x 12 ft., and the spacing of the piles, directly under the cap, is 3 ft. on centers.

The base of rail in the new bridge is to be 4.56 ft. above that in the old structure, and it is specified that the raising of the present grade is to be completed in time so as not to interfere with the construction of the piers and abutment.

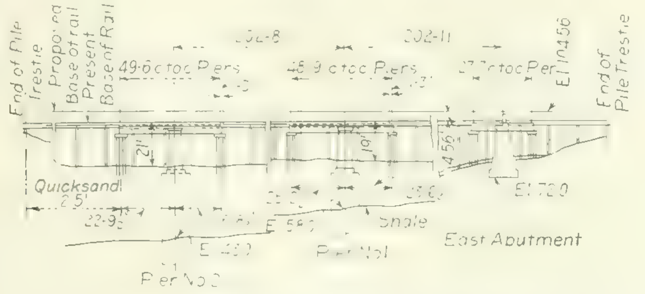


Fig. 4. Elevation Showing Falsework to be Used During Construction of Piers and Abutment—South Canadian River Bridge.

PERSONNEL.

The bridge was designed, and the construction details shown were worked out, by the Engineering Department of the Chicago, Rock Island & Pacific Ry., C. A. Morse, chief engineer, and I. L. Simmons, bridge engineer. We are indebted to Mr. Simmons for the data upon which this article is based. The substructure is to be constructed by the Missouri Valley Bridge & Iron Co.

Some Data on the Methods Used to Waterproof Bridge Floors.

(Staff Abstract.)

In our issue of Jan. 27, 1915, we gave a set of specifications by Samuel Tobias Wagner covering essential points in connection with the waterproofing of steel-floor railroad bridge. The accompanying data are a part of the discussion of these specifications.

METHODS USED ON D., L. & W. R. R.

The following data by G. J. Ray, chief engineer, Delaware, Lackawanna & Western R. R., apply mainly to the methods of waterproofing bridge floors used on that railroad:

The first of the solid steel-floor bridges with which the writer had any experience was built between 1903 and 1906. The floors of the deck bridges were made of channels, with the flanges up and riveted together. The floors of the through bridges were of the ordinary trough type. With both through and deck bridges enough concrete was placed to provide good drainage. In most cases, the water was run off the bridges at one end, as they were on heavy grades. Plates were turned down over the back-wall, and, although fairly good drainage was provided, this construction did not prevent the water from finding its way through the back-wall and down over the face of the abutment. No waterproofing was placed on the deck, and it was soon found that the ballast would have to be removed, and waterproofing applied. The water found its way down through numerous cracks formed in the concrete on top of the solid steel floor.

Five-ply felt, with brick protection, was used later when these structures were waterproofed. This waterproofing has eliminated the leakage through the floor system, but there is still some trouble with seepage through the back-wall and over the abutment. Where this trouble was serious, the nuisance, to a great extent, has been eliminated by constructing a copper gutter along the abutment under the bridge seat.

In 1907 there was built on the Delaware, Lackawanna & Western R. R. a six-track deck girder bridge, with a reinforced concrete floor 84 ft. wide and 349 ft. long. The bridge is at the neck of a yard with numerous crossovers and slip switches on the bridge, so that the floor had to be sufficiently strong to permit the maximum loading at all points. A reinforced concrete deck, 1 ft. thick, was placed directly on top of the girders. Drainage outlets through this floor were provided at low points in each 814 sq. ft. of surface. As the bridge was rebuilt under traffic, the floor could be built for only two tracks at a time. A ridge in the concrete was made at the construction joints to prevent leakage, but no waterproofing was applied. Although this floor was built and put in service seven years ago, it is in good condition today, and no leakage has occurred. Other bridges have since been built in the same manner and with equally good results. In one case, in 1908, the writer built a deck girder bridge, 91 ft. wide, with a clear span of 60 ft., over a city street, with a reinforced concrete floor, without the application of waterproofing. The floor is in perfect condition today, and has never leaked a drop; neither has any water found its way over the back-wall to the bridge seat. The floor is 16 ins. thick at the center and 13 ins. at the ends, and the slab extends past the back-wall, with a groove in the underside to intercept the seepage.

At first, the writer had some doubt as to the success of the last-mentioned construction over city streets, as there is no question about the destructive tendency of water in passing through concrete. Therefore, nearly all the solid-floor bridges on this road have been waterproofed, regardless of the type of construction. During the past five years, this company has built deck girder bridges over city streets with concrete slab floors, similar to those described in the paper; also numerous through girder ballast-floor bridges with reinforced concrete slabs over the floor system, and also with the entire floor system—or bridges as a whole—encased in concrete. As a rule, the concrete for one or more tracks is poured complete in one operation, thus avoiding construction cracks at points where leakage is likely to occur. Where construction joints are necessary, copper flashing strips can be built into the concrete on each side of the joint, thus eliminating the leakage. These bridges, as a rule, have been waterproofed with five-ply felt, with brick protection, or with treated burlap and asbestos felt with asphalt mastic protection. There have been only a few leaks with either method, and up to date no trouble has been experienced from leakage through the sliding joint between the floor slab and the back-wall. A double layer of treated felt or cotton drill has been placed in this joint with good results, and in all cases great care has been taken to extend the waterproofing at least 18 ins. down over the back-wall, and to provide a good drainage system to carry off the water.

The only indication of water passing through the floor system has been a very slight seepage in a few places along the girders where the steel was painted prior to the construction of the concrete floor. The writer believes that the surest way to prevent this trouble is to eliminate painting of steelwork which is to be covered with concrete.

With long structures, Mr. Wagner's method of taking care of the drainage should produce good results where the drain pipes can be connected directly to the sewer, without traps, so that the pipe will not freeze during cold weather. With short bridges over city streets, it is difficult to maintain longitudinal drains under bridge floors, and down-spouts at abutments to street sewers. With a temperature of about 32° F., ice and snow will melt on the bridge floor and freeze in the leaders and drains under the bridge. This difficulty is not so great where columns are placed on the curb line, and down-spouts can be carried directly to the sewer by vertical pipes. It will be found, however, that in cold climates such drains are constantly freezing, and are a source of expense to maintain.

Where columns are permissible on the curb line, the writer has used steel construction encased in concrete for the long span over the paved portion of the street and reinforced concrete slabs over the sidewalks. This construction permits of a perfect job of waterproofing, and eliminates any possibility of water getting down the face of the abutment from seepage through the back-wall. In such cases, the columns have been constructed of concrete; the depth required from the top of the rail to the under clearance does not exceed 4 ft. 7 ins. for spans up to 50-ft. centers. This type of construction, as a whole, is not unreasonably expensive. The encased steelwork is costly, but the slabs over the sidewalks are economical, on account of the short spans, and the thickness of the abutments can be reduced materially. Standard track centers can be maintained by keeping the center girder shallow. Painting is entirely eliminated, and the design can be made ornate enough to please the most skeptical critic.

On eight through girder bridges recently constructed, the cost of the concrete floor, including reinforcement and encasement of I-beams, averaged 35.6 cts. per square foot of floor space. These bridges varied in length, center to center of bearings, from 53 ft. 8 ins. ot 120 ft. 7 ins., and in depth, from top of rail to under clearance of girders, from 3 ft. 8 ins. to 4 ft. All waterproofing was done with three-ply treated burlap and asbestos felt, protected with asphalt mastic, 1½-in. thick. The average cost of the waterproofing was 28 cts. per square foot, thus making the entire cost of the floor system 63.6 cts. per square foot, exclusive of the structural steel.

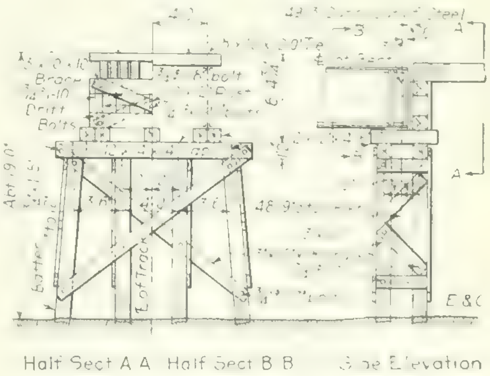


Fig. 5. Details of Pile Bents, Blocking and Falsework Girder to be Used During Construction of Pier No. 1 of South Canadian River Bridge.

As regards the specifications proposed by Mr. Wagner, the writer believes that—

(1) The specifications for materials and methods of applying them, as set forth, should obtain good results.

(2) With through girder construction and a depth of from 3 ft. 8 ins. to 4 ft., from top be designed which will permit of encasement

in concrete, thus eliminating painting, and insuring a water-tight job at reasonable cost.

(3) With deck-plate girder bridges a water-tight reinforced concrete floor, without waterproofing, can be constructed which will not exceed 12 ins. in thickness.

(4) Where waterproofing is to be applied to any type of solid floor bridge, the kind of materials to be used should be determined before the details of construction are fixed.

DISCUSSION BY J. B. W. GARDINER.

The question of a proper waterproofing membrane, in the writer's opinion, is deserving of more extended discussion than Mr. Wagner has given it. Although it is unquestionably true that no membrane is of itself a waterproofing agent, the function which it performs in a waterproofing system is fully as important as that performed by the plying cement. They are entirely interdependent. The membrane is a binder—and a binder only—and as such its function is to hold in place the asphalt which is expected to shed the water and carry it to the drains. In the course of application the membrane and the plying cement should be cemented together so that they are practically a unit. Consequently any movement of one part of the system occurs simultaneously in the other. Therefore, in so far as they are applicable, the specifications for the membrane should demand the same qualities as those for the plying cement. To illustrate: Mr. Wagner's asphalt specification requires ductility through a wide range of temperatures, which means that it must remain firm and elastic under extreme changes of weather. This quality in asphalt is essential, first, that it may not be shattered by the shock of impact when a moving train first passes on the bridge, or by the vibration of the entire structure due to the moving load; and secondly, the asphalt must yield or stretch to meet both the slight deflection which occurs as the center of mass shifts with the load and the movement in the concrete base incident to temperature changes. Expansion joints, it is true, eventually take care of this movement, but they do not do so immediately. By this, the writer means that the movement is taking place throughout the entire length of the slab and is merely summed up at the expansion joints. If, then, we encase the ductile asphalt between binders of a rigid inelastic membrane, we have sac- of rail to under clearance, a floor system can rificed all the advantages derived from this ductility. To be logical, therefore, we should insist that the elasticity of the membrane be equal to the ductility of the asphalt.

Another point to be considered is the presence of oils which show more than a certain percentage of volatility when subjected to a temperature of 325° F. for a specified time. Far fetched as it may seem this test has a distinct bearing on membranes. In order that the membrane may have the maximum protection against rotting it should be thoroughly saturated with a stable asphalt. Under no circumstances should bitumen solvents be used in this process. In many cases waterproofing membranes are treated by immersing them in a bath of asphalt liquefied by the addition of petroleum residue, in the proportion of 1 part asphalt to 4 or 5 parts residue. This applies principally to felts and burlaps. The result is saturation, it is true, but saturation largely with the petroleum residue, which, being a bitumen solvent, will eventually re-act against the plying cement. The specifications therefore should require that the membrane be saturated with an asphalt which would comply with Mr. Wagner's specification. As is pointed out, flashing effectively against the web of a half-through girder is an extremely difficult problem, largely because of projecting stiffeners, gussets, knee-braces, etc. This difficulty is not lessened by the use of a stiff non-flexible membrane which cannot be made to fit snugly against the web at all points. Flexibility would seem, therefore, to be an important quality of the membrane. This fact is largely responsible for the use, first, of burlap, and, later, of cotton fabric as waterproofing membranes.

A few words as to the relative merits of cotton and burlap, which is a jute fiber, are pertinent. Jute consists of the chemical compound of cellulose with lignin, to which some investigators have given the name, bastose. It is much more readily affected by the action of acids and alkalies than cotton fiber, which is 95 per cent pure cellulose. The influence of moisture, and even of air, will also rot the jute fiber. These characteristics go far toward fixing the cause of the trouble which so many engineers have experienced with waterproofing of this type.

Two other points in connection with membranes deserve passing mention, namely, resistance to puncture, and tensile strength. The desirable resistance to puncture, measured in pounds per square inch, by a standard paper-testing machine, should be determined by the chief engineer. The minimum tensile strength should be sufficient to stand the test for elasticity, without fracture, with a reasonable factor of safety.

As to the method of application, there is one point mentioned by Mr. Wagner, the reason for which the speaker does not understand, and in which, so far as his knowledge of the subject goes, he cannot agree; that is, the requirement that the first layer of felt should not be cemented to the floor of the bridge. If there is merit in it, it would seem logical to lay the protecting brick course in a sand cushion instead of cement mortar, so as to keep the waterproofing course separate and distinct from either the base or the protection. On the other hand, one of the cardinal principles of good application is the avoidance of bridges or spans, so that when weight is placed on the waterproofing it will not break because of lack of support. This can only be obviated by making the first layer of membrane conform absolutely to the surface; and this is possible only by cementing the first layer to the surface thoroughly at all points. The possibilty of puncture from other causes is also much more remote if this method is used.

The method described by Mr. Wagner of finishing the waterproofing against the girders or concrete is decidedly the most satisfactory of any in the writer's experience. However, he can see no other object in painting the surface with which the sealing material comes in contact before putting such material in place, than to secure satisfactory cohesion. As there are materials on the market, sold under the name of expansion joint cements, which cohere perfectly without a primer, it would seem cheaper and safer to use them.

As to methods of protecting a waterproofing course on a solid-floor bridge, the writer knows of no more satisfactory method than brick laid in cement grout, being careful to fill all joints in the brick by pouring mortar over its surface after it has been laid, and sweeping it thoroughly into the joints. It does little good to fill the joints of the brick with asphalt, as even the best hard burnt bricks are porous and offer little obstruction to the passage of water. The use of asphalt mastic for a protecting coat is an expensive luxury and by no means a necessity. If the waterproofing is efficient there is no need of this additional precaution.

ACKNOWLEDGMENT.

The foregoing data were taken from the discussions of a paper, The Waterproofing of Solid Steel-Floor Bridges, in Proceedings, American Society of Civil Engineers, Vol. XLI, p. 225.

SEWERAGE AND SANITATION

Comment on Cost of Philadelphia's Reinforced Concrete Sewers.

To THE EDITORS: We have read with interest your article on pages 245-246 in the issue of March 17 which deals with the first concrete pipe that was laid in Philadelphia, Pa.

We were the contractors for this work (although no mention is made of this fact), and the pipe was made and delivered by the Lock Joint Pipe Co. of New York.

The specifications for this work called for the pipe to be laid in a concrete cradle as described on page 246.

This construction certainly makes a substantial sewer, but we wish to call attention to the fact that the prices bid should not be taken as a criterion of costs on work of a similar nature as our actual costs were very considerably in excess of the prices bid.

Very truly yours,
CANTRELL CONSTRUCTION Co.,
EARL M. SEITZ, Chief Engineer.
Camden, N. J.

St. Louis will officially open its mechanical filtration plant, the largest of its type in existence, on May 15.

Design Features of New Sewerage Works at Edmonton, Alberta.

(Staff Abstract.)

The construction plant and methods employed in building the new system of tunnel sewers at Edmonton, Alberta, were described in this section of April 21, 1915. The present article illustrates and describes some of the design features.

As stated in the previous article, the ordinary variation in river stage is 15 ft., and this corresponds to a variation in stream width from 400 ft. at low water to 650 ft. at flood. The variation in stage due to extreme floods has reached 30 ft. on two occasions.

STORM WATER RUN-OFF.

As is usual in designing sewers for cities in the earlier stages of their growth, very meager data were available with regard to intensity of rainfall. Government rainfall records only a drainage system requires the intensity of give the total fall on any day, or the seasonal distribution, whereas the engineer designing rainfall during short periods of time. Such data not being available, the best use was made of existing figures by securing additional information from the observers.

The Government rainfall records extend back to 1880. They show that during the period between 1880 and 1910 the rainfall averaged 13.53 ins. and the snowfall 46.4 ins. The melting of the snow does not, however, produce in Edmonton the maximum storm run-off, because the water from the melting snow is either evaporated by the dry atmosphere, or absorbed and held by the ground, which is left in a dry condition by the long, dry autumn. Even on impervious ground, such as paved streets, the snow melts but gradually, as there is little rain during the spring season. Maximum storm run-off occurs during the wet season in summer.

From the Government records of the previous 30 years Mr. Alexander Potter, the consulting engineer, plotted curves showing all the storms during that period, the durations in hours being shown as abscissae, and the average rate of rainfall per hour as ordinates. An enveloping curve for these storms was drawn, and from this curve he computed the maximum average rate of rainfall that might be expected in Edmonton, for a storm of given duration, as follows:

Dunration of storm. Hrs.	Min.	Av. intensity of rainfall. Ins per hour.
0	30	0.8
1	00	0.7
2	00	0.61
3	00	0.45
4	00	0.32
5	00	0.30
6	00	0.25
24	00	0.12

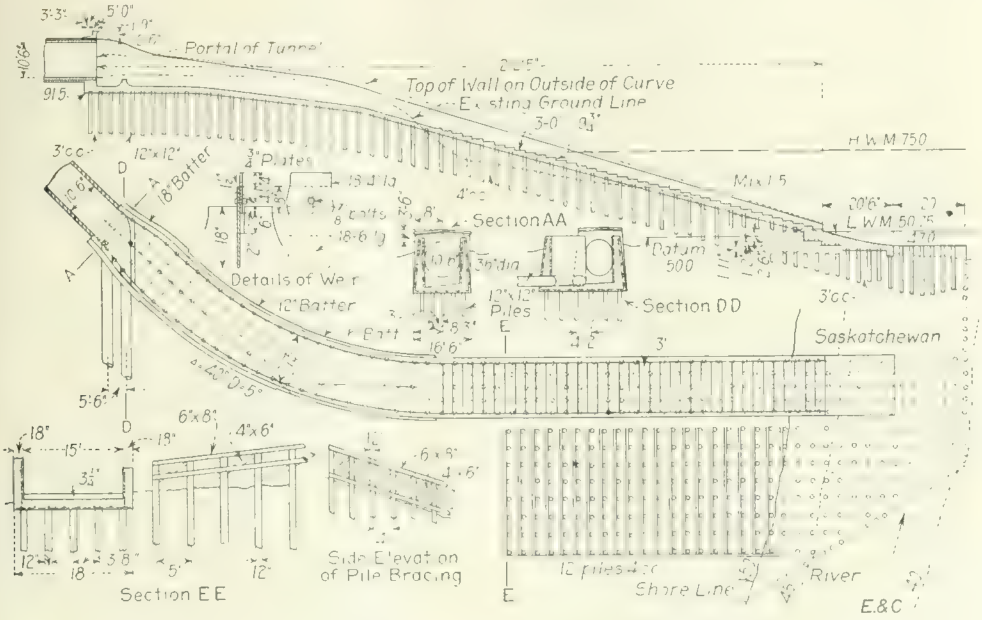


Fig. 1. Plan and Principal Sections of New Main Sewer Outfall Structure at Edmonton, Alberta.

Acting on the accepted principle in sewer design, that it is not necessary to design for the usual storm, and in consideration of the number and frequency of storms of greater intensity than ½ in. per hour, Mr. Potter decided to design the sewers for a flow equivalent to ¼ in. per hour, or one-half the rainfall.

OUTFALL STRUCTURE.

The 10-ft. 6-in. sewer ends near the river in an open rectangular conduit, the latter being intended to conduct the storm overflow to the river. The dry weather, or sanitary flow, will be tapped off in two lines of cast iron pipe and taken to the disposal plant when the latter is built. The bottom of the open rectangular conduit is in the form of steps. The entire outfall structure is of reinforced concrete. As part of this structure is below high-water mark, it would be liable to damage from logs or other floating material during high stages of the river, and to damage from ice jams in the spring. The details of a protection work of pile on the upstream side of the conduit are shown in Fig. 1.

MANHOLES AND DROP CONNECTIONS.

As soon as the sewer on each side of a shaft was completed the manholes and drop connections were constructed. The drawing, Fig. 2, shows these in mass concrete. The contractors preferred, and were allowed to use, the block form of construction in the lower half of the sewer passing through the manhole. The shaft timbering was drawn as the work of building the chambers leading to the surface progressed. Both outside and inside forms were required in building manhole barrel and drop connections. Part of the former was removed as the work progressed, and before the back filling was placed. The inside forms were removed from below.

GIVING LINE AND GRADE.

The general method employed in setting out line was to suspend, by means of piano wire, two 20-lb. plumb bobs down the shaft, these being immersed in a pail of oil. The two wires were brought into line at the surface by means of a transit, which was then taken below and the line extended into the tunnels. The level was transferred down the shaft by means of a steel tape, the point so obtained being used as a bench mark in giving grade. As the two faces approached within 10 to 15 ft. an opening was driven through to allow the meeting of grades and alignment to be checked. No adjustments were necessary, as all faces met both in alignment and grade with almost perfect accuracy.

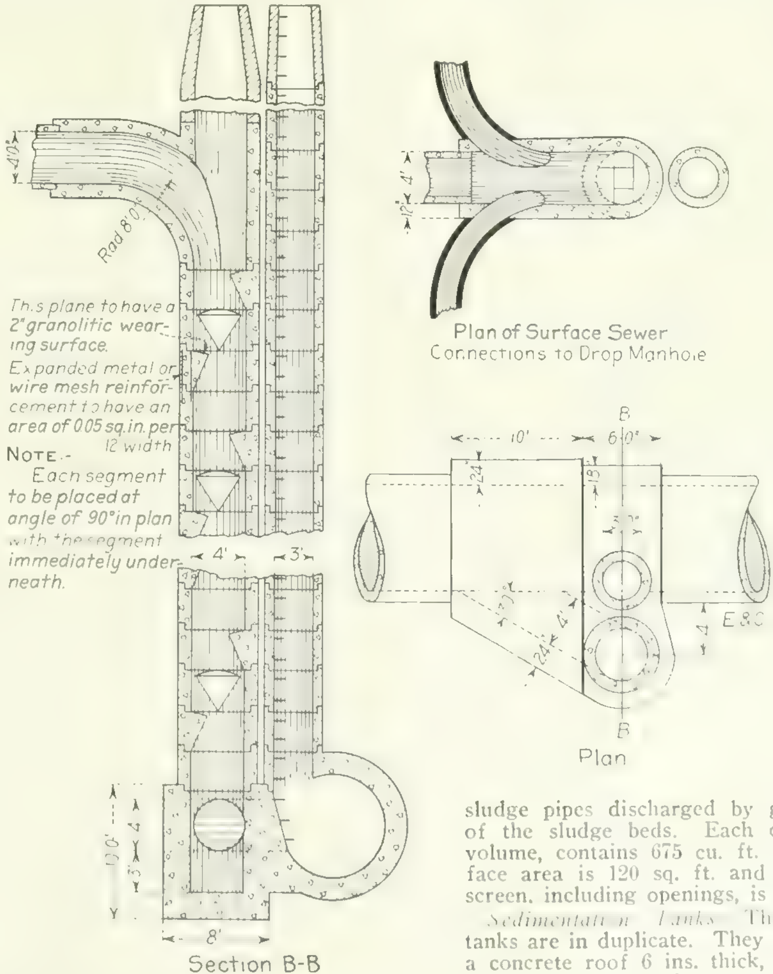

This plane to have a 2" granolitic wearing surface.
Expanded metal or wire mesh reinforcement to have an area of 0.05 sq. in. per 12" width
NOTE.- Each segment to be placed at angle of 90° in plan with the segment immediately underneath.
Rad 8'0"
4'0"
4'
3'
8'
Section B-B
Plan of Surface Sewer Connections to Drop Manhole
10'
6'0"
B
Plan
E.&C.

Fig. 2. Details of Manhole and Drop Connection of New System of Tunnel Sewers at Edmonton, Alberta.

ACKNOWLEDGMENT.

The foregoing information is from a paper before the Canadian Society of Civil Engineers by Mr. A. J. Latornell.

Design, Construction and Operation of Lethbridge, Alberta, Sewage Treatment Works.

(Staff Abstract.)

The present population of Lethbridge is about 12,000. The water pumped averages about 1,300,000 gals. per day, and gravity sewers carry about 1,000,000 gals. of this to the new sewage disposal plant here described. This plant is one of the first of its kind in America, and the present article not only describes the features of design and construction, but also offers criticisms, and states certain conclusions reached since the plant was placed in operation for the guidance of designers of similar works in the future. The design provides for a daily flow of 2,000,000 Imp. gals., reckoned on the basis of 20,000 population using a maximum of 100 gals. of water per day. The total cost of engineering and construction amounted to $84,000. A diagrammatic profile of the plant is shown in the accompanying cut.

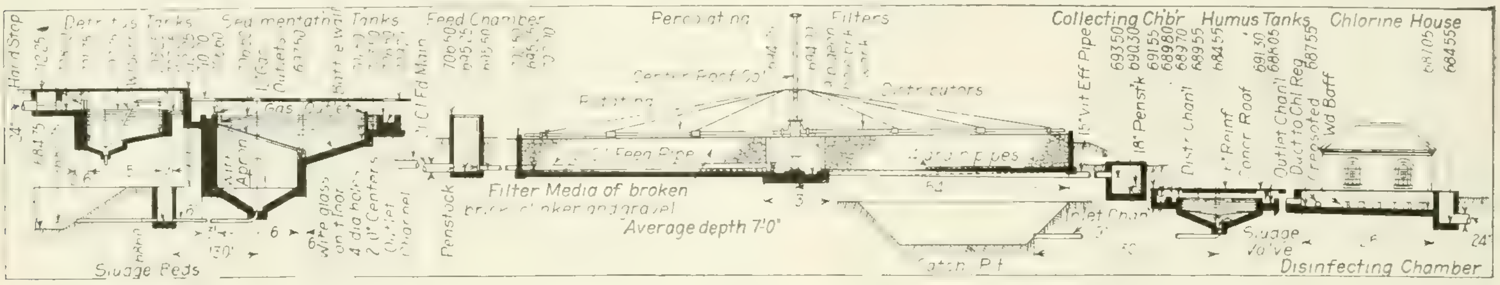
DESIGN.

Detritus Tanks.—The detritus tanks which contain the screens are in duplicate and have hopper bottoms, each equipped with a sludge valve. The screens do not reach to the bottom of the chambers. They are of ½ in. wrought iron with ½ in. openings. After passing through the screens the liquid passes over a weir into a collecting channel, and is then distributed through two 18 in. pipes controlled by penstocks into the distributing channels of each sedimentation tank. The sludge or detritus in the compartment of the detritus chambers is intended to be disposed of through sludge pipes discharged by gravity into one of the sludge beds. Each detritus tank, in volume, contains 675 cu. ft. The liquid surface area is 120 sq. ft. and the area of the screen, including openings, is 52 sq. ft.

Sedimentation Tanks.—The sedimentation tanks are in duplicate. They are covered with a concrete roof 6 ins. thick, supported by 24 in. I-Beams, excepting over channels, which are covered with removable creosoted planks. Throughout the length of each are two distributing weirs. The one first reached by the liquid is on a slope of about 2 ins. in the length of 100 ft., and the second weir is level. This latter weir is intended to equalize the flow so that the velocity of the liquid across any portion of the tank will be uniform, thereby causing the minimum of disturbance during settlement. Before reaching the collecting weir the sewage is baffled by a 6 in. concrete wall with 4 in. holes near the bottom of it at intervals of 3 ft. The liquid passes through these apertures into the collecting channel over the weir. This channel averages 15 ins. in depth, there being a bottom slope of 6 ins. from end to end. The particles capable of settling during the period of flow in the tank are deposited on slopes of wire glass, and when they have accumulated in sufficient mass the solids slide down the slopes and under the glass apron into the sludge compartment. This apron is a distinctive feature of the Lethbridge tank, and consists of ¼ in. wire glass laid on 4 in. I-beams spaced 5 ft. on centers. The apron has a slope of 1 ft. in 3.3 ft., and completely covers the sludge chamber. The corresponding fore-slope at the collecting side of the tank is formed in concrete on solid foundations, in which the wire glass is imbedded to form a smooth surface. The slope of this portion is the same as that of the apron. Each tank is 100 ft. long and 32 ft. wide. The period of flow for maximum capacity is practically 2½ hours, and the maximum average velocity of flow is at a rate of .037 ft. per second. The total contents and measurements of the various compartments are as follows:

	Cu. ft.
(a) Total capacity	34,000
(b) Sludge capacity*	10,133
(c) Capacity above apron	16,475
(d) Capacity between sludge line and apron	8,000
(e) Liquid surface area	3,200

*Sludge capacity is taken up to toe of fore-slope.



Diagrammatic Profile of the New Sewage Treatment Plant at Lethbridge, Alberta, Canada.

The capacity of the sludge compartments of both tanks amounts to 20,266 cu. ft. Storage is provided for a period of 3½ months, based on a separation of 3½ cu. yds. of liquid sludge to each 1,000,000 gals. of sewage. Each compartment has four hopper-shaped bottoms, a separate sludge valve being provided at the junction of the four slopes in each bottom. Two slopes of each hopper have a pitch of 1 in 2 and the other two slopes have a pitch of 1 in 3, these variations being caused on account of the fact that the hoppers are not square. The top of the sludge compartment is formed by the glass apron, and this apron has sufficient pitch to allow gases which collect on the under side to pass to the extreme upper part of the apron, from which they are removed through small galvanized iron pipes. In addition there are two 9 in. vitrified pipes at the ends of each tank, which also serve as outlets. The sludge valves open on a 6 in. cast iron pipe line running lengthwise with each tank, and after these pipes are carried beyond the wall of the tanks they meet a 9 in. pipe line leading from the detritus tank sludge chamber directly to the sludge beds. The stems operating the sludge valve extend through the glass apron to the roof and are exposed for use by removing small cast iron covers set in the concrete roof. One inch water services direct from the city force main are connected to the end of each line of sludge pipes for the purpose of flushing, if desired.

The collecting channel between the sedimentation tanks discharges into a cast iron pipe with a bellmouth on a level with the bottom of the channel. The sewage in entering this bellmouth is subjected to a natural vortex motion for the purpose of giving the liquid a chance to draw down and absorb all the oxygen possible. This pipe, which is 21 ins. in diameter, discharges into a distributing chamber in which are located the three controlling valves for each of the three filter units. The liquid passes through to either of the filters by means of 12 in. cast iron pipes laid along the bottom of the filter floors to the riser pipes at the centers of the filters. The filter apparatus is of the standard rotating "Cresset" type. The sprinkling arms cover a circle, having a diameter of 108 ft., and are probably the largest yet installed in this country.

Filters.—The filters are three in number with concrete floors and have their surfaces exposed to the weather. They are placed in juxtaposition so that the circular walls surrounding them do not meet at the point of contact of each filter. The walls are of concrete, and the filters are built on the natural soil, except at one place, where it was found that the ground was not sufficiently high to carry the floor. At this point the outside walls were carried down to the proper foundation, and the space between the ground level and the under side of the concrete floor was filled with gravel, the maximum fill being about 2 ft. The medium is composed of a mixture of broken brick, hard furnace slag and gravel, the average diameter of the particles being about 2½ to 3 ins. Near the bottom of the filters the slag was put in, in large pieces to protect the 4 in. collecting pipes of vitrified and field tile which have ¼ in. open joints, and also to permit the quick flow of the liquid along the bottom. The central arm or standard carrying the revolving arms was surrounded by a pigeon-holed brick wall, about 4 ft. away from the drum. This construction was not only for the purpose of inspecting the machinery, but also to provide ample aeration for the filter beds themselves. The slope of the floor is 6 ins. in a distance of 54 ft. The total medium area of all three filters is 0.62 acre, the average depth of medium 7 ft., and the minimum capacity of the sprinklers is one-fifth of maximum, or 133,300 gals. to each distributer.

Humus Tanks.—These tanks, for the purpose of obtaining further settling of the partially purified liquid after passing through the filters, are constructed in duplicate, and are built adjacent to the filters, and at a depth sufficient to provide a good fall from the central collecting channel of each filter to the distributing channels of the tanks. They have each a capacity of 4,120 cu. ft. The bottom slopes of these tanks are drained to one central sludge valve, and in order to clean out one of these tanks it is necessary to decant the liquid and drain off humus from the bottom with the aid of flushing. These tanks are likewise constructed of concrete and are provided with a roof of concrete reinforced with expanded metal and steel beams in the same manner as the sedimentation tanks. The liquid is drawn off from the tanks into the collecting channel over weirs 12 ins. wide, and it then passes into a baffle race at the upper end of which is inset a pipe leading to the float chamber in the chlorinating house. There is also to be installed a small pipe carrying the hypochlorite solution.

Measurements of each humus tank are as follows:

Capacity, cu. ft.	4,120
Liquid surface area, sq. ft.	1,200
Length of influent and effluent weirs, ft.	80
Distance apart of influent and effluent weirs, ft.	15
Difference in elevation of influent and effluent weirs, ft.	.1

The design of the chlorinating plant is so arranged that there is an automatic regulation of the flow of chlorine solution into the liquid. This is done by the rise and fall of the float in the float chamber, which operates a lever, which in turn regulates the supply. Thus if the volume of liquid coming through the humus tank is increased, the level rises in the baffle race, causing a consequent increase of chlorine solution to be applied. The baffle race is only intended to give a thorough mixing of the chlorine solution before the liquid is discharged into the main outfall sewer, which carries the finally purified effluent to the river at a distance of about 1,000 ft.

Sludge Beds.—The sludge beds are in duplicate and are simply rectangular excavations in the soil. It was not found necessary when the plant was constructed to do anything towards putting in a gravel or broken stone bottom to these beds, as there are strata of gravel in the excavation which carried away moisture from the deposited sludge in a most effectual manner. This was taken advantage of in the construction of the sludge beds. A narrow roadway at the end of each bed gives access for carts for removing the dried humus. Each bed has a surface area of 480 sq. ft.

CONSTRUCTION.

The excavation work was started in February, commencing with the sedimentation tank. For this part of the work almost 6,000 cu. yds. was removed from the toe of a coulee, the greatest depth being 43 ft. The surplus dirt was all removed with dump wagons and slips, piled up around the site and afterwards used for banking. After removing the top 2 or 3 ft. of soil the excavation was all hard shale, making the work somewhat slow and necessitating blasting, but had the advantage of requiring no shorting or timbering of any description.

The concrete was first started by running the footing for the walls and erecting on them sectional forms of dressed boarding. The forms were placed the required distance away from the face of the shale wall and braced from the parallel wall 16 ft. distant, the same bracing thus serving for two walls. The concrete was poured in layers of from 2 to 3 ft., a complete circuit being made each day. No reinforcement or joints of any description were introduced, the 18 ft. walls being 3 ft. and 4 ft. thick at the bottom and tapering to 18 ins. at the top. The 5 ft. walls were a uniform thickness of 18 ins. For a small portion of some of the walls near the top 2 ft. square metal forms were used. These were found easily and quickly handled, left a good face, but were awkward when the length of the wall was not a multiple of the size of the form, or when the intersecting floors were not square with the surface. In laying the hopper floors a runner was laid down each angle, and after laying the concrete side these were extracted and the spaces were filled in a week or so later. This was found satisfactory where the foundation was hard shale. The floors were 12 ins. thick of 1:2:4 concrete laid in one layer, screeded and finished with a steel float. The aggregate used for all concrete was river gravel obtained close to the site; occasionally sand was screened out, but usually the natural gradings with slight adjustment were found to be sufficiently accurate. The 6 in. concrete roof was reinforced with No. 3 mesh 10-gage expanded metal. The concrete was 1:2:4 laid in one layer and finished with light tamper and wooden float, the cribbing being partly supported from underneath and partly hung from the 24 in. beams carrying the roof.

The foreslope was composed of a 9 in. concrete base with ¼ in. wire rolled glass 2 ft. square laid on the surface and embedded in a rich mortar of cement; no clips were found necessary. The glass apron was carried on 4 in. I-beams at 8:5 lbs., with 5 ft. centers let into the wall at the upper end and supported on concrete piers 18 ins. high at the lower. On the top flange of the beam creosoted wood strips were fixed with small iron cleats sunk flush with the wood. The ¼ in. wired glass in sheets 5 ft. x 3 ft. were laid on these strips, embedded with a mixture of litharge and white lead. Each sheet was secured along the lower edge with two copper clips 3 ins. wide secured to the wood. Thus each sheet was supported entirely independent of the other.

In building the circular walls of the filters templates, convex and concave, cut to the proper circle were placed on top of the foundation, which had been run in trenches. The boxing of placed boards bent horizontally and attached to upright studs was kept in position by the templates at the bottom, and at the top by distance pieces, and securely wired through the thickness of the wall. The boxing was braced from the inside only by means of perpendicular pieces of 2 in. x 6 in. placed at a distance of about 7 ft. from the cribbing opposite every second stud and tied into the studding at the top and bottom, and one diagonal brace to each. This method of construction fulfilled the double duty of efficient bracing and also of providing bents for the gangways from which to pour the concrete walls.

The machines mixing the concrete for the filter walls and floors were placed on a staging erected on the same level as the top of the walls. Three mixers were worked, one at the center of each filter. A gangway 10 ft. wide and on the same level and 330 ft. long ran down the center for the complete length of the three filters, connecting up the three machine stagings and permitting the teams hauling gravel and sand to enter at one end and drive off at the other. From the mixing stage radial runways were placed out to the edge of the filters, in order that the concrete hand dump carts might travel in a circle. The proportions of materials composing the concrete for the floors and walls were the same as for the tanks, the floor being lightly tamped and screeded off. In each filter eight lines of 4 in. vitrified open jointed branch pipes were embedded half their depth in the concrete. These lines ran from the circumference to the center, and had a fall of 6 ins. The portion of the floor lying between the lines of branches was built with a slight cross fall and drained with 4 in. butt-jointed field pipes.

In placing the medium, the overhead gangway, and especially constructed wagons were used. The medium for filters No. 1 and No. 2 was first broken to the required sizes, selected and shaken free from dust and small particles by means of coke forks and carefully placed in the wagons. The bottoms of the wagons were of an inverted "V" shape, and projected beyond the sides and over the wheels. The sides were hinged at the top to the two ends, allowing the cart to be dumped on to chutes at each side of the gangway. Each chute terminated on a portable platform from which the medium was taken and spread by means of wheelbarrows. Any medium smashed in dumping was shoveled off the platform back to the gangway. The medium for filter No. 3 consisted entirely of screened gravel, and was carted from the borrow pit directly into the filter.

OPERATION AND MAINTENANCE.

Operation of the plant was commenced in the month of October, 1912, and the apparatus was given a fair trial before heavy frosts set in. Some difficulty was encountered in obtaining a proper seal in the drums of the rotating filters, and it required a considerable length of time to find out the exact cause of the defect. After careful examination it was found that the upper portion of the drum had developed a very small leak which allowed the air gradually to escape, with an ultimate loss of the seal. This was easily repaired and continuous running of the filter units was then possible.

After a month or two, however, it was noticed that a very considerable amount of colloidal matter was accumulating in the revolving arms of the filters, and it was found necessary to employ a man for a large portion of the day to keep the small holes in the filter arms from choking. After several endeavors to find the cause of this trouble it was observed, that when the accumulation in the detritus tank increased the accumulation in the filter arms became more objectionable. Since no adequate means were provided for removing the detritus from the bottom of the tanks it was decided to flush the accumulating sludge out into one of the sludge beds. This process was then adopted at regular intervals. It appeared, however, that if the detritus tanks were sufficiently shallow to cause practically all the matter which would not pass through the screens to go over the sedimentation tanks and there be deposited as sludge, the liquid reaching the tanks would be more uniform in consistency, and the process of treatment improved. An alteration of the shape of the chambers was then considered, providing for the filling up of the lower portion of the detritus tanks with stone or gravel and the building in of a concrete floor, the screens being sloped sufficiently to give the proper area for the capacity of the plant. By doing this it was hoped that the difficulty in connection with the clogging of the filter arms would be obviated, and the nuisance caused by the flushing of the fresh sludge into the sludge beds eliminated. The particular design adopted for the detritus chamber was felt to be the most troublesome feature of the plant.

After the plant had been operating for a month or two severe frosts were experienced, which caused considerable ice to form on the top of the exposed filter beds, and on one occasion, after a snow fall of some 6 or 8 ins., one of the filters was started up with the expectation that the warm sewage would melt the snow. Unfortunately, however, the weather suddenly became colder, and instead of the snow disappearing it was changed into ice, and it was found impossible to get rid of this accumulation until it was removed entirely from the filters. This was the only time that there was any trouble with the revolving arms on account of the accumulations, and it should never recur, as the operator has had the benefit of past experience. Throughout the winter months ice appeared on the surface of the filter beds during cold weather, and gradually built up into circular ridges between which were narrow openings, the openings, of course, appearing directly in the line of spray from the filter arms. No attempt was made to measure the efficiency of the beds under such conditions, but it is hoped that a proper laboratory will soon be installed with a chemist in charge, and analyses made of the effluent not only from the filters but also after passing through all stages of purification. After running the plant throughout the winter months it was found possible to obtain continuous operation of the filters with their machinery and surfaces exposed to the weather. In the following summer it was established that the fly nuisance was not a serious factor in so isolated a position. The construction of costly roofs over the filter units was therefore abandoned, although provision had been made in the design of the filter machinery for the support of roof trusses from the central posts.

The filters are all thrown into use by the opening of penstocks by hand, which would appear to be a better arrangement than automatic control, for the reason that the winter conditions are sufficiently severe to cause freezing in the drums of filters which might be thrown out of commission for any length of time unless these were drained. Every time a filter is shut down, therefore, the operator proceeds to drain out the drum forming the air seal.

The difference in level between the surface of the liquid in the sedimentation tanks and the top of the riser at the center of each filter gave considerable trouble when a large volume of sewage was delivered to the plant. There was a noticeable surge in the distributing chamber at the entrance to the filters, and frequently the top of the riser would overflow, thus discharging unfiltered sewage into the humus tanks. It was deemed advisable to make an overflow from the distributing chamber, and this was accomplished by cutting through one of the walls of the chamber and inserting a 12 in. pipe delivering into a trough laid on the top of the filter medium between filters Nos. 1 and 2 at a place not reached by the distributing arms. This arrangement seems to give satisfaction, and once or twice each day there is a surge which is efficiently taken care of in this way.

ACKNOWLEDGMENT.

The general design of the works was prepared by the consulting engineer, Mr. T. Aird Murray of Toronto. The plans were carried out by Mr. A. C. D. Blanchard, who at that time was city engineer. The filter machinery was furnished by Adams' Hydraulics, Ltd., of York, England. The work was carried out under the direct supervision of W. A. Adam, assistant engineer. Messrs. Hotsen, Leader and Goode successfully executed the work involved in the principal contract. Our information is taken from a paper by Mr. Blanchard before the Canadian Society of Civil Engineers.

ROADS AND STREETS

Effect of Fineness of Sand and of Clay and Loam on the Strength of Mortar.

Contributed by F. L. Roman, Testing Engineer, Illinois Highway Commission

While it is known that fine sand generally gives a weaker mortar than coarse sand, the quantity of very fine material in sand which will seriously impair the strength of the mortar is not so well understood. The U. S. Office of Public Roads, Circular No. 100, specifies that sand for concrete masonry shall contain not more than 20 per cent of material passing a No. 50 sieve, and the National Conference on Concrete Road Building held in Chicago, February 12-14, 1914, recommended after some discussion, that sand for concrete roads shall contain not more than 15 per cent passing a sieve having 50 meshes to the linear inch, and not more than 2 per cent passing a sieve having 100 meshes to the linear inch. At the time of this conference in Chicago, a series of tests were in progress in the laboratory of the Illinois Highway Department, on the effect of various percentages of fine sand below 50 mesh on the strength of mortar. A description of the tests together with the data obtained is given below.

Materials.—An ideal graded sand was prepared by mixing materials of various sizes by weight according to the parabola of a sand of maximum density. The sand was composed mainly of silicious materials and all the grains were hard and clean. All the sand passed through a ¼-in. sieve and was retained on the No. 50-mesh sieve and was graded as follows, the per cents being by weight:

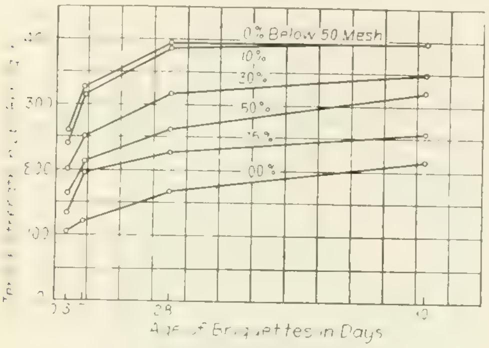


Fig. 1. Curves Showing Strength of Briquettes of 1 Part Cement and 3 Parts Sand at Various Ages.

	Per cent.
Passing 1/4-in. sieve	100
1/4 to 1/8-in.	38
1/8 to 1/10-in.	15
1/10 to 1/20-in.	26
1/20 to 1/30-in.	12
1/30 to 1/40-in.	6
1/40 to 1/50-in.	3
Passing 50 mesh sieve	0

Clean material passing a 50-mesh sieve and composed mainly of quartz dust was also selected. The sieve analysis of this material gave the following results, all percentages being by weight:

	Per cent.
Passing 50 mesh sieve	100
1/50 to 1/80-in.	52
1/80 to 1/100-in.	5
Passing 100 mesh sieve	43

The cement used was a Portland cement of good quality, meeting the standard specifications of the American Society for Testing Materials and showing the following analysis:

Specific gravity	3.15
Fineness:	
Retained on No. 100 sieve, per cent	4.5
Retained on No. 200 sieve, per cent	24.3
Time of setting (Vicat needle):	
Initial set	2 hrs. 30 min.
Final set	6 hrs.
Water required for paste of normal consistency, per cent	21.5
Soundness tests:	
Accelerated test	Good
Normal test	Good
Tensile strength:	
24 hours neat, lbs	395
7 days neat, lbs	730
28 days neat, lbs	877
7 days, 1 per cent cement, 3 per cent Ottawa sand, lbs	248
28 days, 1 per cent cement, 3 per cent Ottawa sand, lbs	294
90 days, 1 per cent cement, 3 per cent Ottawa sand, lbs	316
Chemical tests:	
Sulphuric anhydride (SO_3), per cent	1.43
Loss on ignition	2.10
Insoluble residue	0.41

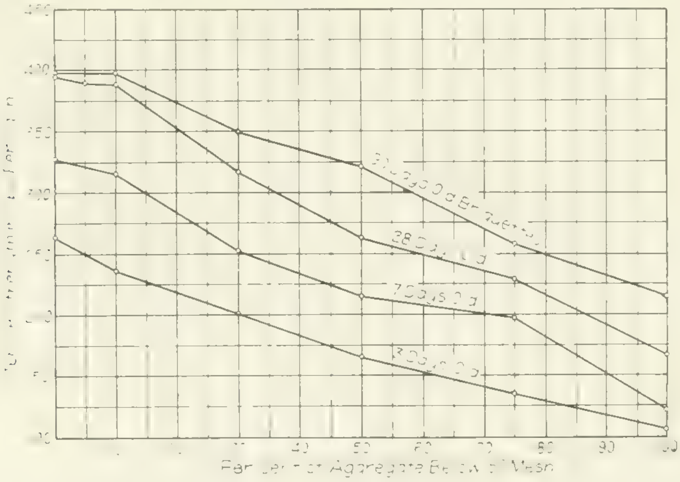


Fig. 2. Curves Showing the Decrease in the Strength of Mortar of 1 Part Cement and 3 Parts Sand, When the Portion of the Sand Passing Through a 50 Mesh Sieve Increases.

Tests.—For the purpose of determining the effect of various amounts of the fine material below 50 mesh on the strength of 1 to 3 mortar, mixtures of the coarse sand (¼ in. to 1/50-mesh) and of various percentages of fine material below 50-mesh were prepared. Briquettes of 1 part cement and 3 parts sand mixtures were molded and tested at 3 days, 7 days, 28 days and 90 days. The composition of the sand mixtures and the average strength of the resulting briquettes at various ages are given in Table I. In the earliest experiments, five briquettes were taken for each test. Shortage of some of the materials used made it necessary to decrease later this number to three briquettes.

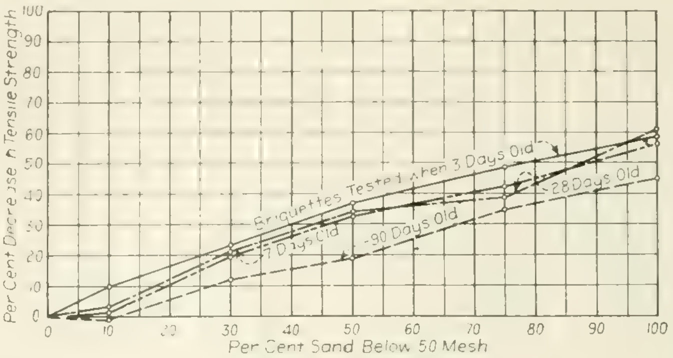


Fig. 3. Curves Showing per cent Decrease in Strength of Mortar of 1 Part Cement and 3 Parts Sand When the Portion of the Sand Passing Through a 50 Mesh Sieve Increases.

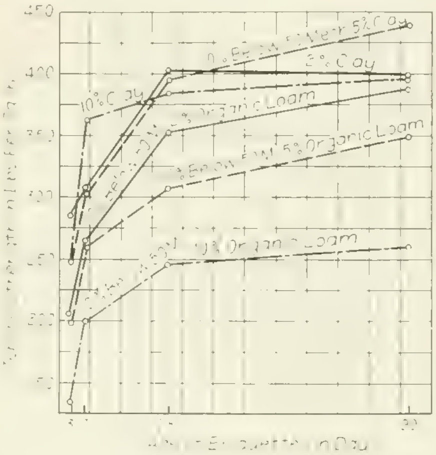


Fig. 4. Curves Showing Strength of Mortar of 1 Part Cement and 3 Parts Sand Containing Clay or Organic Loam Passing Through a 50 Mesh Sieve; the Organic Loam Contains 30 per cent of Organic Matter.

The curves of Fig. 1 show the tensile strength of these briquettes of 1 part cement and 3 parts sand mixtures at various ages.

The curves of Fig. 2 show the decrease in strength of mortar of 1 part cement and 3 parts sand mixtures, when the portion of the sand passing through a 50-mesh sieve increases.

The curves of Fig. 3 show the per cent decrease in strength of mortar of 1 part cement and 3 parts sand mixtures, when the per cent by weight of the sand passing through a 50-mesh sieve increases. The per cent decrease is also given in Table II.

TABLE I.

*		†			
1/4 to 1/50-in. in per cent by weight	Passing No. 50 mesh sieve in per cent by weight.	Age 3 days.	Age 7 days.	Age 28 days.	Age 90 days.
100	0	262	327	395	396
95	5	...	...	389	...
90	10	236	316	388	398
70	30	201	252	317	349
50	50	165	215	263	322
25	75	134	198	229	258
0	100	107	123	168	216
Standard Ottawa sand	...	183	248	294	316

*Composition of sand mixture.

†Tensile strength of briquettes of 1 part cement and 3 parts sand in pounds per square inch.

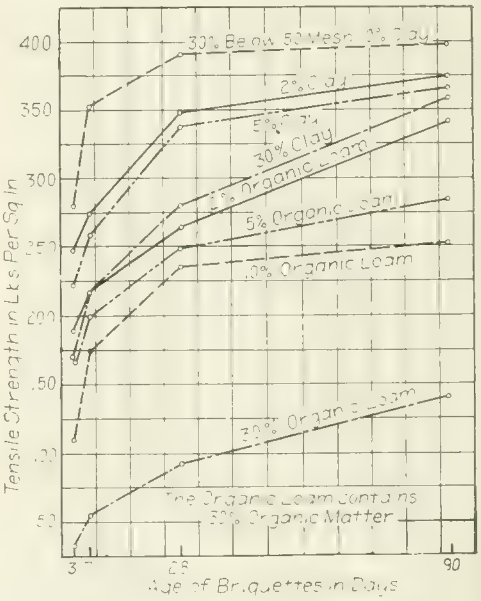


Fig. 5. Curves Showing Strength of Mortar of 1 Part Cement and 3 Parts Sand Containing Clay or Organic Loam Passing Through a 50 Mesh Sieve; the Organic Loam Contains 30 per cent Organic Matter.

The fine material in sand passing through a No. 50-mesh sieve is seldom as clean as the material selected for the above tests, and series of tests were undertaken to determine the effect on the strength of mortar of fine material in sand when the fine material contains clay and loam. It is generally understood that "dirt" (meaning clay, humus and organic matter) in sand is harmful to the strength of mortar. To show the difference in their effect on the strength of mortar, yellow clay and loam containing 30 per cent of organic matter were used in the following tests. Both the clay and the loam were dried and ground to pass a 50-mesh sieve. On ignition, the loam was found to contain 30 per cent of organic material. The loam was kept in water for 3 days, the water showing no alkaline or acid reaction to litmus. Various percentages of clay and loam were substituted in the sand mixtures for the material passing 50 mesh. Briquettes of 1 part cement and 3 parts sand mixtures were tested at the age of 3 days, 7 days, 28 days and 90 days.

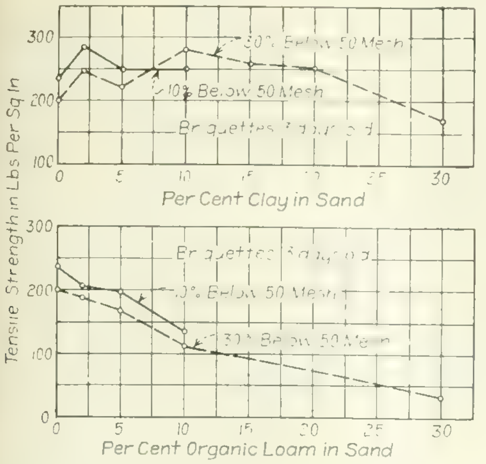


Fig. 6. Curves Showing the Effect of Clay and Organic Matter in Sand on the Strength of Mortar Briquettes of 1 Part Cement and 3 Parts Sand Tested When 3 Days Old; the Organic Loam Contains 30 per cent of Organic Matter.

TABLE II. — PER CENT DECREASE IN STRENGTH OF MORTAR WHEN THE PORTION OF THE SAND PASSING THROUGH A 50 MESH SIEVE INCREASES.

Per cent sand below 50 mesh.	3 days.	7 days.	28 days.	90 days.
0	0	0	0	0
5	..	..	1.5	..
10	10	3	2	—0.5
30	23	22	20	12
50	37	34	33	19
75	49	39	42	35
100	59	61	57	45

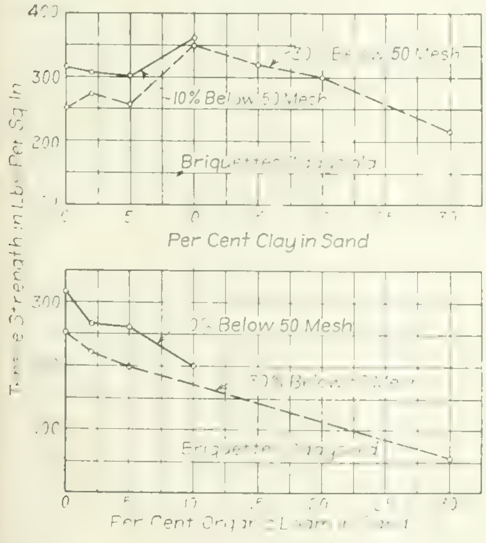


Fig. 7. Curves Showing the Effect of Clay and Organic Loam in Sand on the Strength of Mortar. Briquettes of 1 Part Cement and 3 Parts Sand Tested When 7 Days Old; the Organic Loam Contains 30 per cent of Organic Matter.

The composition of the sand mixtures and the strength of the resulting briquettes are given in Table III.

The curves of Figs. 4 and 5 show the tensile strength of briquettes of mortar of 1 part cement and 3 parts sand mixtures containing clay or organic loam. The strength of the mortar increases with the addition of small quantities of clay. The quantity of clay which may be added to the sand without causing a decrease in the strength of its mortar, seems to vary with the size of the grains and the gradation of the sand. A fine sand would apparently permit the addition of more clay before showing a decrease in the strength of its mortar than would a coarser sand. With a sand containing 10 per cent fine material below 50 mesh, it would appear that only 10 per cent of clay could be added without causing a decrease in the strength of the mortar, while with a sand containing 30 per cent of fine material below 50 mesh, 20 per cent of clay could be added without decreasing the strength of the mortar.

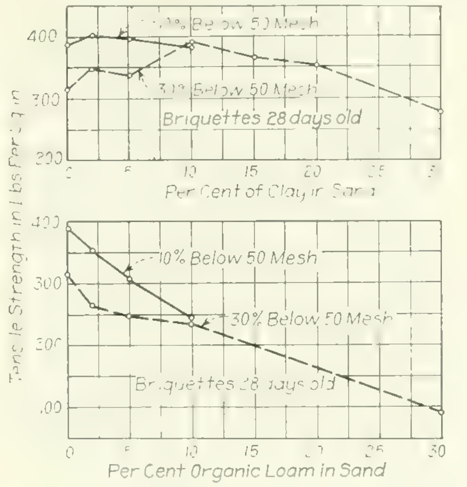


Fig 8. Curves Showing the Effect of Clay and Organic Matter in Sand on the Strength of Mortar. Briquettes of 1 Part Cement and 3 Parts Sand Tested When 28 Days Old; the Organic Loam Contains 30 per cent of Organic Matter.

The addition of organic loam causes a rapid decrease in the strength of the mortar. The addition of only 5 per cent of organic loam or 1.5 per cent of organic matter causes a decrease in the strength of the 1 to 3 mortar of 15 to 20 per cent. The addition of 30 per cent of fine material below 50 mesh does not cause a larger decrease in the strength of its 1 to 3 mortar, than does the addition of 2 per cent of organic loam or 0.6 per cent of organic matter. The reverse effects of clay and organic loam in sand on the strength of mortar is shown better by the curves of Figs. 6, 7, 8 and 9. Table IV and the curves of Fig. 10 show the per cent decrease in tensile strength of mortar of 1 part cement and 3 parts sand due to the presence of various proportions of organic loam.

TABLE III.

1/4 in. to 1/50 in. in per cent by weight.*	Sand passing 50 mesh sieve in per cent by weight.	Clay in per cent by weight.	Organic loam in per cent by weight.*	Age 3 days.†	Age 7 days.	Age 28 days.	Age 90 days.
90	10	..	..	236	316	388	398
90	8	2	..	285	308	402	399
90	8	..	2	206	265	353	386
90	5	5	..	248	301	395	429
90	5	..	5	198	261	307	349
90	..	10	..	250	363	384	397
90	..	..	10	134	200	246	260
70	30	..	..	201	252	317	349
70	28	2	..	247	275	347	376
70	28	..	2	189	222	265	342
70	25	5	..	[illegible]	278	338	367
70	25	..	5	167	199	249	285
70	20	10	..	281	353	391	398
70	20	..	10	111	175	236	252
70	15	15	..	259	321	369	416
70	10	20	..	253	300	356	402
70	..	30	..	170	218	281	359
70	..	..	30	33	55	92	111

Note.—Organic loam contains 30 per cent of organic matter.

*Composition of sand mixtures.

†Tensile strength of briquettes of 1 part cement, 3 parts sand in pounds per square inch.

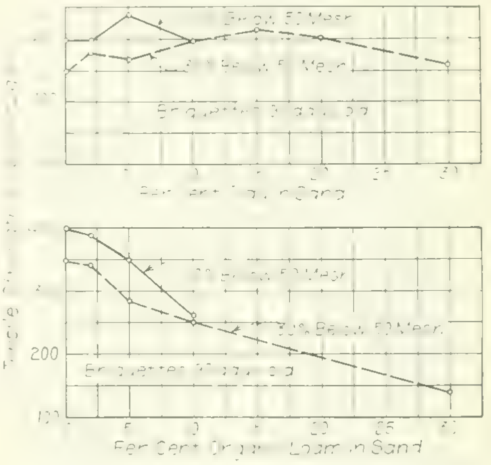


Fig. 9. Curves Showing the Effect of Clay and Organic Matter in Sand on the Strength of Mortar. Briquettes of 1 Part Cement and 3 Parts Sand Tested When 90 Days Old; the Organic Loam Contains 30 per cent of Organic Matter.

TABLE IV.—PER CENT DECREASE IN THE STRENGTH OF MORTAR OF 1 PART CEMENT AND 3 PARTS SAND WHEN ORGANIC LOAM IS ADDED TO THE SAND.

Per cent loam.	3 days.	7 days.	28 days.	90 days.
10 Per Cent Below 50 Mesh.				
0	0	0	0	0
2	12	16	9	3
5	16	17	21	12
10	43	37	37	35
30 Per Cent Below 50 Mesh.				
0	0	0	0	0
2	6	12	16	2
5	17	21	21	18
10	45	31	26	28
30	84	78	71	60

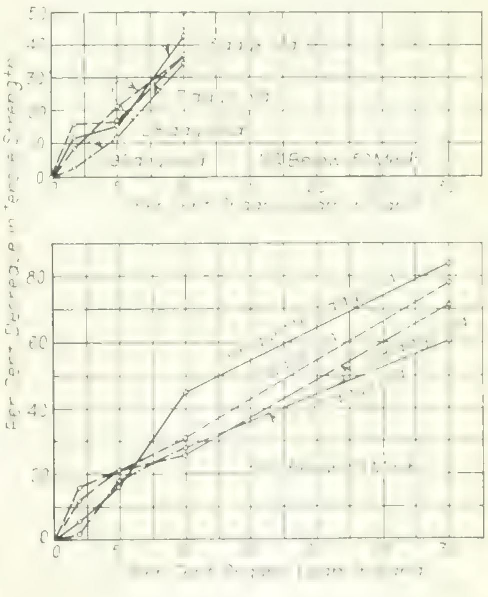


Fig. 10. Curves Showing per cent Decrease in Strength of Mortar of 1 Part Cement and 3 Parts Sand When Organic Matter is Added to the Sand; the organic Loam Contains 30 per cent of Organic Matter.

CONCLUSIONS.

(1) In a well graded sand, the presence of fine material passing the No. 50 sieve causes a decrease in the strength of its 1:3 mortar; the strength of the 1:3 mortar obtained from the portion of the same sand retained on the No. 50 sieve being taken as the basis of comparison. In a badly graded sand the presence of a small proportion of clean sand passing the No. 50 sieve might probably, under certain conditions, cause a slight increase in the strength of the mortar, but the presence of a large proportion of the material passing a 50-mesh sieve will cause a decrease in the strength of the mortar. The effect of the fine sand passing the No. 50 sieve may be explained by the fact that the sand grains are equal in size or only slightly coarser than the cement particles and cause a dilution of the cement. This fine material acts very much as if inert material had been added to the cement at the time of manufacture. Fine sand cannot be mixed readily with cement, and it requires a great deal of handling to obtain a uniform mixture. As it is generally the fact in practice that mortar and concrete are not mixed thoroughly, it is probable that the decrease in strength of the mortar when the fineness of the sand increases would be even larger than shown by the above tests.

(2) Small amount of clay in sand seem to cause a small increase in the strength of the mortar. The tensile strength curve of 1:3 mortar briquettes in which the sand contains increasing percentages of clay rises at first with small quantities of clay. With larger quantities of clay, however, the strength of the 1:3 mortar briquettes begins to drop. The effect of clay is not well understood, as the addition of clay should cause a dilution of the cement and should apparently cause a drop in the strength of the mortar. The increase in strength might, however be explained by assuming that the clay which is carried by the water is composed of extremely fine particles which fill the voids in the cement. This would cause an increase in both density and strength.

It should be noted, that in all tests given above fairly dry mortars were prepared, and in the wet mortars commonly used in practical work even small quantities of clay may cause trouble. In wet mortars, clay will flush to the surface with the water, and cases have been met in practice in which layers of clay were apparent in the concrete, and each batch of concrete was separated from the next one by a layer of clay. Even in small quantities clay is also harmful when it appears in lumps and when it coats the sand grains. Tests invariably show that small quantities of clay which would cause an increase in the strength of the mortar when present as dust in the sand will cause a large decrease in strength when the clay coats the sand grains.

(3) Organic loam in sand, even in very small quantities, will cause a decrease in the strength of the mortar. In the tests above, 1½ per cent of organic matter in sand caused a decrease in the tensile strength of 1:3 mortar of 15 to 20 per cent. Often 1 per cent and sometimes 2 or 3 per cent of organic matter in sand cannot be detected in the general appearance of the sand, and whenever the sand appears dark and loamy, it is a sure sign that it should be tested before using in concrete work.

A Proposed Construction to Reduce the Cost of Brick Roads.

To the Editors: The following are comments on the paper by Prof. James I. Tucker, University of Oklahoma.

I admit that at the time of passing through the die there is a vertical fiber in brick, but I believe that the distinctive feature of a vertical fiber is somewhat interfered with by the fusion during burning. Whether or not this is true, so far as I have been able to learn the fact remains that there have not as yet been devised any physical tests that can demonstrate the superiority of a vertical fiber brick over the non-vertical fiber. Nor is it necessary that there be a vertical fiber in brick. The efficiency of vitrified brick of uniform quality in resisting actions of abrasion, impact, etc., is already so high that scarcely anything more need be desired until some other features of the brick pavement have been developed to a higher stage. I consider it proper that the idea of there being a vertical fiber in brick should be given the benefit of the doubt, even though it is not apparent that any economy worth considering will result. In extreme cases where the haul is excessive, such as was experienced at Panama recently, there could result a substantial saving due to reducing the freight rate by using a 2½-in. or 3-in. brick instead of the standard 4-in. The brick used by the Government at Panama were ordinary pavers, but in order to keep down the freight transportation charges, the brick that were used were only 3 ins. deep. I believe that from the manufacturers' point of view, the idea of using vertical fiber brick forestalls the opportunity for using the cement grout filler, inasmuch as vertical fiber brick cannot be manufactured with the necessary lugs to provide the space for the filler.

It is my opinion that repressing weakens brick, but in seeking an alternative we need not necessarily resort to vertical fiber brick. The wire-cut lug brick has a legitimate field of usefulness at this point.

I am not willing to admit that transverse joints are needed at all, nor is it necessary to make the longitudinal joints near the curbs unsightly poured joints, for they can be very easily made by using a prepared felt. Scarcely anyone will deny the fact that we do have contraction cracks, but even so, a contraction crack cannot possibly be as bad as a transverse joint where the pavement is broken down for three or four courses of brick on each side of the joint, as so frequently occurs. Except for very short lengths, I very much question whether there is a longitudinal creeping in a brick pavement due to expansion. I prefer to say that there is a tendency to creep. For a very short section of pavement, it is probable that the brick would actually creep, and the section would be somewhat longer in summer than in winter, but with a long section of pavement, it seems to me that there exists only a tendency to creep and the expansion action is taken up in the brick and in the grout filler.

Of 43,000 sq. yds. of brick pavement contracted for in four different counties in Illinois in 1914, 64 cts. per square yard was the contract price for the 4½-in. concrete base, or say about 15 cts. per inch of thickness. Reducing the thickness of this base to 2 ins. would make it cost about 30 cts. per square yard, providing the cost were a direct function of the thickness, but it is not such a function. The same expense for preparing the sub-grade must be incurred, whether the pavement is 2 ins. in thickness or 6 ins. in thickness. There is required the same amount of labor per square yard of pavement to finish the pavement, whether the thickness of the base be 2 ins. or 6 ins. The cost of the pipe line for furnishing water is a function of the length of the line rather than of the amount of water required; so without question there would need to be added at least 5 cts. per square yard, making the cost about 35 cts. per square yard for a 2-in. concrete base.

The wire reinforcing at 27½ cts. per rod of 36-in. fence would be about 5 cts. per square yard, without allowing anything for delivering and placing the wire. In order to use a 2-in. concrete base, it would be necessary that the shaping of the sub-grade be done with almost absolute perfection, which would cost about 10 cts. per square yard if it were at all possible to do it. For shaping the sub-grade for a 4½-in. concrete base, we usually figure 3 cts. per square yard. Our grout filler costs the taxpayer about 9 cts. per square yard, whereas, a bituminous filler would cost 20 cts. per square yard, or 11 cts. more than the grout filler. Let us now see what we have:

	Cts. per sq. yd.
Two-inch concrete base	35
Reinforcing material and labor	6
Excessive work, shaping the sub-grade to perfection	7
Bituminous filler, as against cement grout filler	11
Total	59

Or practically as much as we are now paying for a 4½-in. concrete base without any reinforcement. A 2-in. concrete base requires that the sub-grade be shaped to a degree of perfection that is not at all practicable under actual construction conditions. During construction a shower will come up, and immediately after the shower is over, even though it was light, the work must be resumed with the sub-grade not entirely dry. The answer is, that the sub-grade becomes more or less cut up, and from a quarter to a half an inch of the concrete base is depended upon and provided for to take care of just such conditions as these. Still further, the aggregate cannot always be dumped along the sides, and even if it could, the wheelbarrows would cut up the sub-grade in getting to the mixer. The water supply does not always work satisfactorily, and the supply tank on the mixer often overflows and softens the sub-grade. It has occurred that the best of soils contained so much water that it was necessary to run the mixer on boards which frequently sank 2 ins. into the sub-grade, leaving corresponding ridges which had to be taken off. In order to provide for such occurrences as these, it is my experience that on the whole, it is more economical to provide in the concrete base a thickness that is half an inch greater than is what is absolutely necessary, on the assumption that the half inch will be used to counteract irregularities that invariably arise.

In reinforced concrete girder bridge construction, we provide that there shall be 1½ ins. of concrete below the reinforcing steel near the bottom of the superstructure. This is entirely practicable because we have a lumber form on which to place the concrete.

In constructing the concrete base for a brick pavement, to spread out only 1 in. of concrete and then place the reinforcing requires that the shaping of the sub-grade be done with such a degree of perfection as is not warranted by the present stage of the science and art of highway engineering.

I agree with Professor Tucker that we are extravagant in our design of the brick pavement. For rural highway construction and conditions having similar traffic burdens, it is my judgment that there can be developed a 2¾ or 3-in. vitrified brick that will stand a medium rattler test and provide a dependable wearing surface for some thirty or more years. For conditions similar to those in Illinois, where both coarse and fine aggregate are expensive, economic procedure consists in designing so as to use the least total volume of such aggregate, and consequently the 4-in. concrete base is more satisfactory than would be a gravel or macadam base some 6 ins. in thickness. There could easily be conditions, however, where a concrete base for a brick pavement would be neither necessary nor economical. I believe firmly in the use of a cement grout filler. This being the case, I consider that the sand cushion is wholly a misnomer, and is not only unnecessary but it even undesirable.

The average contract price of our brick pavements is about $1.90 per square yard, as against $1.20 per square yard for concrete pavements.

Professor Tucker's paper has been of considerable value to me in a suggestive way, and I trust that the comments that I have made may prove equally interesting to him.

Very truly yaurs.
H. E. Bilger, Road Engineer.
Illinois Highway Department.
Springfield, Ill., April 3, 1915.

(Copy of the above letter was submitted to Professor Tucker whose reply is appended. An abstract of the original paper which is here commented on was published in our issue of April 28, 1915.—Editors.)

To the Editors: Commenting upon Mr. Bilger's review of my paper on Vertical Fibre Brick, I thank you for this opportunity to reply. His letter illustrates the difficulty when one desires a discussion upon features at all novel. If the attendant circumstances are set out, the new features may be so obscured as to scarcely receive consideration; if they are not, the casual reader finds the thesis so bald as to be practically meaningless. The paper was aimed to set out four things:

(1) That it was reasonable to think of a structure in paving brick analogous to a grain or fibre, and that it was rational to lay them in a pavement so as to take advantage of it.

(2) That the grout-filled pavement was in a measure designed upside down, with consequent waste of money and loss of service, very great in the aggregate.

(3) That with a foundation rationally designed, a soft filler had all the advantages of grout, and others the grout did not have.

(4) That so long as McAdam's fundamental principle is not consistently recognized, to the effect that after all, it is the subgrade which really carries the loads, and so long as we adhere to thick plain concrete bases, then pavement design is illogical and wasteful.

He does not, however, discuss any of these points save No. 1. To reply to certain specific points:

(a) There certainly is an appreciable difference between the number of brick required per square yard when laid flat, and when laid on edge. If in addition the thickness of the bricks can be safely reduced to 3 ins. or less, then it seems "an economy worth considering will result."

(b) There seems to be a misconception about forming a lug on the vertical fiber brick. It is simply and adequately done by rounded notches in the die, and not by the wire cutting machine, nor by re-pressing, since this operation is especially tabooed.

(c) I cannot acquiesce in the argument that transverse expansion joints are not needed; nor that the distinction between creeping or "only the tendency to creep" is here a valid one. It seems to be saying that while five pennies make a nickel, twenty nickels make nothing! Either numerous published photographs or the last few years have grossly maligned good pavements, or the "tendency to creep" was at the least very pronounced! Even the famous Indianapolis Speed-way, so its builder told me, bulged up so extensively that two or three complete courses across the finish-stretch had to be removed to let the brick surface return to its original position.

(d) The contention is not made for a 2-in. reinforced foundation *unless* the sub-grade is on the average much better prepared than is now usually the case. It *is* insisted it would be more logical and much cheaper to secure extra bearing-power by extra work on the subgrade than by putting the money into more concrete. The argument that any pavement base acts only through tension, that concrete is notoriously weak in tension, that supplying the tension member in it is therefore rational is not discussed by Mr. Bilger.

(e) In applying the reinforcement it certainly is not intended to lay 2 ins. of concrete in two courses with the reinforcement between. The practical way would be to lay the wire in advance of any concrete, fastening it down with wire "hairpins" if necessary. Then the concrete would work down through it sufficiently. Nor is it at all important that the wire be exactly placed in the center of the concrete so long as it is well covered, say by a half-inch of mortar. Nor is it objectionable if part of the wire is at the top and part at the bottom of the slab, since if there is downward deflection under a load, by reason of a soft spot in the subgrade, calling for bottom reinforcement, there is assuredly a corresponding solid portion of earth supplying the reactions at which places the reinforcement is needed on top.

It cannot be successfully shown, either, why the subgrade should be sandpapered to a perfect contour. The essential thing, usually neglected, is that it be solid and unyielding. If rolled with genuine thoroughness it will perform its function with complete satisfaction, whether or not there are areas slightly flat, or extra-convex, as these will be absolutely imperceptible to the user of the pavement.

In conclusion, the writer has no desire to appear controversial. Should there be merit in his contentions, and similar ones have been made by other engineers at other times, he hopes they may provoke discussion among those dealing with this problem. He desires to see valid reasoning which will prove his positions to be ill-taken, and not merely *ex parte* statements.

JAS. I. TUCKER.

Norman, Oklahoma, April 20, 1915.

Method of Determining Spacing of Joints in Concrete Pavements or Roads.

Contributed by H. J. Fixmer, Division Engineer, Board of Local Improvements, Chicago.

The proper spacing of joints in concrete construction is an engineering problem and not one to be determined by guess.

Such reliable information as we are able to secure indicates that joints should be provided for at intervals not exceeding 25 to 30 ft. The spacing of joints depends on many factors, and these should be given due consideration before deciding the location or spacing of such joints. It is customary in engineering science to provide for unforeseen and uncertain contingencies by the employment of a "factor of safety." Were this factor judiciously applied to the spacing of joints, it appears that the spacing should never exceed 30 ft. and would ordinarily vary from 15 to 25 ft.

In order to determine the proper spacing of joints, the many factors are considered and values assigned to them and an effort is made to combine them in a simple formula. These values are, of course, only tentative, and while justified only by very meager data, at least give us the assurance of being better than a guess.

(1) The coefficient of expansion amounts to about .000006 per degree Fahrenheit per unit of length. This rate of movement amounts to about ¼ in. per 100 ft. of length per 30° range of temperature.

Values of T for ranges of temperature, to be expected at time work is being built, are assumed as follows:

RANGE.

$$T = \begin{cases} 30° = 0 \\ 60° = .1x \\ 90° = .2x \\ 120° = .3x \end{cases}$$

(2) The coefficient of "Shrinkage and Swell" depends on temperature and amount of water present during the mixing and curing of the concrete. When setting in air, concrete contracts from .0008 to .0005 per unit of length; when submerged or covered with water, it expands to about .0005 per unit of length. Where the concrete is directly exposed to rapid drying out it tends to shrink about 1 in. per 100 ft. This would develop a concentrated tensile strength of about 700 lbs. per square inch.

Values of S for manner of curing may be assumed as follows:

$$S = \begin{cases} \text{No curing} & .2x \\ \text{Kept moist} & .1x \\ \text{Kept wet} & 0 \end{cases}$$

Concrete after curing will dry out and crack, but on account of the increased strength due to lengthened time of setting, it will be more able to resist cracking.

(3) The features of the subgrade have an important effect on the cracking, both transverse and longitudinal.

The coefficient of "friction" will vary, depending upon the smoothness and porosity of the subgrade material. It must be observed that the concrete adheres to the subgrade and conforms to every unevenness.

The value for this coefficient of friction or "roughness" is termed Y and may be assumed as follows:

Kind-Subgrade	Condition	Coef. of Friction Y
Clay	Uniform	6 to
	Rough or "cut up"	1.2
Sand	Uniform and smooth	8 to
	Rough and coarse	1.4
Stone	Uniform and filled	1.0 to
	Open	2.0

Let Z equal value of solidity.

When well rolled........$Z = 0$
When poorly rolled.......$Z = .1$
When not rolled..........$Z = .2$ to $.4$

Let M equal value of drainage. Moisture and frost action are more damaging to the formation of longitudinal than transverse cracks.

When well drained..........$M = 0$
When poorly drained.........$M = .2$
When partly submerged......$M = .4$

Let N equal value of shape of subgrade.

When subgrade is dished.....$N = 0$
When subgrade is flat........$N = .05$
When subgrade is crowned....$N = .10$

Shape of subgrade affects the longitudinal cracking far more than transverse. The effect is slight on transverse cracking, and might be ignored.

Let G = longitudinal grade of road. G—.03 multiplied by per cent of grade.

Let L = loads in tons carried by heaviest vehicle. L = tons × .02.

Let E = the total "Coefficient of Subgrade."

Then $E = Y + Z + M + N + G + L$.

(4) The strength of the concrete mixture depends on many factors such as the proportion of aggregates, amount of water used, amount or duration of mixing and proper placing. Let x equal value of strength,

		——x equals——	
Mixture.		Proper Mixing and Placing.	Indifferent Mixing and Placing.
When 1-3-6	mix is used..	20	18
When 1-2-5	mix is used..	30	25
When 1-2-4	mix is used..	30	25
When 1-1½-3	mix is used..	40	30

(5) The weight of the slab per foot of length varies directly and equally with the depth of concrete.

Let d = depth of slab in inches (not less than 6 in.).

Let l = length of slab in feet, on one side of joint, under stress.

Concrete weighs 144 lbs. per cu. ft. or 12 lbs. per inch in depth per sq. ft.

Weight of slab = $12dl$ per foot of width.

Surface in contact = $12d$ per foot of width.

Let D = distance between joints or length of slab.

Let $D = 2l$.

Then $12dlE = 12dx$.

$$l = \frac{x}{E} \qquad \text{Then } D = \frac{2x}{Ef} - S - T + d.$$

(6) It is good practice to introduce the "factor of safety" as is customary in all engineering design, since our object is to *prevent* cracks except where we *provide* for them.

The value of f may be taken at 1.5 or preferably at 2.0.

Taking for example a concrete road laid under ordinary good practice, values can be inserted for the various factors directly from the foregoing tables.

$$E = 1.0 + .1 + .2 + .05 + .03 + .08 = 1.46.$$

$$D = \frac{2x30}{1.46x1.5} - 3 - 3 + 7$$

Hence $D = 28$ ft., with "factor of safety of 1.5.

We can now determine proper spacing in a logical manner, and use such factors as can be realized by rigid inspection or as we have good reason to know will be secured in practice.

Street Cleaning in Victoria, B. C.—Cleaning with hand brooms has been found cheaper in Victoria than sweeping with horse brooms. In 1913 the cost of cleaning with horse brooms and disposal of sweepings was 33.9 cts. per thousand square yards, with hand brooms 26.9 cts. and with brooms and pick-up cans 21.5 cts. In 1914 the cost with hand brooms and pick-up carts and cans was 16.5 cts. These costs do not include rental or overhead charges.

The International Geodetic Association has given notice that, owing to the war in Europe, no meeting of the association will be held in 1915.

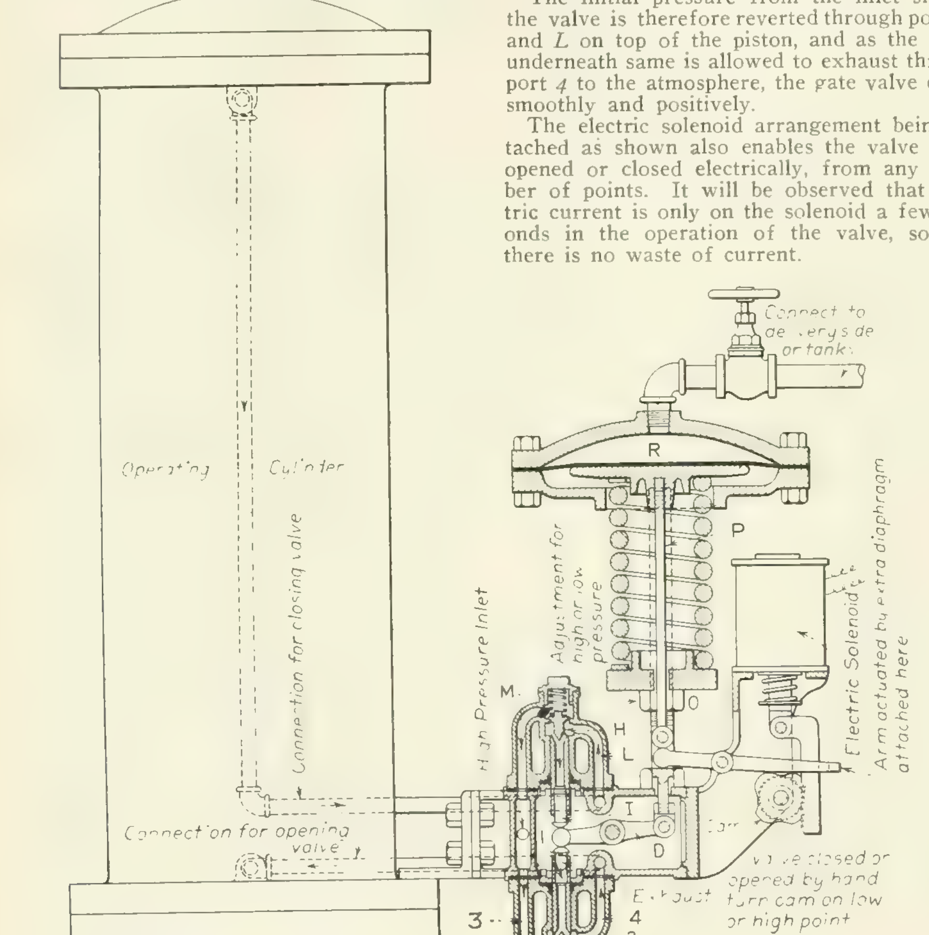
CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

Automatic Control Apparatus for Hydraulic Gate Valves.

The automatic control apparatus illustrated herewith can be attached to any hydraulic gate valve for automatically controlling its operation and maintaining a uniform stage of water in tanks, standpipes or reservoirs.

The automatic features are as follows: (1) automatic control; (2) electrically operated from distant points to close or open gate valve; (3) to close gate valve automatically by increased pressure in the distribution line, such as for fire service; (4) automatic control arranged to work both ways controlling the height of water in tanks, standpipes or reservoirs, and to automatically open the gate valve to allow the pressure to return through the gate valve to the distribution lines wherever the pressure is less on the inlet side of the gate valve. This automatic control can be connected to any make of hydraulic gate valve.


Operating Cylinder
Connection for closing valve
Connection for opening valve
High Pressure Inlet
Adjustment for high or low pressure
Connect to delivery side or tank
R
P
M.
H
L
O
I
D
3
4
2
Cam
Exhaust
Electric Solenoid
Arm actuated by extra diaphragm attached here
Valve closed or opened by hand turn cam on low or high point
E&C

Essential Features of Golden-Anderson Automatic Control Appliance.

As shown by the large section illustration of the automatic control appliance, the gate valve is open, which is due to the fact that the pressure above the diaphragm *R* from the tank or outlet side of the valve has been relieved, and the spindle *P* is forced upward by the large coil spring. The arm *D*, therefore, has closed exhaust valve *1* and opened high-pressure valve *2;* also allowed exhaust valve *I* to open the high-pressure valve H to close.

The initial pressure of the mains entering at high-pressure inlet (due to pipe connection made from inlet side of the valve) also enters unrestricted through ports *3* and *4*, underneath the piston in the operating cylinder, and the valve has, therefore, been opened, as the pressure above the piston has exhausted through port *L* to the atmosphere.

When the pressure in the tank or in the main on the outlet side of the valve has reached the point at which the large coil spring has been adjusted by the nuts *O*, this pressure still increasing acts on diaphragm *R* and causes the spindle *P* to move downward and operate arm *D*, which now closes exhaust valve *I* and opens high-pressure valve *H;* also permits exhaust valve *1* to open and high-pressure valve *2* to close.

The initial pressure from the inlet side of the valve is therefore reverted through ports *M* and *L* on top of the piston, and as the water underneath same is allowed to exhaust through port *4* to the atmosphere, the gate valve closes smoothly and positively.

The electric solenoid arrangement being attached as shown also enables the valve to be opened or closed electrically, from any number of points. It will be observed that electric current is only on the solenoid a few seconds in the operation of the valve, so that there is no waste of current.

With the addition of an extra diaphragm attachment, at the point indicated at the end of the arm under the solenoid in the illustration, the valve can be hydraulically closed at any time by putting increased pressure on the mains. The diaphram is adjusted to a few pounds above the normal supply, and the increased pressure acting on same operates the pilot valve as described above.

This device is manufactured and sold by the Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburgh, Pa.

Asphalt from the northern section of Alberta is to be tried on the streets of Edmonton. This Canadian asphalt was the subject of a recent report by the Dominion Department of Mines.

A Device for the Protection of Public Water Supplies Against Pollution Through Connection with Industrial Supplies.

The tracing of a number of typhoid fever epidemics in various parts of the country, at different times, to leakage through defective check valves in connections between city water mains and industrial systems which are normally or occasionally supplied with polluted water, appears to have led to a condemnation of all such connections. Thus L. H. Van Buskirk, Assistant Engineer, Ohio State Board of Health, stated in ENGINEERING AND CONTRACTING of March 10, 1915, that "the only safe policy is to insist on a complete separation of the public water supply from any and all private supplies." Mr. Walter E. Miller of Madison, Wis., has invented a device, here described, by means of which he claims it is possible fully to protect the public supplies in such cases without eliminating the connections to the industrial systems. A description of the new method for protection follows:

Mr. Miller's method, illustrated by Figure 1, is one which provides a dead section, or section of practically no pressure, in the pipe line connecting the public and private systems. This section is created by, and lies between, an ordinary check valve and an ordinary hydraulic cylinder gate valve installed a short distance apart in the line, the gate valve being in the rear of the check, i. e., on that side nearest the city main.

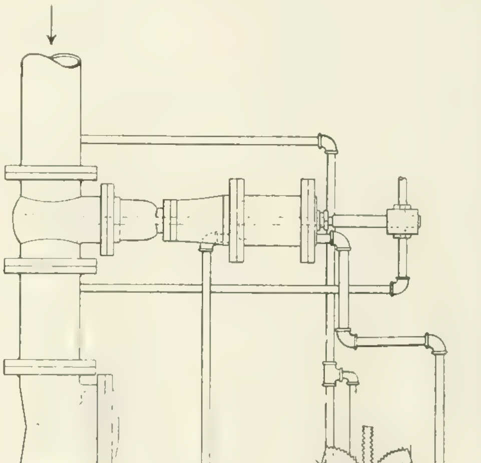


Fig. 1. Diagrammatical Elevation of Miller Device for Preventing Backflow in Water Supply Systems.

The gate valve shown in section in Fig. 2, is automatically opened and closed by the difference between the pressures in the two systems acting through a separate power cylinder whose piston operates the cock or cocks controlling the hydraulic cylinder gate valve. Another cock is provided which opens with the closing, and closes with the opening, of the gate valve. With the gate valve closed, as it will be, automatically, when the pressure in the private system is the greater, this additional cock, then open, provides an outlet for any water leaking past the check. In this way the tightness of the gate and check valves can at any time be very readily determined by external inspection by simply noting the rate at which water is escaping through the open vent cock.

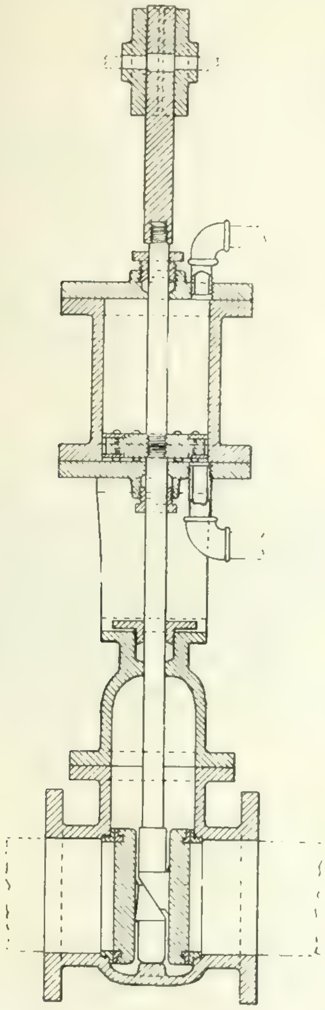


Fig. 2. Central Vertical Section Taken Longitudinally Through Main Waterway of Miller Device for Preventing Backflow—Shows Hydraulically Operated Gate Valve and the Drain Valve.

Provision is also made in the design for preventing any by-passing of polluted water by leakage through the separate power cylinder and into the city mains by using two pistons in it on the same piston rod, and a vent at the middle of the length of the cylinder which is always open. Neither piston can pass or cover the vent in this cylinder.

When the pressure in the city or public system is greater than in the private one the gate valve will be automatically opened and the vent cock simultaneously closed, allowing water to flow into the private systems from the city mains until the pressure difference is reversed.

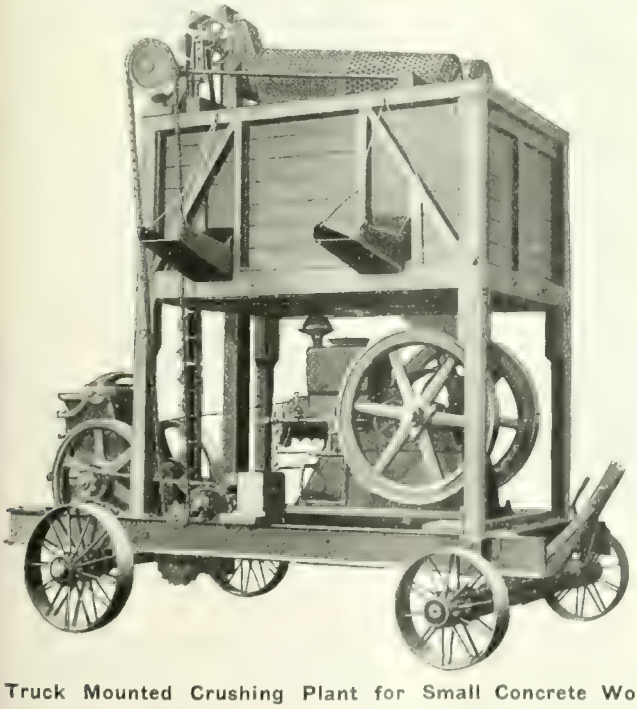
The operation is entirely automatic. The sensitiveness of the device to differences in pressure will be proportionate to the area of one face of one piston in the separate power cylinder. With this cylinder and that of the gate valve lined with bronze or other nonrusting metal, and with correctly made pistons, it is difficult to see how any failure of operation can result.

The accompanying drawing, Fig. 1, does not show such minor auxiliary parts as fastenings for the elements which require them, or guides for the rack bar on the piston rod which operates the control cocks. These are omitted for simplification of the drawing. The device is covered by U. S. Letters Patent No. 1,105,991, dated Aug. 4, 1914.

Truck Mounted Crushing Plant for Scattered Small Concrete Work.

For constructing culverts and similar scattered small concrete structures in country districts away from crushed stone stations and where gravel is not near but field boulders or other rock are available, the truck mounted crushing plant illustrated promises great usefulness. The illustration shows power plant, crusher, elevator, screen and bins, all mounted on a truck. The specifications follow:

The crusher is driven by a 12-hp. double-opposed cylinder engine, guaranteed to produce 12 hp. on brake test. A double-opposed-cylinder is particularly adapted to this work because of its reduced weight and the continuous flow of power. The crusher is a standard No. 7 Telsmith Jaw Crusher, with 7x10-in. opening, manganese steel die plates, cast steel frame, direct crushing stroke and enclosed eccentric. It has a capacity of 2-2½ tons per hour of ½-in. size or ¾ tons per hour of 1½-in. size. A reciprocating feeder conveys the stone from the crusher to the elevator. This feeder is operated by the swinging jaw of the crusher. The elevator is a vertical single chain elevator, with 7x4½x5½-in. buckets, malleable chain and steel boot. The elevator has a folding section at the top, to reduce the head-room required. The standard rig is equipped with a chute screen. Perforations are made to suit. If preferred, the rig is furnished with a rotary screen, central shaft type, 16 ins. in diameter and 4 ft. long. The flat bottom portable bin has four bin gates and a capacity of five tons. This means that one can shovel five tons of stone out of it—not that this amount of stone will run out by gravity. The gravity capacity is about three tons.



Truck Mounted Crushing Plant for Small Concrete Work.

The rig is mounted on an all-steel truck, with 8-in. channel sills, strongly braced. The front axle is of steel channels, with cast steel skeins. The rear axle is of cold rolled shafting, 2 15/16 ins. in diameter. The front wheels are 24x6 ins. and the rear wheels are 30x6 ins. It weighs about 9,000 lbs. A rotary screen will add about 400 lbs. Two horses will pull it on a paved street. Four horses will take it anywhere one can drive an automobile on high gear.

The manufacturers are the Smith Engineering Works, Milwaukee, Wis.

A New Motor-Propelled Street Flushing and Sprinkling Machine.

The new machine is a 3½-ton capacity motor truck of conventional design, upon which is mounted a 900-gal. tank with devices that allow power pressure flushing, power pressure sprinkling, or gravity sprinkling.

For propelling the truck over the street a four-cylinder motor is used, located forward under the hood as on any motor truck Pressure for flushing and sprinkling is produced by a second four-cylinder motor mounted at the rear with separate ignition and cooling system, but taking its gasoline supply from a common tank. The pump for pressure is of centrifugal type, giving up to 60 lbs. pressure, and is in no wise connected with the vehicle-propelling mechanism, thus allowing the operator to change the vehicle speed at will without affecting the water pressure. All controlling devices both for running and for sprinkling and flushing are convenient to the operator's seat. A flexible coupling is provided between the pump and the pump motor.

The two flushing nozzles are provided with universal ball and socket joints, enabling the operator to throw two streams on one side of the street or at any angle desired. The nozzles being well to the front, their work is always observed. The sprinkling nozzles, which are located at the extreme front, can be op-

Motor Propelled Street Sprinkler and Flusher.

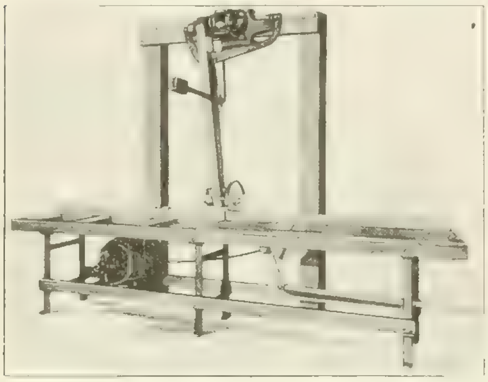
erated by pressure or gravity, as desired. So successful in this pressure machine in operation that it has a range to cover the widest streets found anywhere. While it would ordinarily be most convenient to fill the machine from hydrant or standpipe, it is capable of pumping its charge from rivers or cisterns.

The machine is manufactured by the Tiffin Wagon Co., Tiffin, Ohio.

Electric-Driven Combination Swing and Rip Saw.

(Contributed.)

The Reliance swing saw for crosscut work is a self-contained unit which can readily be installed by bolting with four bolts to any convenient wall or post. Two wires supply the power, doing away with line shafting belting, etc. An automatic starting box permits quick starting and stopping by means of a knife switch placed convenient to the ber up to 12 ins thick.



Electric Driven Combination Swing and Rip Saw.

The latest addition to the Reliance line of electric-driven saws consists of the above swing saw in combination with an electric operator. Current is consumed only when the saw is being used—another saving over constant running line shafting. The outfits are made in several sizes with both direct and alternating current motors, and will cut lumrip saw. A double throw switch controls the operation of either saw and assures the operation of only one saw at one time. An attractive feature of this combination is the fact that the two units are independent of each other, it being possible to use them either in combination or at different parts of the work. The above outfits are particularly suited for the use of contractors or builders, as they can be readily set up on the job and moved to different parts of the work. Either of these outfits will soon pay for itself. They are made by The Reno-Kaetker Electric Co., 614 Baymiller St., Cincinnati, O.

Tool for Making Lead Flange Joint Connections.

The tool illustrated in Fig. 1 was brought out for the purpose of making lead flange joint connections to supplant the more expensive wiped-joint, lead goose-neck water main connections.

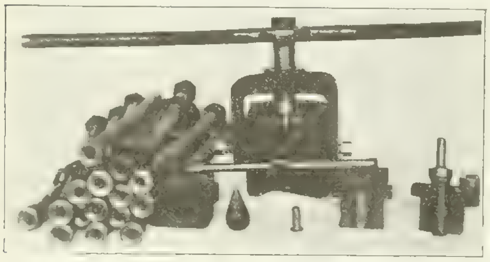


Fig. 1. General View of Hatton Lead Pipe Flanging Device.

The tool and its parts include a vise arranged for holding dies and swage blocks, with bench anvil attached, drilled with three 9/16-in. holes and furnished with three ½-in. bolts 3½ ins. long, with washers, with which the vise is fastened to a work bench. There are four sets of sectional dies which grip the lead pipe firmly and hold it in position for flanging. These dies are designed for the extra heavy lead pipe generally used for corporation goose-necks, and are ½, ⅝, ¾ and 1 in. in size. There are four guide pins of the same size to protect the inside diameter of the lead pipe while the lead is being formed in the die. After the flange is partly formed, and before it takes proper shape, this pin is removed and the fuller mandrill is applied by the screw press. This properly shapes and completes the flange.

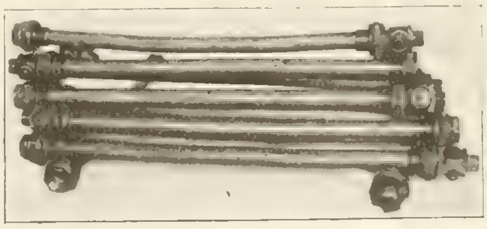


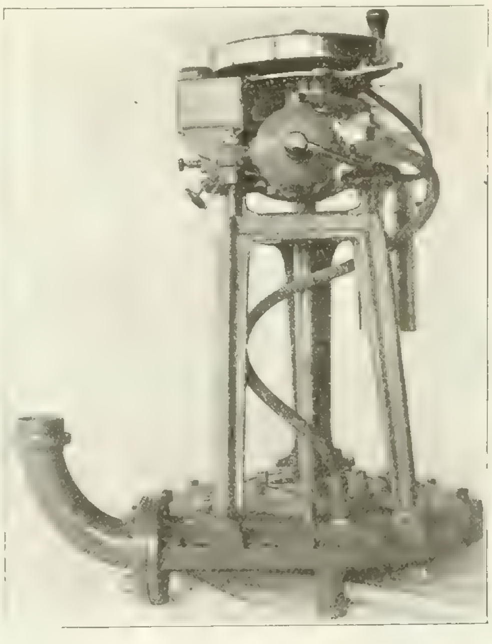
Fig. 2. View of Lead Flange Goose-Necks Made by Hatton Device.

It is claimed that a complete lead flange goose-neck can be made with this tool, by unskilled labor, in from seven to ten minutes. The lead flange-goose necks shown in Fig. 2 were made by one of these tools in 1½ hours.

This device is made and sold by W. J. Hatton, Superintendent of the North Michigan Water Co., Escanaba, Mich.

Use of Evinrude Rowboat Motor for Operating Special Centrifugal Pump.

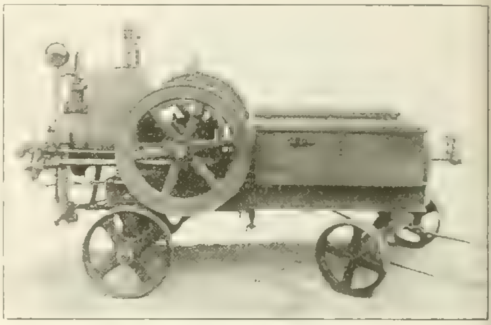
This motor with propeller attached, all devised to fasten to a rowboat or other light craft, has become familiar through the extensive advertising of the name "Evinrude." Recently its use has been extended with success to the propulsion of heavier boats like small coal scows for dredge fuel supply, flatboats for handling men and supplies in ditch work, contractors' houseboats, etc. In the accompanying cut is shown the latest useful application of particular interest to contractors. The motor is attached to a special centrifugal pump, forming an outfit for unwatering pits and trenches or any other place where water accumulates. The whole apparatus is compact and sturdy and can be operated set on staging or suspended from cable; the pump proper must be submerged Under 10-ft. head the pump has a capacity of 55 gals. per minute. The outfit is made by the Evinrude Motor Co., 99 Evinrude Block, Milwaukee, Wis.



Evinrude Motor and Centrifugal Pumping Outfit.

Portable Compressed Air Plant.

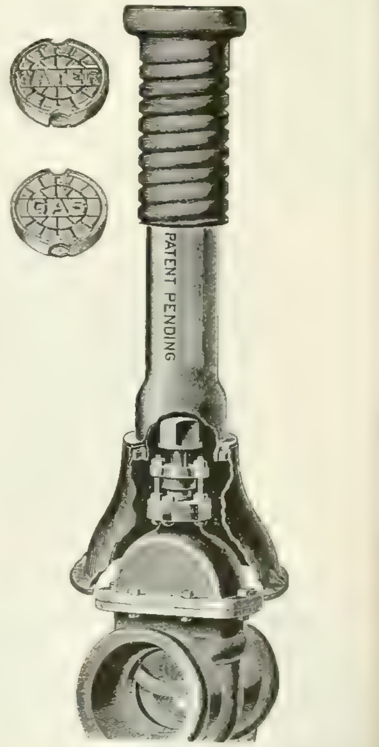
The truck mounted compressed air plant illustrated will operate up to three stonecutting tools at pressures from 30 to 100 lbs. An all-metal truck construction is used, and mounted the total weight is 750 lbs. The outside dimensions are: Length, 5 ft.; width, 2½ ft.; height, 2½ ft. The engine is 4-cycle, horizontal water-cooled gasoline engine with 4x4-in. cylinders; the compressor is single acting, water cooled, 3½-in. bore and 4-in. stroke. The speed of operation is 250 to 500 revolutions per minute. The air tank is 12x30 ins. The outfit can be hauled by hand. It is made by Chris D. Schramm & Son, 318 North Fourth St., Philadelphia, Pa.



Truck Mounted Compressed Air Plant.

Improved Adjustable Valve Box and Box Bases.

The illustration shows the improved form of National adjustable valve box for water or gas valves. The shaft is 5¼ ins. in inside diameter and can be used with any one of the variety of bases manufactured by the same company, the American Foundry and Manufacturing Co. of St. Louis, Mo. Near the top of the bottom section of the shaft, on opposite sides, there are three projecting lugs



Improved Form of National Adjustable Valve Box.

which engage the spiral grooves in the top section of the shaft. This provides for adjusting the height of the shaft.

In setting the valve box in place the base is two or more inches above the flanged joints of the valve dome. The nut of the valve is about on a line with the hub or upper part of the valve box base where bolted to the shaft.

Eight forms of valve box bases are made for use with the adjustable valve box illustrated. These bases may be briefly described as follows: (1) A round base for 6-in. round valves or smaller sizes. Inside diameter at bottom, 14⅜ ins.; height, 11 ins. (2) A round base for 4-in. valves or smaller. Inside diameter at bottom, 10⅞ ins.; height, 8 ins. (3) Round base for 8-in. round valves or smaller. Bottom diameter, 17¼ ins.; height, 11 ins. (4) Round base for 12 or 16-in. round valves. Bottom diameter, 24 ins.; height, 15¼ ins. (5) Oval base for 6 and 8-in. oval or round valves. Bottom, 15x11⅛ ins.; height, 11 ins. (6) A round-dome base, with flange, 17 ins. square. This base is adapted for use when valves are set near surface for any valve up to 24 ins. (7) Oval base for 6-in. valves or smaller. Bottom dimensions, 21x12½ ins.; height, 9½ ins. (8) Oval base for 20-in. valves or smaller. Bottom dimensions, 26x16 ins.; height, 10 ins.

DRAINAGE AND IRRIGATION

Combined Turnout and Drop for Irrigation Canals.

(Staff Article.)

The turnout and the drop are different structures serving quite distinct purposes in irrigation works. Drops are built in irrigation canals for the purpose of destroying excess grade: by introducing a drop, or vertical fall, too steep grade is avoided in canals. Turnouts are structures for diverting water from a larger canal into one smaller. In the accompanying drawing are shown the essential details of a combined drop and turnout. This structure is one to be built on the Flathead Project, U. S. Reclamation Service, Montana, H. N. Savage, supervising engineer.

Referring to the main plan and longitudinal section on the drawing, the head structure in the main canal is at the right hand; the arrow shows the direction of flow. Across canal is a check wall with openings closed by flashboards. Checked by this wall and if head is wanted by closing the openings, the water is diverted through the turnout openings at the left. These openings are two circular pipes which drop to the lower canal level and terminate in a box or chamber with one open side into the lower canal. At the entrance to the pipes and also at the opening of the box are provided slots for flashboards. All parts of the structure except parts of the check wall openings are concrete. The check wall and the box are also reinforced. The volume of concrete is 35 cu. yds. and there are 86 ft. of concrete pipe. All structural details are shown by the drawings.

Methods and Costs of Lining Irrigation Canal with Toncan Metal.

(Staff Abstract.)

Concrete has become very nearly universal as a lining for irrigation canals. In sections of the arid west, however, good materials for concrete are not locally available and here when concrete lining has to be installed raw materials must be shipped in, or, as has been done in several instances, precast lining slabs have to be transported from distant places of manufacture and set in place in the canal. Shipping in concrete materials or precast lining slabs raises the cost of lining and in recent work it was found cheaper to substitute semi-circular toncan metal sheets such as are used for culverts or flumes. The following is a brief account of the metal lining work.

The work described was for the Burbank project in Walla Walla County, Washington. The canal was located on a steep, sandy side hill and lining was absolutely necessary to prevent seepage and also to maintain the canal banks. Concrete materials were not locally available. The work needed also to be completed in as short a time as possible. To meet these conditions selection was made for lining some 3,000 ft. of canal with 6 ft. 1½-in. diameter semi-circular sheets of toncan metal.

The lining was constructed by excavating the canal bed to grade, setting line and grade stakes 25 ft. apart, erecting the No. 120 Hess improved metallic flume of No. 22 gage (0.028) toncan metal selected for the purpose in a similar manner as in the erection of an ordinary steel flume, and correcting for alignment and grade as back-filled by hand with shovels. In constructing a metallic flume, it is ordinarily highly essential to remove all grit and sand from the joints before placing the sheets together in order to prevent leaks. Owing to the close proximity of the lining to the ground surface during erection in this case, this would have been difficult to perform, and the condition was overcome by applying a heavy asphaltic paint to the joints.

On account of virtually erecting the lining in a trench and the consequent inconvenience of working about it, it was not possible to make the same speed as in ordinary steel flume erection. The best progress made in this work was 320 ft. with a crew of 1 foreman and 7 men in 10 hours. This did not include the excavation but did include the erection and cinching of the sheets, the assembling of material for handy use, painting the joints, boring the holes in the 4x4 in. x 8 ft. fir carriers employed, and backfilling sufficiently to permit of the flume to be temporarily sustained on grade and line. The cost of the steel lining was as follows:

	Per lin. ft.
Steel flume, f. o. b. Burbank	$1.30
Timber carriers, f. o. b. Burbank	0.07
Hauling flume and carriers	0.03
Excavation and back filling	0.06
Erection	0.13
Engineering and miscellaneous	0.03
Total cost per foot	$1.62

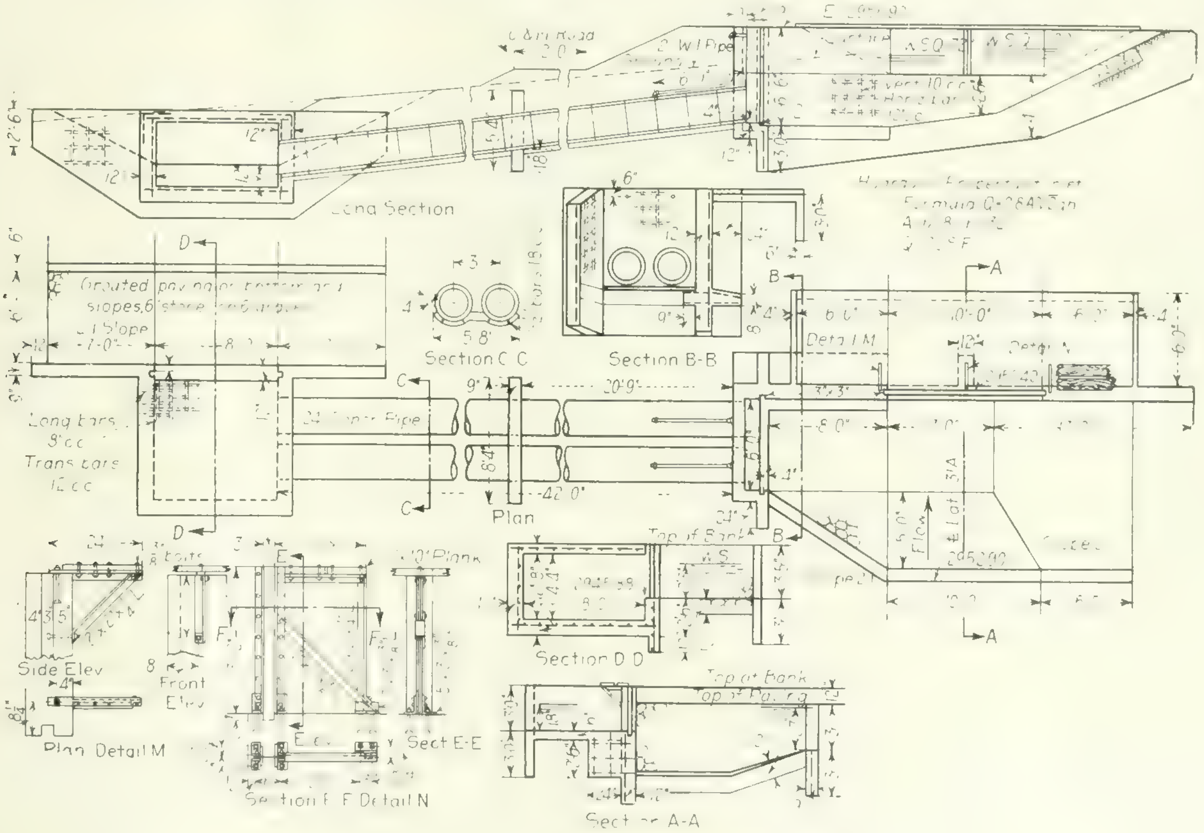


Fig. 1. Turnout and Drop for Irrigation Canal.

The cost of labor was 25 cts. per hour, the foreman 40 cts. per hour, and team and driver $4.50 per day. The material was hauled six miles over heavy roads.

The above information is taken from a paper by E. M. Chandler, Burbank, Wash., in Proceedings Washington Irrigation Institute.

Automatic Check Gate Structure for Turlock Irrigation District, California.

(Staff Abstract.)

Checks are structures used in flat country to check up, or completely to stop off water in an irrigation canal and thus raise the head to facilitate diversion into a lateral. The check is located just below the mouth of the lateral. In the accompanying drawing is shown an automatic check which holds the water above it to constant level without attendance which is necessary for the operation of the more common forms of checks. This check is being used in the Turlock Irrigation District, California, to replace worn out timber checks.

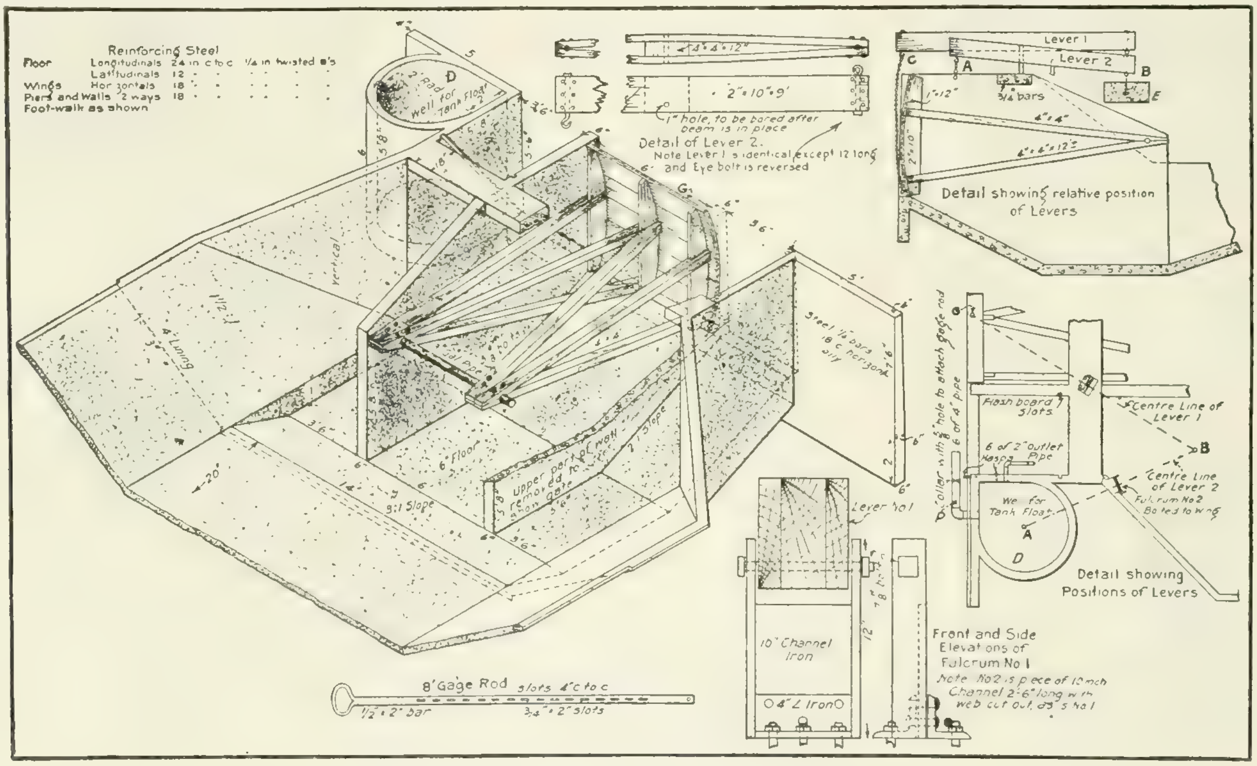

Reinforcing Steel
Floor Longitudinals 24 in c to c 1/4 in twisted ■'s
Latitudinals 12
Wings Horizontals 18
Piers and Walls 2 ways 18
Foot-walk as shown
D
Rad. well for Tank Float
Detail of Lever 2.
Note Lever 1 is identical except 12 long and Eye bolt is reversed
1" hole, to be bored after beam is in place
4"x4"x12"
2"x10"x9'
G
Lever 1
Lever 2
A
B
C
E
1"x12"
3/4 bars
4"x4"
4"x4"x12'
2"x10"
Detail showing relative position of Levers
vertical
4" Lining
6" Floor
9:1 Slope
Upper part of wall removed to show gate
Steel 1/2" bars 18" c horizontal only
Flash board slots
Centre Line of Lever 1
6 of 2" outlet pipe
Hasps
Well for Tank Float
Centre Line of Lever 2
Fulcrum No 2 Bolted to wing
Collar with 5/8" hole to attach gage rod
6 of 4" pipe
Lever No 1
Detail showing Positions of Levers
10" Channel Iron
4" L Iron
Front and Side Elevations of Fulcrum No 1
Note No 2 is piece of 10 inch Channel 2'-6" long with web cut out, as is No 1
8' Gage Rod slots 4" c to c
1/2" x 2" bar
3/4" x 2" slots

Fig. 1. Automatic Check Drop on Lateral of Turlock Irrigation District.

Referring to the drawing the essential parts of the structure are discerned to be, (1) the concrete implacement for the gate; (2) the radial gate; (3) the float well and (4) the system of operating levers. Structural details of these parts are shown by the drawings. It will be noted that there are two levers AB and BC fulcrumed each at mid-length. At lever end A, directly over the well, is hung a tank float playing up and down inside the well. End B of lever AB projects under end B of lever BC, and the two levers are connected at the intersecting ends B. From this point is also hung a counterweight. End C of lever BC attaches by a lifting chain to the radial gate leaf. The system is "balanced" with the gate closed by partly filling the float well with water.

The manner of operation is as follows: Assuming that there is no water in the canal and that the gate is closed. The free end of the well until pipe is placed at the level at which it is desired to retain the canal water. The outlet pipe is placed at a lower level than the inlet pipe. Now as the water comes down the canal it is checked or dammed back by the gate and its level rises until at the level of the inlet pipe when water begins to enter the well. As the water in the well rises it raises the float tank, the levers are pulled down by the counterweight at B and the gate is lifted. Water passes under the gate until level in the canal above is restored to the level of the inlet pipe. Then this surplus water in the well drains out through the outlet pipe, the float tank sinks, the counterweight rises, and the gate closes. It takes about 8 ins. head of water on the gate for it to adjust automatically.

The particular structure shown in Fig. 1 combines both an automatic check and a drop located on a lateral, which carries about 200 sec.-ft. of water. The height of the open ends of both inlet and outlet pipes may be adjusted, as they can be swung about on the threads of the elbows. About two-thirds of the way up these two pipes the gage rods are attached. The slots in the rods are slipped over staples set in the concrete walls near the top and padlocks through the staples over the bars lock the device.

The bucket or tank hanging in the well is made of No. 16 galvanized iron, and is 44 ins. in diameter and 3 ft. high; the top laps over a ½-in. round pipe stiffener and is riveted thereto. Two straps of ¼ x 1½-in. iron pass completely around the bucket at right angles to each other and are brought together 2 ft. above the rim. The concrete counterweight hung below the intersection of the lines of the two levers is of convenient shape and weighs about 300 lbs. more than that portion of the gate to be lifted by it. The automatic radial gate is built up of double 1-in. Oregon pine. Before being set in the concrete the ends of the pipe axle are bored and 12-in. pins are thrust through them, which prevent the axle turning in the concrete.

Where the concrete is mixed by hand on structures like the one described, the Turlock district finds it costs $20 to $22 per cubic yard, while machine-mixed concrete on large structures runs about $13 per cubic yard. The mix used is one part cement to three parts sand and five parts broken stone. Cement costs $2.75 per barrel f. o. b. Turlock, and sand usually is close at hand. Stone costs $1.75 per cubic yard and the hauling 17 cts. per mile per yard additional. The reinforcing bars cost 3¼ cts. per pound at San Francisco. The total cost of a structure like the one in Fig. 1 is about $300.

The data for this description has been secured and the illustration redrawn from a bulletin by F. C. Scobey, irrigation engineer, Office of Experiment Stations. U. S. Department of Agriculture.

What An Engineer Should Know About Water Rights.

Contributed by Morris Bien, Supervising Engineer and Counsel, U. S. Reclamation Service, Washington, D. C.

Engineers in the East are not infrequently required to consider irrigation schemes in which water rights are involved, while engineers in the West are constantly in contact with such problems: still it frequently happens that neither may be well posted on the subject.

There are two basic principles regarding the rights of irrigators to use the waters of natural streams, the doctrine of appropriation and the riparian doctrine. The doctrine of appropriation is that under which one desiring to use water for beneficial purposes may secure such a right by complying with certain provisions of State law and so long as he uses the water for beneficial purposes his right will be superior to any other claim which is subsequent in time, without regard to any claims based solely on the ownership of land along the stream.

Rights claimed merely by reason of the ownership of land along a stream or body of water (riparian lands) so far as they involve the diversion and use of water are specifically involved in what is known as the riparian doctrine.

The doctrine of riparian rights as referred to in discussions in the West was originally part of the common law of England regarding the rights of riparian owners and in its original form as stated and discussed by Blackstone was the right of the owner of land riparian to a stream or other body of water to the use of the water for his own purposes so far as might be possible without interfering with the equal rights of other riparian owners, particularly limited by the rule that the water was not to be diminished in quantity nor deteriorated in quality in any way except possibly a decrease by domestic uses in the household or for the watering of such animals as may be found upon the ordinary farm.

These riparian rights were at one time rigidly enforced and it was possible for a riparian owner to prevent any diminuition in quantity of water flowing by his land because of uses developed by another riparian owner located above him without regard to the question whether actual damage was suffered.

The later doctrine as developed in England and also in the eastern portion of the United States contemplates a reasonable use of the land of the riparian owner for domestic purposes, for cattle, and for agricultural purposes, to the extent at any rate that the water must not be so diminished as to interfere with practically equivalent use by any other riparian owner.

The doctrine of appropriation was developed upon the basis that the prior use of water from a stream gave exclusive right to such amount as is applied for beneficial purposes, as expressed in Section 8 of the Reclamation Act of Congress approved June 17, 1902—"beneficial use shall be the basis, the measure, and the limit of the right."

The riparian doctrine doubtless arose in the humid countries of Northern Europe and probably was based upon the rights of fishing in streams, the use of water for domestic purposes and for primitive milling uses. All of these were of prime importance in the early days in England whence naturally developed the common law doctrine that the stream in its normal state must be preserved for the equal benefit of all those who own lands along its shores.

In those days the development of power in small quantities by the mills of the period was usually possible without interfering with the flow of the stream along the neighboring land and even where there was interference the amount diverted was ordinarily so small that it did not affect the flow sufficiently to involve much difficulty in adjustment. The earlier decisions up to Blackstone's time had settled the law that due compensation must be made for such change in the flow of a stream.

The physical conditions in England that the streams carried considerable quantities of water in proportion to their drainage area and flowed during the entire year caused such small local diversions to be of little importance. The same may be said in a general way of the earlier development in the eastern portion of the United States. Some cases are found in the courts both in the eastern states and in England establishing the right to divert a small proportion of the water for application to the land for irrigation purposes. In the European countries where arid conditions prevail to a greater or less extent as in Italy, Spain and Southern France, the law of waters has been governed by the civil law which is similar in principle to that underlying what is now known as the doctrine of appropriation. The same law was carried over to Mexico where it has been long in force, and similar laws have been applied to the portion of the United States which was formerly under the jurisdiction of the Mexican Government, as in Arizona and New Mexico.

The arid and semi-arid regions of the United States where these doctrines have developed much importance comprise in a general way the territory west of the 100th meridian. There is a narrow fringe along the Pacific Coast and also one west of the 100th meridian that may be called semi-arid, where in some years the rainfall is sufficient to make agriculture profitable without the artificial application of water while in other years it is not.

In California the same law was followed in the beginning of its history and for a considerable period after it became a part of the United States. Subsequently the agricultural industries were overshadowed by the mining industry following the discovery of gold and the great influx of population from the eastern part of the United States in 1849 and afterwards.

This mining development was largely by means of placer mining requiring the use of great quantities of water. In many cases it was necessary to divert water from the stream and carry it for long distances to the point of use, causing the stream to be dry for many miles below the point of diversion during most of the year. The need of great quantities of water under pressure also involved the holding of water in reservoirs, and this storage of water was further rendered necessary by the large fluctuations in the streams which, in many cases in their original condition were dry or nearly so in the summer season.

These requirements of the miners developed a plan of recognizing the prior use for beneficial purposes, irrespective of the amount of water taken from the stream, which in many cases was never returned to it, being diverted to an entirely different drainage area. As with many other matters in the early days of California, the miners developed a code of law for themselves regarding the use of the federal public lands for mining purposes and the streams of the public land in connection therewith, being substantially the doctrine of appropriation as we now know it. This doctrine was confirmed so far as the federal lands are concerned by Section 9 of the Act of July 26, 1866 (14 Stat., 253) now incorporated in the Revised Statutes of the United States as Section 2339, which provides for the recognition of rights to the use of water which have vested and accrued by priority of possession and which have been recognized and acknowledged by the local customs, laws and decisions of the courts and also the necessary rights of way over the public land used in connection therewith.

This is the first federal legislation upon the subject and this recognition of the right of prior appropriation in connection with the taking of water from the streams on desert lands of the United States was confirmed and established by the Federal Desert Land Act of March 3, 1877 (19 Stat., 377), which provides for the taking of public lands as desert land entries upon a declaration of the applicant "that he intends to reclaim a tract of desert land * * * by conducting water upon the same within the period of three years thereafter: *Provided, however,* That the right to the use of water by the person so conducting the same, on or to any tract of desert land * * * shall depend upon bona fide prior appropriation; and such right shall not exceed the amount of water actually appropriated, and necessarily used for the purpose of irrigation and reclamation; and *all surplus water over and above such actual appropriation and use, together with the water of all lakes, rivers, and other sources of water supply upon the public lands, and not navigable, shall remain and be held free for the appropriation and use of the public for irrigation, mining, and manufacturing purposes subject to existing rights.*"

This system in regard to the use of water for mining purposes in California has remained in force with the possible exception of a few cases in the southern part of the state where the mining operations may have conflicted with rights claimed by riparian owners.

In California there have been long disputes in regard to the establishment of one or the other of the two doctrines in regard to the use of water for irrigation. This dispute it may be said has not yet been settled, as the courts of the state have attempted to apply on the same streams these two opposing doctrines. The doctrine of riparian rights has been recognized in many instances in the southern part of California to the detriment of irrigation development.

The courts of the state of Nevada at first followed those of California in applying the riparian doctrine but after a short time the Supreme Court of Nevada reversed itself and adopted the doctrine of prior appropriation holding the common law doctrine of riparian rights to be totally inapplicable to the physical and climatic conditions of the state and therefore as never having formed a part of the common law of the state. The doctrine of riparian rights has never gained a foothold in any of the western states that are wholly arid, such as Utah, Idaho, Wyoming, Colorado, New Mexico and Arizona.

In Idaho a small portion of the northern end is humid but the irrigation interests were so overshadowing in importance from the beginning that the doctrine of appropriation was incorporated in the constitution in the early days of its history.

It is only in those states where the country is in part arid and in part humid and where the humid region was first settled and became in the beginning the more important section, that there has been much consideration of the application of the riparian doctrine in connection with irrigation development, such for instance as the states of California, Oregon, Washington and Montana.

There is not much dispute of the proposition that the doctrine of prior appropriation is essential for the proper development of an arid or semi-arid region where irrigation is necessary for agricultural purposes and that the more the riparian doctrine is recognized the greater are the difficulties with which irrigation development in such regions must meet, and the greater will be the expense and delay in carrying out such development.

In regions where there is not sufficient rainfall to provide moisture for the growth of crops, it follows that the flow of streams is small in quantity compared with the area that would be available for irrigation purposes were there sufficient rainfall; also that the flow of such streams is intermittent, subject to floods when the snows melt and during occasional periods of brief but heavy rainfall, being dry or nearly so at other times.

The early settlers discovered that the only way to raise agricultural crops was by diverting the water from the stream for the irrigation of the land. This process was usually begun promptly by the early settlers in our western territory and generally consisted of a small ditch taken out of a stream, leading the water to a small tract which is cultivated for hay, grain, vegetables, etc., usually in connection with large cattle ranches.

As the activities of the settlers developed, more and more expensive ditches and dams were built to divert the water. After a number of years all the water of the stream that can be used with comparatively small expense has been diverted and applied for agricultural development. If at this period a riparian owner lower down on the stream who has noticed a diminution in the amount of water passing his land brings suit to prevent these diversions, he would under the riparian doctrine be entitled to a decree which would absolutely prevent such diminution of the stream flow. The result would threaten the destruction of existing development on thousands of acres which have been made productive and which on account of the increase of value are an important asset of the community, not only on account of the payment of taxes but also in the development of miscellaneous business to supply the wants of the farmers, causing the growth of towns, occasionally of much importance.

In such cases the farmers have been confronted with the necessity of purchasing the riparian rights with which their operations have interfered. This adds a serious burden to those engaged in agricultural development.

The establishment of larger irrigation enterprises is also made difficult and retarded by the necessity of dealing with the riparian owners to avoid interference with the water needed for the irrigation development, especially where large storage dams or important diversions are to be provided. The necessity for such development must become very urgent before the investor is willing to spend the large sums required to protect himself against the riparian claims.

The law has always been that no person has a right of ownership in the water of a running stream but most illogically the law has recognized a quasi right of ownership in the riparian landowner, because the law does not base his rights upon use, and the damages which he may claim in court do not depend upon interference with any use to which he is putting the water or to which he may desire to put the water. The common law in this respect is inconsistent but this was not manifest in the early days in England and in the eastern states because of the abundance of the water supply. It has been recognized in later years to some extent in both countries where larger and larger uses by riparian owners are permitted even when there is a diminution in the quantity of water.

It is interesting to note that there is more or less tendency in the states of the west where the riparian doctrine is recognized to apply the doctrine of appropriation. For instance, the Supreme Court of Oregon has decided to recognize the doctrine of appropriation as controlling in the use of water for beneficial purposes. The state of Texas has recently passed an act which proposes to establish the doctrine of prior appropriation instead of the riparian doctrine heretofore recognized by its law and its courts.

In the state of Washington various efforts have been made and a vigorous campaign is now pending for the adoption of a code of water laws which would protect rights to the use of water dependent upon prior appropriation. In the states of Montana and California similar attempts are being made with some promise of success.

It is strange that in these states where the possibilities of irrigation development form so large an element of their resources, that the same attention has not been given to its protection as to the mining industry which becomes of less and less importance each year, being gradually subordinated to the agricultural development. Moreover, every ounce of ore taken out of the ground decreases this resource, while every crop taken from the irrigated land is merely a promise of greater and greater yields, because the practice of the irrigators is annually becoming more economical and the areas of irrigation with the same water supply are being greatly extended, while better agricultural methods are constantly increasing the crop values.

To produce results which irrigation makes possible, with the greatest efficiency and the least delay it is necessary that the indefinite claims of the riparian owner which are not based upon use or any benefit to the community, be eliminated and that there be an easy and sure method of acquiring and protecting the essential right upon which such progress is dependent, namely the right to the use of water.

The ownership of arid land is practically of little value without the ownership of right to use the water, and there is no reason why a man should be sustained in the monopoly of a public resource when no labor of his own has caused it to become available for use and when his right is of no benefit to the community and besides stands in the way of important community benefits.

There can be no stability in a right to the use of water where the riparian doctrine is in force, until settlement has been made with every landowner down to the place where the water passes into the ocean or out of the region in which the riparian doctrine is in force.

A clear and unquestioned right to the use of water is a necessity for proper irrigation development and so long as such use may be subject to interference by one who claims merely a right to have things remain unchanged, just so long will there be difficulty and retardation in such development. It is for this reason that we see the vigorous efforts now being made in the states of California, Washington, and elsewhere for the enactment of a code of laws that will eliminate this monopolistic claim which holds back the development of the state that irrigation will make possible.

Devices for Measuring Irrigation Water.

To the Editors: I was interested in your editorial of March 17, entitled "The Immediate Problem in Irrigation Water Measurement," this evidently being brought out by the pamphlet recently published by Mr. Frank Adams of the University of California, the same being illustrative of the various irrigation devices at present in use.

Your last paragraph particularly interests me in that I am inclined to think that instead of saying "Invention has in this task a wide opportunity," it ought to be "Invention has taken advantage of the opportunity and as a result the Venturi meter for the measurement of irrigation water has been perfected and meets every one of the conditions brought out in your editorial."

Through information gained first hand by having been in charge of the operation and maintenance of one of the largest, if not the largest single irrigation projects in the United States, I hardly subscribe to the statement that the most important consideration in connection with this feature of the work should be extreme cheapness, as one can readily see that in localities such as California at the present time where water is at its high value, even as much of an error as 5 per cent would be productive of charges that might be clearly in excess of what the most expensive irrigation device on the market would cost.

I enclose herewith copy of our latest bulletin on the Venturi Irrigation Meter, and your attention is specifically called to the report appearing in the last part of the bulletin, of the Government Board of Engineers which carried on a very comprehensive test on one of these instruments installed under actual conditions, and the table illustrating the same I am sure will prove very interesting.

You will note the percentages developed in those tests. The Venturi meter was treated in your issue of January 20th somewhat briefly, but the main features were brought out.

These instruments are at the present time installed on the Salt River project in the vicinity of Phoenix, Arizona; the Yuma project, Yuma, Arizona; the Imperial Valley, Cal., California Development Co.; Tucson Farms Co., Tucson, Arizona; Greeley Water Works, Greeley, Colo.; and a contract of considerable moment has just been closed with the Sunnyside project, U. S. Reclamation Service, North Yakima, Washington.

I will be very glad to furnish you any further information you may desire.

Very truly yours,
Builders' Iron Foundry,
By Howard S. Read.

(The tabulation from the report referred to by our correspondent is given in Table I.—Editors.)

TABLE I.—TESTS ON 15 SECOND-FOOT VENTURI IRON METER.

Date, 1914.	Venturi meter, second feet.	Weir, second feet.	Current meter, second feet.	Loss of head.	Weir and current meter.	Weir and Venturi meter.	Venturi meter and current meter.
Feb. 27	6.80	6.74	6.69	.10′	+0.74	0.89	+1.62
Feb. 27	12.75	12.12	12.25	.24′	—1.07	—5.20	+3.92
Feb. 27	15.60	15.93	16.86	.26′	—5.84	+2.07	—8.08
March 21	8.90	8.20	8.49	.11′	—3.54	—8.54	+4.61*
April 15	7.30	7.13	6.80	.10′	+4.63	—2.38	+6.85
April 15	6.60	6.64	6.31	.05′	+4.97	+0.60	+4.40
April 16	12.70	12.27	12.54	.21′	—2.20	—3.50	+1.26
April 20	15.10	15.23	14.57	.29′	+4.33	+0.85	+3.51
April 20	13.35	13.44	11.89	.25′	+11.53	+0.67	+10.93
April 20	10.50	10.34	9.72	.14′	+5.99	—1.55	+7.43
April 20	3.88	3.80	†3.28	.017′	....	—0.21	....
April 20	3.40	3.38	‡2.96	....	....	—0.06	....
				Means	+1.95	—1.51	+3.64

Note.—Above is taken from sheet furnished by the United States Reclamation Service showing results of tests conducted by engineers of the service on the 15 second-foot Venturi irrigation meter installed on the project. These results are plotted in the curve shown below.

*Venturi not set at zero.
†Velocity only 0.5′ per sec.
‡Velocity only 0.46′ per sec.

A press dispatch from Panama, April 15, says that up to April 1 tolls on the canal amounted to $2,894,300; and that the total cost of operation and maintenance during the same period was $3,020,000, leaving a deficit of $125,700.

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Assortment of Cargo on Panama Canal Vessel.—Among items listed in the cargo of 4,500 tons carried by the *Peter H. Crowell* through the Panama Canal on its way from New York to the west coast were: battery cells, caustic soda, olives, chemicals, earthenware, glassware, lard, liquors, structural steel, machinery, refined petroleum, vegetable oils, paint, paper and paperware, pianos, rubber goods, salt, soap, stamped ware, tobacco, textiles, wooden ware, marble, starch and thread. "Balance 1,189 tons, small lots of various articles."

CURRENT NEWS

The Doings of the Week.

There has been no spectacular developments the past week in either the stock market or the fields of business and finance. Industrial and commercial conditions continued to show improvement. Speculative transactions on the stock exchanges reached a high mark and the bond market showed the presence of a large investment demand. Two large issues of railway securities were marketed. A $40,000,000 issue of 4½ per cent notes by the Baltimore & Ohio was over-subscribed. The stockholders of the New York Central Lines subscribed for practically all of the $100,000,000 6 per cent debentures offered recently by that company. Official figures for March exports gave a balance of $141,000,000, making a new high record for that month. It is now estimated that the foreign trade balance of this country will exceed $1,000,000,000 during the current fiscal year. In the construction field several large contracts have been placed during the past week and a number of exceptionally large undertakings reached the call for bids stage. An interesting development of the Canadian construction field is the statement that the Alberta Hydro-Electric Power Co. will shortly proceed with the building of a series of six dams and power houses at a cost of $2,000,000. In the Southern states a considerable amount of municipal work is now being advertised. In the iron and steel trade the feature of particular interest was the buying of basic pig iron in nearly all districts outside of the East. Large orders for war munitions were placed during the past week. The report of the Steel Corporation showed March earnings 33 per cent greater than the total for the two previous months. February earnings were practically double those for January. A few rail orders have been placed and the Pennsylvania R. R. has formally renewed its inquiry. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending April 28 were as follows:

Finished Iron and Steel.	Apr. 28	Apr. 21.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.15	1.15
Iron bars, Pittsburgh........	1.20	1.20
Iron bars, Chicago...........	1.15	1.15
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York.........	1.369	1.369
Tank plates, Pittsburgh......	1.15	1.15
Tank plates, New York......	1.319	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York......	1.369	1.369
Skelp, grooved steel, P'gh....	1.12½	1.12½
Skelp, sheared steel, P'gh....	1.17½	1.17½
Steel hoops, Pittsburgh......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.80
Galv. sheets, No. 28, P'gh....	3.25	3.25
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh..........	1.55	1.55
Fence wire, base, P'gh.......	1.35	1.35
Barb wire, galv., P'gh.......	2.10	2.10

For structural material f. o. b. Pittsburgh *The Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.15 to 1.20 cts.

Railways.—Aside from new financing by the Baltimore & Ohio and the New York Central Lines there have been no particularly important developments in the railway field. Both of the above roads have large construction projects in view, and it is possible that their success in disposing of their securities will enable them to take up these developments soon. It is likely that a considerable amount of track elevation work in Ohio and Indiana cities will be placed under contract in the near future. There also are a number of small railroads that are planning to start construction this month or early in June. The Lehigh Valley R. R. awarded a $600,000 contract to Henry J. Miller, Inc., Baltimore, Md., for the erection of the terminal at Buffalo, N. Y.

Roads and Streets.—One of the larger county highway undertakings of this year reached the call for bids stage last week. Vermillion County, Ill., is asking bids for the construction of 174 miles of concrete or brick surfaced roads. On the Pacific Coast a large amount of work is being advertised by County Commissioners in the State of Washington. California counties also are showing much activity in placing work. In Oregon, Multnomah County, will shortly take bids on about $1,250,000 worth of work. Counties and road districts in Southern states are preparing to undertake a great deal of construction work this season, and a good part of this will be ready for bids this month. The State Highway Commission of Illinois is calling for bids on another letting of state roads. New York is advertising 20 to 30 contracts for highway repairs. Other states have lettings of considerable size now ready for bids. The Maryland Roads Commission awarded 6 contracts; Idaho State Highway Commission let three grading contracts; Beltrami County, Minn., awarded a contract at $98,900 for a state rural highway. Charleston, S. C., is calling for bids on 65,000 sq. yds. of street paving and Anderson, S. C., opens proposals May 11 on 75,000 sq. yds.

Bridges.—No especially large bridge jobs appears to have come up for advertising during the past week. A fair number of smaller structures, however, are ready for bids. It is expected that proposals will be asked in a few days for a number of good sized structures. Cincinnati, O., probably will advertise the Kemper Lane concrete viaduct, a $165,000 job; and Milwaukee Wis., may take bids soon on the State St. Bridge. The contract for the Woodsdale bridge for Hamilton County, O., was let to Cleary-White Construction Co., Chicago, at $76,284.

Drainage and Irrigation.—One of the larger drainage undertakings that has come up for letting so far this year is now being advertised. The work is to be done for the Peace Creek Drainage District of Polk County, Florida. It calls for the construction of 142 miles of ditches, requiring 2,432,743 cu. yds. of excavation. The National Drain Tile Co., Terre Haute, Ind., has been awarded a $41,500 contract by the Jamesburg Drainage District of Danville, Ill. The Utah Construction Co., Ogden, Utah, secured the contract for the East Canyon Dam for the Davis & Weber Counties Canal Co.

Waterworks.—Several good sized contracts in the waterworks field have been awarded during the past week, and a considerable amount of new work, including several large jobs, came up for advertising; Salt Lake City, Utah, awarded a $70,485 contract for a rubble concrete dam at Twin Lake; Milwaukee, Wis., let a $240,000 contract for a water tunnel; Reading, Pa., opened bids on about $175,000 worth of municipal work, including a new filter plant. Hartford, Conn., is calling for bids on a small contract in connection with its Nepaug Reservoir Development, but early in June will take proposals on two large jobs; Philadelphia, Pa., opens bids May 25, for furnishing and laying 17,000 ft. of 48-in. pipe, and several thousand feet of smaller size mains; Bluffton, O., is calling for proposals for improving its waterworks, and Newark, N. J., is taking bids for furnishing some 5,000 tons of cast iron water pipe.

Sewerage.—Low bid for trunk sewers for Kenosha, Wis., amounted to $114,678; Madison, Wis., awarded a $70,000 contract, and District No. 78, Little Rock, Ark., let a $48,000 job. New work coming up for advertising include a trunk sewer for South Bend, Ind., sewage disposal works for Easton, Md., and addition to sewer for West Chester, Pa.

Rivers and Harbors.—The largest government levee letting so far this year is now being advertised by Maj. E. M. Markham, U. S. Engineer, Memphis, Tenn. The undertaking calls for 4,500,000 cu. yds. of levee work in the Upper and Lower St. Francis and White River Levee Districts Marsch, Cleary & White Co., Chicago, Ill., was awarded the contract at $458,000 for the White River Flood Protection work for the city of Indianapolis, Ind. The Canadian Government has let a contract for 2,500,000 bbls. of Portland cement for use in the construction of the Welland Canal. The River and Canal Commission of Augusta, Ga., awarded contract for 1,018,000 cu. yds. of levee work. The Hercules Stone Co., Tenino, Wash., at $310,000, was low bidder for furnishing 200,000 tons of stone for Lone Tree Jetty, Washington. Contract for furnishing and installing steel rolling doors, etc., for cotton warehouses and terminals New Orleans, was let at $86,430. G. T. Fogle & Co., St. Albans, W. Va., at $34,308 was low bidder for concrete work at Dam No. 2, Muskingum River, Ohio, for U. S. Government.

Low Bidding Prices.

Extremely low bids have been a feature at many lettings this spring. In fact numerous contracts have been taken at prices that seemingly allowed a dangerously small margin between profit and loss. When the successful bidder on a $300,000 job is $75,000 under the engineer's estimate and $50,000 lower than his nearest competitor it is reasonable to conclude that some one has made a mistake in his figures. But when this same thing happens time after time it begins to look as though half the contracting profession was bidding wild. Mistakes of course happen frequently, but all the extremely low bids at recent lettings cannot be ascribed to errors in the estimates. It would seem rather, the bidders in their eagerness to secure work are willing to take long chances. Neither has it been the inexperienced contractors that have been submitting the low bids. In fact some of the best known firms in the country have taken jobs at prices that seemed ridiculously low as compared with those of previous years. Of course many contractors are bidding on work at the present time with the sole purpose of keeping their organizations intact and their outfits busy until jobs more to their liking develop. But there is no good reason why this work should be taken at prices that mean a big loss.

State Owned Railways.

There has been considerable agitation in late years for public ownership of railroads. Recently there was some talk of the State of California purchasing the Western Pacific Ry. Georgia and Texas already have state owned railways and wish they hadn't. The following quotation describes the experience of Mississippi with a publicly owned railway:

> "The Great Southern," or "Jackson & Montgomery road" is now in operation 14 miles, that is from Jackson to Brandon, and is graded 3 miles further eastward. This property is owned by the state, and like all state enterprises is a slow coach. Each mile of the road has cost the state treble the amount it would have cost a private company, and being tired of the job, the present legislature has offered all the road completed, all the cars, locomotives, depots, lands, utensils and [illegible] negroes, now on the road, to any company that may organize by the first of June next and guarantee to complete the road within a given number of years, constructing 5 miles the first year, 10 the second, etc. It is apprehended that the citizens of Vicksburg deeply interested as they are in the completion of this road will subscribe to the stock, or that the Vicksburg & Jackson R. R. Co. will take over the work, in which case it is sure to go through.

The above extract is reprinted from the March 25, [illegible] issue of the [illegible] of New Orleans.

FEEDING THE MULTITUDE: EXPERIENCES IN BOARDING A CONSTRUCTION FORCE OF 5,000 MEN.

[Reprinted from the Saturday Evening Post.]

A gentleman who is more or less of an authority says that if you touch a Scotchman's stomach you wake a devil in him. Speaking from long experience with stomachs, I should say that the Scotch have no monopoly of this particular evil spirit. If the gentleman I have quoted had ever been in the mess-contracting business on a large scale he would have stretched that statement to cover all nationalities, with extra-special, three-star devils allotted to Bohunks, hard-rock miners and teamsters.

You can sell a workman shoddy clothes, shoes with pasteboard soles and cigars that are mostly Connecticut cabbage, and he may forgive you; but when you attempt to ring in a substitute for beef you are taking long and desperate chances.

I claim intimate acquaintance with the devil that lives in the stomach of the male of the species. Women sympathize with the cook and make allowances for the commissary department. I once had a contract which called for the feeding of several thousand women daily. They made less trouble for me than a dozen hard-rock miners would have done.

Every married woman who does her own cooking will agree that a man has a devil which lives in his stomach. There is nothing about which the average man is half so cranky as the food he eats. Eighty per cent of the petty domestic quarrels start at the table; disprove the statement if you can.

"What! Chops again? Why in the name of all that's good and great can't we have a steak once in a while?"

"Why, John, I had a nice steak for you Tuesday night and you waited until the last minute and then telephoned that you wouldn't be home for dinner; Went to your old club, I suppose!"

"Well, there's one thing about the club—I can get what I want there. Now, my mother used to have some variety to her cooking! I remember ———"

And they are off to a fine flying start with no telling where they will finish; but one thing is certain—the demand for variety was the cause of the trouble.

Variety! How well I know that word as applied to the commissary department! Ever since the dawn of history people have been complaining about the lack of variety in their food. Very likely Noah had trouble with the crew of the ark—big trouble, for his sons brought their wives along.

Moses is one Old Testament character who has always had my sympathy. He led the children of Israel out of Egypt, and no sooner were they across the Red Sea than they began to complain about a shortage of food. Manna was sent them from heaven—a miracle; but were they satisfied? No; they wanted meat, and they got quail.

The next we hear of them they were reminding Moses of the melons and the onions and the leeks they used to have when they were the slaves of Pharaoh! And they wanted fish—on a desert! What do you suppose they would have done to Moses if they had been paying their board?

The purchase of a meal ticket carries with it the right to kick about everything that comes on the table; and sometimes the objections have nothing whatever to do with the food itself.

For instance, I remember receiving a telephone call from a grading camp where I was feeding 50 or 60 Bohunks, which is rather a handy name, because it covers the entire Slavonic group. The Slav is a temperamental cuss on any subject at all mush or music, it makes no difference to him. The chief cook was on the wire.

"Better come out as quick as you can, boss." said he. "And bring a gun along; there's something doing."

When I got there it was done. The mess house was a total wreck. At first glance I thought my waiters had been slaughtered, for the interior was smeared to the ceiling with great red splotches. The cook was sitting on the overturned range, with a shotgun across his knees.

"Is anybody hurt?" said I. "There's blood all over the place!"

"That ain't blood," said he, "that's ketchup. The Bohunks found a case of it in the kitchen and bounced the bottles off the ceiling."

"But what started 'em off?" What was wrong with the food?"

"Why, nothing, I guess. As near as I can make out them huskies got sore at having to eat in the same room every day, so they shuffled up the scenery some. They busted the benches and tables, smashed all the windows, upset my range and called it a day. They didn't say a word about the grub."

The cook's story was absolutely correct. In this case there was no complaint about the food; the trouble was with the surroundings. I gave those Bohunks a new mess house, benches and tables, new knives and forks—and cut down on the food to make up for the added expense. It worked like a charm.

So much for the personal relation between the feeder and the fed. It is a thing that figures in every mess contract. The saddest place in the world is the average boarding house, and the saddest person in it is the woman who owns it, for she is shouldering all the troubles of the housewife, multiplied as many times as there are boarders.

Imagine, then, the troubles of a man with 5,000 ravenous and rough-necked boarders at his tables, 100 cooks, 400 waiters and 50 camps scattered over 200 miles of mountain and desert! This was the smashing big contract with which I broke into the feeding game in dead earnest, having trifled with subsistence and commissary for several years on a smaller scale.

In the beginning I was in the general contracting line, roughly speaking, prepared to bid on any job involving men and mules. A great deal of the work was on the desert and in the moutains, which made it necessary for me to feed the men I employed; and, being an amateur in the subsistence end of the business, I was thankful if the cook-house and mess tent broke anywhere near even.

A few sharp reverses wiped out my capital and at the age of 31 I found myself where I started, except that I had a big warehouse full of camp equipment and a string of mules at pasture. In the contracting game the mule is the real standard of value—the backbone of the enterprise. A mule can do things and go into places where a gasoline truck will cough and quit. The mule will cough, too, but he will not quit.

One day I met a friend who was in the subsistence and commissarial line, and he told me he was figuring on a big thing—a contract covering a period of five years, involving the feeding and housing of thousands of men in all sorts of inaccessible places. A river was to be coaxed out of its bed and taken 200 miles over mountain and desert. It was the first I had heard of the job, but I spoke up at once. "You'll have competition, then. I'm after that job myself."

It was really a tremendous undertaking and in the beginning I had no adequate idea of the magnitude of the job. I borrowed an automobile from a friend—my own machine had been swept away in the general smash of my fortunes—and made a trip over the proposed line of country, studying it with an eye to establishing central stations and camps. Then I was ready to figure, and I wore out several pencils making estimates and calculations of all sorts.

To cut a long story short, the contract was awarded to me—and my troubles began. I had no money, but I managed to dig up sufficient capital to give me a start. The contract itself guaranteed my credit, and I remembered a remark once made to me by the wisest man of my acquaintance. "There are only two ways to owe money," said he. "One is to owe so little that your obligations can be met at a moment's notice. The other is to owe so darned much that they won't dare to close you up."

As I was beginning on the proverbial shoe string there was no chance for me to owe a little money and pay it on demand. My only hope was to owe a great deal, and I went into the debit column with a tremendous splash.

In addition to foodstuffs I needed a stock of general supplies; for, according to the terms of my contract, I was to maintain a store at each camp, dispensing the necessaries of life, such as tooth brushes, bachelor buttons, playing cards, candy, smoking tobacco, shoes, suspenders, socks, towels, writing paper, overalls, razors, gloves, handkerchiefs, knives, pipes, soda water, shirts, soap, blankets, combs, alarm clocks—in fact, anything and everything for which there might be a call.

The merchants received me with open arms and loud cheers; everybody seemed to want my account and I tried to please them all. I bought like a drunken sailor—bought by the gross, by the ton, by the carload. I bought as though I were preparing for a siege—and one was headed in my direction, though I did not know it at the time.

You see, my sense of proportion was warped. I had been fooling with the subsistence game off and on for years, feeding by twenties and fifties, and sometimes at a loss. Now I was going to feed by thousands, and it was absolutely necessary that my operations show a profit. The magnitude of the undertaking, the size of my purchases, the ease with which they were made—all these things helped to impair my sense of values.

I thought by the ton and the carload when I should have been thinking by the ounce and the pound. I could not see any amount under five figures when my eyes should have been glued to the humble copper cent.

I am a hearty eater myself and a full meal appeals to me, as I believe it does to the average man who leads an active life. The main idea, I reasoned, was to give the men enough to eat three times a day. I piled my camps with the newly-purchased supplies and left it to the cooks to see that the men had plenty.

They saw to that all right enough, but the profits were slow in appearing. The result was an accumulation of debt that staggered me. Worse than that, it also staggered my creditors. I began to search for the leak.

I found it where you may find it in your own houhehold—in the kitchen. It was waste—pure, simple waste. The average cook is a waster, but the camp cook is the king of wasters. He has but one idea—and I cannot blame him, for it was mine in the beginning—that idea being to prepare enough food to go round; and when a camp cook guesses on quantity there is nothing of the piker about him, for he is thinking of the boarder and not of the poor old boss.

During that first year 100 cooks were working by guess, and what mistakes they made were never on the short end. They wanted to be quite certain of having enough food and as a result they prepared too much. The surplus went into convenient ravines, where the coyotes found it and destroyed the evidence. The only thing a coyote will not eat is a tin can; but he will chew that can into a tiny lump if it has contained meat. I suppose I fattened thousands of coyotes that first year, but my creditors grew lean and anxious. I grew anxious myself, for my indebtedness was well into six figures.

I hired a man who had made a scientific study of subsistence, and he went from one end of the line to the other, examining into conditions and picking up pointers. He then came back to the general field headquarters and made a report—short, sweet and pointed

"The cook is at the bottom of this deficit," said he.

"That is no news," said I.

"The cook and about forty other things," continued the expert; "but he is the biggest leak. I propose to eliminate him as factor in profit and loss. I am going to fix him so that he can't waste anything but his breath."

The subsistence shark locked himself up for a week or ten days, and when he reappeared he brought with him the key to the situation in the shape of a formidable document, which he christened the Subsistence List.

This list was about 4 ft. long, single-spaced on a typewriter. It began with allspice and baking powder, and ended with yeast and yellow coloring. It included every possible thing that might by any chance find its way to a camp table, even down to fly paper. The totals were computed on a 30-day basis to cover camps of from 20 to 100 men.

Tacked to this list, like a rider on an insurance policy, was the coyotes' death knell, so far as I was concerned, though the heading did not so state. It said: "As a matter of daily check, allow in quantities not to exceed ——"

That second list was the real thing, because it left nothing to the imagination. For instance:

Beans (white), 1 lb. to each 7 men per day.
Meat (fresh), 1½ lbs. to 1 man per day
Coffee, 1 lb. to each 12 men per day.
Fruit (dried), 1 lb. to each 12 men per day.
Fruit (canned), 1 gal. to each 4 men per week
Sugar, 1 lb. to each 2 men per day.
Corn meal, 1½ lbs. to each 10 men per day.
Flour, 1 lb. to 1 man per day.
Soap, 1 lb. to each 25 men per day.
Potatoes, 1⅓ lbs. to each 1 man per day.
Other vegetables, 3/5 lb. to 1 man per day.
Tripe, 1 lb. to each 19 men per day.

I give only a few items, for that "allow in quantities not to exceed" list included everything edible and also some things which were not.

"But—you're making a bookkeeper out of the cook," was my objection. "Suppose old Whitey Anderson up here in Blind Horse Cañon has 37 men on his hands and wants to know how much 'other vegetables' to allow 'em. He can't do a sum in straight multiplication, let alone your ringing in fractions on him. He'll do what he thinks is right—by guess, same as usual."

"He will not," said the expert. "Do you think I'm going to let any of those cooks fool round in the supply room? Not on your life! The cooks are going to stay in the kitchen. I propose to extend the powers of the commissary clerk."

Well, there was a commissary clerk at each camp, of course. Up to this time he had been a sort of storekeeper, and his activities had been confined to ordering more stuff from his division headquarters and roaring to the general field headquarters when he did not get it on time.

Between us we extended the powers of the commissary clerk—extended them to the limit. We make him a camp straw-boss, a weigher and checker, a head waiter, a kitchen inspector, a high court of appeal, and a few other things; but the first order we issued contained the joker:

1—Commissary clerk must go into kitchen have the cook come into storeroom at a stated time each day and, under the heading Supplies Required, Form 53A, list all articles the cook requires for the next day's work. Commissary clerk must then consult the Subsistence List and make the issues in accordance with same. Supplies of any kind must never be issued in bulk, but must be issued only in sufficient quantities to run the boarding house one day."

When we were through we had things tied up so that the cook could not get an egg without signing his name to an order; and for the guidance of the commissary clerk we issued a pamphlet of General Instructions. We required of him weekly, bi-monthly and monthly reports and inventories; and, just to keep him happy, we maintained a traveling auditor—the sort of fellow who would want to know why the clerk used 60 lbs. of codfish when the scale called for 48, and why he was short 5 lbs. of butter.

The result of the new system was a revelation—an eye opener. Having eliminated the waste, profit followed immediately. The ounces of beans and butter, the pounds of ham and hominy, saved in the kitchens, turned the scales in my favor and changed a losing game into a winning one.

I held a mass meeting of my creditors and they listened to reason. I owed them so much money that there was nothing else for them to listen to. Inside of one year from that date I was discounting all my bills and steadily reducing the bulk of my original indebtedness. After that I bought carefully and kept an eye out for the tiny leaks.

The efficiency department then attacked the old question of variety. I do not claim that we solved this problem, but we did the best we could under the circumstances. To prove this I quote sample menus, served at all our camps during one day of the summer season:

BREAKFAST:
Rolled oats and milk.
Steak—pan-fried.
Pork sausage and country gravy.
Cottage fried potatoes.
Stewed fruit and cake.
Hot wheat cakes and syrup.
Wheat and raisin bread; hot biscuits.
Coffee.

DINNER:
One relish. One soup.
Short ribs of beef—Spanish.
Corned beef and cabbage.
Browned potatoes.
Bayo beans and pork.
Macaroni and cheese.
Sago pudding.
Bread. Crackers. Coffee. Iced tea.

SUPPER:
One relish.
Roast beef with brown gravy.
Breaded tripe or cornedbeef hash.
Minced potatoes—browned.
Baked navy beans with tomato sauce.
Stewed fruit and sponge cake.
Wheat and Graham bread.
Hot rolls. Tea. Coffee.

Do not suppose the boarders were always pleased. Remember the children of Israel, who asked for fresh fish on a desert; so did a few thousand of the men who from time to time sat at my tables. During the trout season we were sometimes able to oblige them. They asked for other things, too; and the fact that some of the camps were forty miles from the railroad, located in almost inaccessible cañons, made not the slightest difference to them. It was variety they wanted.

I gained a great appreciation of Moses in those days; for, if I remember correctly, he had about 40 years of it and I had only five. Moses must have been a wonder!

One of my greatest troubles was with labor. The boarders were mostly blanket-carrying nomads; and I have noticed that once a man gets the feel of a blanket roll on his shoulders it is hard for him to settle down. My cooks and waiters caught the go-fever from the boarders and, like the boarders, left without giving notice.

I found it advisable to maintain a reserve force at general field headquarters, prepared to start at a momen't notice—usually just after pay day. There were times when I loaded cooks and waiters into an automobile and drove all night in order that some isolated camp might have breakfast in the morning.

I recall one tunnel outfit that will serve as a sample. The hard-rock men were driving a hole through a mountain—thirty of them in one camp. One evening a man turned up for supper—a hard-rock miner, carrying his blankets. The boss offered him a job, but he laughed.

"Why, in South America," said he, "hard-rock men get $15 a day—gold. That's where I'm headed for; this country is played out."

It was two weeks before pay day; but from that time on there was only one topic of conservation—South America, where a hard-rock man got $15 a day.

The result was inevitable. When pay day came the hard-rock men took their checks and their blankets, gave three cheers for freedom and started for South America, the embarking point being the railroad station, distant some 15 miles across the desert.

My cooks and waiters asked for their time and joined the stampede. I do not know what they figured to do in South America or how they expected to get there, but they started just the same. The commissary clerk remained faithful. He reached me by telephone and I hustled my reserves into an automobile.

Seven miles from the tunnel camp, and located out on the desert, was a frame shack, with a 10-ft. barbed-wire corral behind it. The man who lived there had a liquor license and sold bottled beer and squirrel whisky. The corral had no gate except the back door of the shack, which was a very clever idea, because it kept any customers from escaping. When they wanted to sleep the proprietor escorted them into the bull pen, as he called it, and tossed their blankets after them. Fist fights, too, usually finished out there.

Owen Wister once wrote a story in which he described such a place accurately, without waste of words, as "chronically hilarious after sundown; a dot of riot in the dumb Arizona night." The road from the tunnel camp to the railroad passed this frame shack.

I landed my reserves by daylight, had breakfast and then went farther up the line to look in on some other camps. Two days later I returned, traveling the desert road. I stopped at the shack, for my late cook was sitting on the doorstep.

"Thought you'd gone to South America!" said I.

"Well, I didn't," said he. "I'm still here."

"What became of the other cook and the waiters?"

He jerked his thumb over his shoulder.

"Out in the bull pen, sleepin' it off."

"And the hard-rock men?"

"They're there, too. You see, boss, it was awful hot walking, so we stopped to get a bottle of beer. We got our checks cashed—and I reckon there won't be no South American tour—not this month, anyway. How 'bout a job?"

Among the many things I learned in those five years was that it is a mistake to pay any man a profit on a product if you can possibly manufacture that product yourself. Soda water was one of our best sellers. I installed a soda water plant. I manufactured my own tinware and cooking utensils, and my own portable buildings. I built a pack house, with an up-to-date refrigerating system, and slaughtered my own beef.

At every division headquarters there was a hog camp. The hogs were fattened on the refuse from the kitchen and tables, and when their time came they appeared on those same tables, completing the circle. The coyotes gave it up as a bad job and moved back into the mountains. They were the only victims of the system.

There is a moral, if you care to listen to it: Put a pair of scales in your kitchen. Weigh everything that comes in and everything that goes out, and you will thus beat the game of subsistence two ways.

The difference between cooking by guess and cooking by ounce is spelled in money.

Building Construction for City and County of Denver, Colo.

Bond issues aggregating $1,000,000 for the construction of public buildings are to be voted on at an election to be held May 18 by the city and county of Denver, Colo. With the proceeds of these issues it is proposed to undertake the following improvements:

Criminal Court Building	$125,000
City Market	150,000
Addition to hospital	500,000
Police Headquarters	175,000
Women's Industrial Home	50,000

The city market project provides for acquiring lands and the establishment thereon of improved and enlarged market facilities. These will include market stalls, sheds, trackage, salesrooms, buildings, etc. The facilities will be rented to truckers, gardeners, commission merchants, wholesalers and dealers. The $500,000 bond issue for hospital purposes is to provide an administration building for the city and county hospital, including small wards, operating and dressing rooms, X-ray and other rooms, and additional buildings. The latter will include quarters for nurses, internes and superintendent, hospital wards, new kitchen and dining room and repairs and modifications in existing buildings. It also is proposed to install a refrigerating plant and to erect contagious diseases detention hospital.

PORT DEVELOPMENTS BY AMERICAN CITIES.

Notes on Work Under Way or Contemplated.

During the past 10 years many million dollars have been expended by American cities for port facilities. Nearly all the large seaboard municipalities have work of this kind under way or are contemplating making a start on harbor developments. The following summary of the current appropriations available for port developments and the improvements to be made at various cities in this country are taken from the Third Annual Proceedings of the American Association of Port Authorities. The information was collected early this year by the secretary of the association.

Astoria, Ore.—The Port of Astoria has $100,000 available per year from taxation for port developments. It has issued $400,000 of bonds and has the right to issue $600,000 more. It proposes to erect $50,000 coal station, cold storage station and grain elevator. The port is considering inaugurating a port owned and controlled steamboat line from Astoria to the head waters of the Columbia and Snake Rivers. F. J. Walsh is Chief Engineer of the Port.

Baltimore, Md.—The current appropriations available are as follows: Key Highway, McComas St., Fort McHenry breakwater, $930,224; annual harbor dredging, $55,277; Broadway pier, $13,000; deepening main channel, $250,000. The Harbor Board has had work started on a municipal belt railroad. Tracks have been laid on the first section of the Key Highway and the contract for a second section was to be let shortly (this was on Feb. 4). This belt road will be incorporated in the third section of the Key Highway and McComas St. Oscar F. Lackey is Harbor Engineer.

Beaumont, Tex.—Extensive plans for harbor developments for this city have been prepared by H. McL. Harding, consulting engineer, 17 Battery Pl., New York City, and the question of issuing bonds for the work will be voted on.

Boston, Mass.—On Nov. 30, 1914, $3,699,942 was available for development of the port. The directors are preparing the site for the dry dock to be 1,200 ft. long over all, 120 ft. 3 in. wide at the entrance and 35 ft. deep over the sill at mean low water. In connection with the dry dock a channel is being deepened to 30 ft. depth at mean low water. This dredged material is being used for reclaiming 35 acres of land from the harbor. At the anchorage basin in the upper harbor a pile tie up pier is projected. Edward F. McSweeney 40 Central St., Boston, Mass., is Chairman of the Port Directors.

Cleveland, O.—Improvements to Cuyahoga River, designed and approved by the River and Harbor Commission, will extend the navigable portion of the river 6 miles from the lake. These will call for straightening the channel. For work in the lower valley $1,000,000 has been voted by the people. For the upper valley property owners have been given authority by the city to dig a new channel and take for their remuneration the old river bed which will be filled in by them. Edgar B. Thomas is Harbor Engineer.

Jacksonville, Fla.—The city has acquired about 5,000 ft. of water frontage and there now are in course of construction two piers 206 by 1,000 ft., constructed of Lackawanna steel piling bulkheads, with a wooden fender wharf 30 ft. wide. The superstructure will be constructed on filled piers. The sum of $1,500,000 has been appropriated, of which only a portion had been expended up to Jan. 29 last. P. D. Cassidy is Secretary of the Port Commissioners.

Los Angeles, Cal.—A total of $5,500,000 in bonds for harbor improvements was voted in 1910 and 1913. Of this about $3,500,000 has been spent for dredging, wharves, freight sheds, terminal, paved harbor approaches and right of way. This work is constantly going forward, the latest project adopted being a fish harbor to accommodate the rapidly growing fishing industry. The Harbor Commissioners are now working on a project to municipalize all harbor terminals. Homer Hamlin is Harbor Engineer.

Milwaukee, Wis.—The city is now condemning the first unit of land necessary to the creation of a lake terminal near the harbor entrance. The total frontage will approximate 6,000 ft. The inner basin will be of the same length and will have an average width of nearly 500 ft. and a depth of 21 ft. About $300,000 is now available (Feb. 2, 1915) and more money will be provided as the work progresses. Herman Bleyer is Secretary of the Harbor Commission.

Newark, N. J.—The Department of Docks and Meadows had expended up to Feb. 11, 1915, approximately $1,600,000 for the purchase of meadowland for reclamation for factory sites, for excavation of a deep water channel to these sites, for reclamation of the lands, and for the construction of a dock. Nearly all of this amount was expended in 1914. The development is being made under a state law authorizing the city to expend $2,000,000. The project as at present planned covers the reclamation of about 1,150 acres of marsh land, the excavation of at least 2 miles of channel 700 ft. wide at the bottom and 20 ft. deep at low water, the construction of a public dock along both sides of this channel, and also the construction of several 1,200 ft. piers extending into Newark Bay beyond the area to be reclaimed. The partial development now under contract and being constructed should make available by the end of 1915 250 acres of this land laid out in city blocks with deep water along the 4,500 ft. of dock now being constructed.

New London, Conn.—Developments at New London are being carried out under a state appropriation of $1,000,000. Contracts were let in 1913 for the substructure of Pier No. 1, estimated to cost $500,000. This pier will have a length of 1,020 ft., a width of 200 ft., and slips 265 ft. wide. The contract was about 65 per cent complete on Feb. 1. It is planned to eventually cover this entire section with a fireproof warehouse, built in sections as required, and equipped with elevators and other approved appliances for handling and storing freight. Superstructure of steel sheds and concrete warehouse are under consideration.

Pensacola, Fla.—A $400,000 bond issue was voted by the city about a year ago for the construction of public docks and a belt railroad. It is expected that the bonds will be sold in the near future and the actual work of construction commenced. L. Earle Thornton is City Engineer.

Philadelphia, Pa.—An unexpended amount of $2,278,486 was available on Jan. 30, 1915, for the development of the port. This will be used in the continuation of the present policy of the construction of city owned piers along the undeveloped portion of the South Philadelphia water front; the continuation of the bulkhead wall along the Delaware River; the construction of bulkheads on the Schuylkill River; and the dredging of docks along the Delaware water front and of the channel of the Schuylkill River. George W. Norris is Director Department of Wharves, Docks and Ferries.

Portland, Ore.—The total amount of money voted by the people for water front improvements within the limits of the city is $2,500,000. There is now available (Jan. 30, 1915) a balance of $300,000 for future improvements. F. W. Mulkey is Chairman Commission of Public Docks.

Providence, R. I.—The State Harbor Improvement Commission is in charge of port developments at Providence, East Providence and Pawtucket. One public pier has been built in Providence and is now in use. This is known as State Pier No. 1; it is 600 ft. long and 120 ft. wide and has a 2-story steel shed. Adjoining this pier the state owns land sufficient for the construction of two more piers of equal size. In Pawtucket the state owns a 700-acre tract upon which is now (Feb. 17, 1915) being built a quay wall 700 ft. long. The city of Providence has built a quay wall 3,000 ft. long and this may be opened to public use within a year. The total amount now authorized for port development by both state and city is about $2,250,000. This sum is for the completion of the improvements above mentioned. Charles C. Remington is Secretary of the Commission.

San Diego, Cal.—The city has a 800 ft. long municipal pier and ½ mile bulkhead. Other wharfage available will approximate 10,000 ft. The city has expended for public improvement of the harbor $1,000,000 and is now expending an additional $400,000 reclaiming lands and creating a turning basin.

Tacoma, Wash.—The city has some $130,000 for the further use on the municipal dock on which about $300,000 already has been expended. Work may be started in September on the Hylebos waterway. This will be a canal about 300 ft. wide and 2½ miles long. It will be an industrial waterway for the low lands of the harbor and will be built by a special district.

FOURTH LOCK AT THE SOO.

Bids Asked on Masonry Construction.

Involve About 172,000 Cu. Yds. of Concrete.

One of the largest concrete jobs that have come up for bids so far this year is now being advertised by the U. S. Engineer Office, Detroit, Mich. The work calls for the construction of the concrete masonry for the fourth lock at Sault Ste. Marie, Mich. The improvement is located on the north side of St. Marys Falls Canal. The area within which the concrete is to be placed is about 2,170 ft. in length and from 130 to 150 ft. in width, and the axis of the lock pit lies approximately parallel to and 220 ft. north of the third lock axis. The approximate quantities of materials and work are as follows:

	Estimated quantity.	Possible variation, more or less, per cent.
Excavation, cu. yds.	4,000	75
Drilling rock for anchor rods, lin. ft.	24,000	30
*Concrete, Class A, in lock and canal walls, cu. yds.	135,000	25
*Concrete, Class B, elsewhere than in walls, cu. yds.	37,000	25
Portland cement, bbls.	210,000	30
Metal delivered and placed:		
Square cold twisted steel bars, cwt.	8,000	30
Anchor rods in rock, with nuts and square plate washers where required, cwt.	4,000	25
Wire cloth, cwt.	1,000	50
Steel rails, I-beams and foundation bolts, with nuts, etc., cwt.	720	25
Sheet lead stop waters, cwt.	400	30

*Exclusive of cement.

The site of the work is surrounded by cofferdams within which the lock pit has been excavated in the dry. The contractor for the work now advertised must maintain these cofferdams and must execute all work in the dry. The average amount of pumping necessary in connection with the excavation of the lock pit during December, 1914, was about 2,500,000 gals. per day. The main excavation within the cofferdam has been done under another contract. The contractor for the masonry, however, will have to do any additional excavation that may be required if the rock is not found suitable for foundations or for other reasons. The material is believed to be mainly Potsdam sandstone bed rock. The excavation, in general, will be hand work, and the use of explosives may be limited to such quantities as the contracting officer may consider safe to use for each location. All excavated material will be deposited within ½ mile of the work.

Each lock wall is to be 1,715 ft. long. Of this length about 1,200 ft. is 26 ft. wide at the base and about 50 ft. high. The remainder of the wall is for gate abutments and recesses. The walls are to be founded on solid rock and are to be built in sections about 30 ft. in length, alternate ones being built first and the intermediate sections later.

The lock floor in general is about 1½ ft.

thick, covering the area between the lock walls. The culverts or tunnels are about 9 by 10 ft. in cross section and extend under the floor throughout the greater part of the length of the lock and are separated by concrete walls. The miter walls extend across the lock to support the gate sills, and are from 5 to 20 ft. high and 12 ft. or more in thickness. The lock floor, where it does not form culvert covers, will be laid, in general, in sections not exceeding 30 ft. in length. The culverts will be built in sections the entire width, including six or four culverts. In general, such sections will be about 30 ft. in length. The miter walls, bulkheads and other cross walls will be made of monolithic blocks.

The contract also includes building on the rock, within the cofferdam limits, short reaches of canal wall adjacent to the lock. It likewise calls for lining about 48 lin. ft. of tunnel in rock, estimated to require about 125 cu. yds. of concrete, and the building of about 320 lin. ft. of tunnel in trench, in addition to the tunnels, shafts and passages through the masonry. Four coal bins and four ash pits will be built within the walls.

The contractor will furnish such iron and steel as may be required for anchor rods, reinforcement, foundation bolts, tee rails, etc., and sheet lead for stop waters. The U. S. government will furnish about 450 tons of machinery, castings, structural steel, piping and ducts for electric conducts, etc.

Two classes of concrete will be used: Class A will be placed in lock and canal walls, and is in general massive work with comparatively little reinforcement. Class B concrete will be placed in floors, culverts and miter walls, and, in general, will be in smaller masses and more heavily reinforced. The contractor will be permitted to imbed in the Class A concrete "plums" of limestone, trap or other sound rock. These "plums" must not exceed in volume 25 per cent of the section. The concrete will be of such proportions as may be directed by the contracting officer. The mortar ordinarily will be made from 1 part cement and 2 to 3 parts sand by weight. Not more than 3 per cent of the concrete will be composed of mortar made up of cement and sand, and granolithic containing fine broken stone.

The broken stone for concrete will be crushed from trap or other equally sound, hard igneous rock. It will be separated into two sizes, one passing a 2½ in. ring and being retained on a ¾ in. ring; the other size will pass 1 in. ring and will contain the dust from crushing. Gravel from granite or other hard rock, if screened, may be used for the culverts and floors. Bars for reinforcement will be square cold twisted, low carbon bars, rolled from open hearth billets only. Other styles of deformed bars may be permitted by the contracting officer. The forms for the main faces of the lock walls must be built of steel.

Bids for the construction of the concrete masonry for the fourth lock will be received until noon, May 24, by Lt.-Col. Mason M. Patrick, U. S. Engineer, 337 Federal Bldg., Detroit, Mich.

Road and Bridge Construction in De Soto County, Florida.

A special road and bridge district in the northwest part of De Soto County, Florida, has been organized and has authorized a $210,000 bond issue. The district covers an area of approximately 248 square miles. The contemplated improvements under this bond issue include 35.5 miles of highway, graded, drained and hard surfaced with marl, rock, sand, asphalt, oil-sand, etc.; 11.5 miles of highway, graded, drained and hard surfaced with brick, concrete, asphalt, etc.; 49 miles of road cleared, graded and drained. There will be six steel bridges or reinforced concrete, and bids will be received on both the selection to be made the day of the letting. There is not much of any road building material in the district, aside from phosphate rock and clay. All other materials will have to be shipped in by rail. Waldo M. Francisco, Zephyrhills, Fla., is Consulting Engineer for the district.

HARBOR OF REFUGE, LAKE HURON, MICH.

Bids Asked for Improvements at Harbor Beach.

Timber Cribs—Concrete—Breakwater Construction.

Two fair sized contracts for work in connection with the government harbor of refuge at Harbor Beach, Lake Huron, Mich., are now being advertised. One of these calls for crib work and replacing timber superstructure of breakwater with concrete. The other contract provides for furnishing and placing stone riprap along the lake face of the main breakwater.

The work under the first mentioned contract is located on the south breakwater and the main breakwater. The depth of water alongside the south breakwater varies from 15 ft. at its north end to about 6 ft. at its south end. It is exposed to storms from a northerly to southeasterly direction. The harbor affords good protection for a contractor's plant. The site is not accessible except by boat.

The work consists of furnishing all labor, appliances and material (except fir timber and stone for crib filling and riprap) for the removal of two old timber cribs and their filling stone, building two new cribs, preparation of their foundations, placing them and replacing by concrete superstructure, the existing timber superstructure of the remainder of the breakwater and renewing about 728 lin. ft. of oak fender. Soundings over the two old cribs which are to be removed show from about 1½ ft. to about 8 ft. of water below elevation 580. The timber work and stone in these old cribs are to be removed to a depth of about 15½ ft. below elevation 580, and a stone foundation prepared for the new crib. Stone obtained while removing the old cribs will be utilized for a stone foundation, for crib filling and for riprap. It is estimated that about 1,500 cu. yds. of old material will be removed in these two old cribs. One of the new cribs will be 64 ft. in length; the other will be 66 ft. Both will be 22 ft. wide and 15½ ft. deep. Each crib will contain about 45,000 ft. b. m. All fir timber for the crib construction and for repairs of old timber superstructure will be furnished by the United States. The cribs will be filled with stone and will be protected on both sides by riprap carried up to a height not less than 4 ft. above the bottom of the cribs.

The old superstructure of the breakwater, consisting of a timber crib work filled with stone, will be removed to the planes shown in the plans. The center wall and the timber ties of that part of the breakwater will be 22 ft. in width and the timber ties of the 18 ft. section are to be removed to about 2.5 ft. below the planes of the outer walls and two courses of steel tie rods 1¼ ins. in diameter, 8 rods to each crib, provided. About 1,630 lin. ft. of old superstructure is to be removed. The concrete superstructure will be built in monolithic sections. In general, the mix will be 1 part cement (1½ for deposit under water), 3 parts sand and 6 parts gravel or broken stone.

The estimated quantities include the following:

Bolts, tie rods and washers, lbs.	35,000
Concrete sections in place, cu. yds.	9,000
Cement, bbls.	12,000
Mooring posts	7
White oak fenders, ft. B. M.	7,280

Bids for the above contract will be received until noon, May 20, by Lt.-Col. Mason M. Patrick, U. S. Engineer, Detroit, Mich.

The riprap work, as previously noted, is to be done along portions of the lake face of the main breakwater. This breakwater consists of stone filled timber cribs set upon stone foundations and capped with a concrete superstructure. Stone riprap has been placed along the lake face of this structure, but it has been spread out or carried away until the present average depth over it is about 14 ft. It is proposed to extend this stone riprap protection up to about 4 ft. above mean lake level at the following locations: From the upper angle at block 13 to about block 79, a distance of about 1,600 ft. and near the lower angle from block 161 to about block 185, a distance of about 700 ft. The breakwater is about 4,700 ft. long and from 2,500 ft. to 4,000 ft. distant from the shore. It is exposed to heavy seas from the northwest to the southeast. The depth of water about 75 ft. outside of the breakwater varies from 18 to 27 ft.

The construction will consist of a footing of large stone, with a base of about 20 ft., placed to form the toe of the reinforcement. The core of the section will have a top surface with a slope of 1½ on 1. Above the core and forming the face of the finished slope will be two or more courses of large stone from 6 to 8 ft. in thickness from blocks 185 to 56, and from block 56 to block 1, one or two courses of large stone about 4 ft. in thickness. Minimum weight of each core stone will be not less than 25 lbs.; of each large stone forming exposed slope at toe it will be not less than 5 tons. It is estimated that 15,000 short tons of stone will be required to form the core of the reinforcement and 35,000 short tons will be needed for the toe and exposed slope.

Bids for furnishing and placing the riprap will be received until noon, May 19, by Lt.-Col. Mason M. Patrick, U. S. Engineer, Detroit, Mich.

SEWERAGE FOR HUNTINGTON, N. Y.

Bids to be Opened May 14 for Sewer and Disposal Works.

14.6 Miles Vitrified Pipe—Settling and Storage Tanks.

The Sewer District of Huntington, N. Y., a place of about 5,000 population in 1910, is calling for bids for constructing a system of sewers and sewerage disposal work. The town is located in Suffolk County and is about 25 miles from New York City. The improvement comprises about 14.6 miles of vitrified pipe sewers ranging in size from 8 in. to 15 in. in diameter, a 14-in. cast iron outfall sewer to the disposal works and a 15-in. vitrified pipe effluent sewer from the works to the harbor. The sewerage disposal works will be located about 500 ft. to the west side of New York Ave., and will comprise a settling tank holding 100,000 gals., a storage tank of 100,000 gals. capacity, a building containing sterilizing apparatus, automatic tide gate and other appurtenances, a sludge drying bed and various connecting pipes, embankments and walkways. The approximate quantities include the following:

Lin. ft.	Size, ins.	Depth cut. Ft.	to Ft.
4,400	8	0	6
18,375	8	6	8
5,555	8	8	10
2,847	8	10	12
1,010	8	12	14
245	8	14	16
50	8	16	18
310	10	0	6
7,885	10	6	8
885	10	8	10
50	10	10	12
680	12	0	6
1,205	12	6	8
120	12	8	10
35	12	10	12
75	12	12	14
80	12	14	16
50	12	16	18
225	15	0	6
730	15	6	8
610	15	8	10
50	15	10	12

The other approximate quantities include:

20,000 ft. 8-in. vit. pipe sewer with bituminous joints.
4,000 ft. 10-in. vit. pipe sewer with bituminous joints.
2,000 ft. 12-in. vit. pipe sewer with bituminous joints.
500 ft. 10-in. vit. pipe sewer with bituminous joints.
2,000 ft. trenching and laying 14-in. c. i. pipe sewer 0 to 6 ft. cut.
3,015 5-in. Y-branches.
240 manholes.
55 flush tanks.
90 tons cast iron pipe.
4,000 sq. yds. of bituminous macadam relaying.

Lump sum bids will be received for the construction of (1) settling tank and appurtenances, (2) the storage tank, (3) the building, sterilizing devices, and (4) sludge drying beds. The settling tank will be of the Imhoff type. The walls, hopper bottoms, walks and supports of the sedimentation tank will be of plain concrete. The partition walls between the sedimentation chamber and the sludge chamber will be a mortar slab 2 ins. thick, reinforced with 4-rib Hy-Rib, No. 20 gage, supported on 3 in. by 3 in. by ⅜ in. angle irons. The inlet and outlet channels will be constructed of concrete. The swing gates will be of cypress and the six scum boards also will be cypress. The portable sludge pump to be furnished by the contractor will be of the self-contained type and will consist of a 2-cylinder vertical gasoline engine driving a centrifugal pump. It will have a capacity of 500 gals. per minute against a head of 20 ft.

The storage tank will be of concrete construction and will be erected adjacent to the northeast end of the settling tank. The sterilizing building will be 1-story, of brick construction. The chlorinating device for applying liquid chlorine to the sewage will be of the dry type, and will have a capacity ranging from 5 to 50 lbs. liquid chlorine per day. The two sludge drying beds will have an area of about 1,200 sq. ft.

Bids for constructing the sewers and sewage disposal works will be received by the Sewer Commissioner at the Town Hall, Huntington, until 2 p. m., May 14. George W. Fuller, 179 Broadway, New York City, is the Engineer.

DIKE AND REVETMENT WORK ON MISSOURI RIVER.

Bids Asked on Six Contracts for Bank Protection.

18,850 Ft. 3-Row Timber Dike—26,000 Ft. Revetment.

A considerable amount of standard dike and revetment construction is now being advertised for bids by the U. S. Engineer at Kansas City, Mo. Bids are asked on six contracts, as follows:

Location miles below Kan. City.	Type.	Lin ft	Date of Opening.
12 and 20	Timber dike	4,200	May 10
24	Revetment	9,000	May 10
30 and 33	Timber dike	5,900	May 20
163	Timber dike	2,250	May 20
	Revetment	12,000	
[illegible]2 and [illegible]8	Timber dike	5,500	May 24
[illegible]8	Timber dike	1,000	May 24
	Revetment	5,000	

The work under the first contract listed above consists of the construction of about 1,000 lin. ft. of standard 3-row timber dike at Sissons Bend and 3,200 lin. ft. at Blue Mills Bend. The first section is on the left bank of the Missouri River about ½ mile below Clement City, Mo. The two dikes in Blue Mills Bend are also in the left bank about 2 miles from South Liberty, Mo.

The 9,000 lin. ft. of revetment is to be constructed on the right bank of the Missouri River, in Jackson's Bend, extending about 1¾ miles down stream from a point about 2 miles above Atherton, Mo. The third contract provides for the construction of two dikes in Napoleon Bend on the left bank of the Missouri River about 1 mile below Napoleon, Mo., and four dikes in Upper Camden Bend on the left bank about 1 mile above Camden, Mo. The 2,225 ft. of dike and the 12,000 ft. of revetment are to be constructed in Euphrase Bend on the left bank of the Missouri River about 9 miles below Glasgow, Mo. Three dikes are to be built. Under the fifth contract six standard 3-row timber dikes of an aggregate length of 5,500 ft. are to be constructed. One of these is on the left bank of the Missouri River, opposite Waverly, Mo., two are on the right bank in the upper end of Bakers Bend, and three are on the left bank in the lower end of Bakers Bend, about 6 miles below Waverly, Mo. Under the last contract three standard 3-row timber dikes and standard revetment are to be constructed on the left bank of the Missouri River, in Bakers Bend, about 6 miles below Waverly, Mo.

For the standard 3-row timber dike, long leaf yellow pine piling will be used. This will be not less than 14 in. nor more than 18 in. in diameter at a point 3 ft. from the butt, nor less than 8 in. in diameter. The piles will be driven to a least penetration of 25 ft. in the upper row and 20 ft. in the other two rows. The rows will be 10 ft. apart c to c, and the piles 10 ft. apart, c to c in the row. The piles will be sawed off to a level grade of 4 ft. below the top of the adjacent bank unless the bank is higher than 6 ft. above standard high water. In this case the elevation of the top of pile will be 2 ft. above standard high water.

The bracing lumber will be long leaf yellow pine. The Wales will be composed alternately of 12 ft. and 22 ft. timber. The filling blocks will be solid pieces 8 in. by 12 in. by 2 ft. A double ½ in. galvanized wire strand cable will be placed on every other bent of piles. Curtain poles will be cottonwood or willow timber not more than 6 in. nor less than 3 in. in diameter, and will be placed 12 in. centers along the middle row of piles.

The foot mattress for the dike will be 12 in. thick and 75 ft. wide and will extend 40 ft. beyond the head of dike. The mattress will be woven of bar growth willow brush and strengthened by a system of ⅜ in. galvanized strand. The bank at the root of the dike will be slope 1 vertical to 3 horizontal and will be paved with 1-man stone.

For the standard revetment the mattress will be 12 in. thick and 86 ft. wide, and the shore edge will be not more than 2 ft. in elevation above standard low water. The mattress will be made of bar growth willow and strengthened with a system of galvanized strand. The slope will be paved with 1-man stone.

Bids for the above dike and revetment work will be received by Lt. Col. Herbert Deakyne, U. S. Engineer, Kansas City, Mo.

A $25,000,000 Station at Philadelphia.

The Pennsylvania R. R. is reported to have engineering plans well underway for a new $25,000,000 station at 15th and Markets Sts., Philadelphia. The main features of the development are understood to include the following:

The closing of Filbert St., west of 15th St.; abandonment of present site of the Broad St. station; extension of the Pennsylvania elevated west of 15th St. to make a loop for suburban electric trains; erection of stores on the north side of Market St. under the elevated west of 16th St.

It is stated that coincident with the erection of the new terminal the Pennsylvania will make extensive improvements at the West Philadelphia station for the handling of southern traffic. Minor changes also may be made at the North Philadelphia station to facilitate the dispatch of through trains to the west. Practically all of the real estate necessary for carrying out these projects is said to have been already acquired by the company.

$12,000,000 Bond Issue for California Highways.

A bill has been introduced before the state legislature of California providing for a bond issue of $12,000,000 for the state highway system. This amount will be in addition to the $18,000,000 bond issue authorized at an election in 1910. If the present bill is favorably acted upon the proposition will be submitted to the people at the general election in 1916. Of the original $18,000,000, about $8,600,000 already has been expended and contracts aggregating $3,700,000 more have been let. It is stated that the amount needed to complete the 1,059 miles of trunk lines of the system is $11,150,000, while to complete the 1,162 miles of laterals the sum of $6,208,000 is needed.

Construction for Water Commissioners of Hartford, Conn.

Several contracts for work in connection with the Nepaug reservoir of the city of Hartford, Conn., will be advertised for bids in the near future. The Board of Water Commissioners is now asking proposals on Contract 8, comprising the construction of a gravel road about 1½ miles long through new country. The road will have a travel path 14 ft. wide with 8 ins. of gravel surfacing, together with the necessary culverts and guard fences. Bids on this work will be received until 3 p. m., May 17.

It is expected to let contracts in the near future for the following work, which is in the immediate vicinity of this location and which may be looked over by prospective bidders at the same time that the road work on Contract 8 is examined:

Contract 9—East Dike. Contract probably will be advertised about June 1 and calls for the construction of an earth dam about 25 ft. high and 600 ft. long, containing about 28,000 cu. yds. of earth embankment and 1,500 cu. yds. of masonry core wall.

Contract 10—Richards Corner Dam. Contract probably will be advertised about June 15 and calls for the construction of an earth dam 70 ft. high and 800 ft. long, containing about 250,000 cu. yds. of soil and gravel filling, 13,000 cu. yds. of masonry core wall, 10,000 cu. yds. of rock excavation and a concrete conduit and stream control for a drainage area of 62 square miles

Later in the year a contract will be let for clearing the entire Nepaug reservoir area of about 900 acres and grubbing about 125 acres of shore line.

Caleb Mills Saville, Pilgard Bldg., Hartford, Conn., is Chief Engineer of the Board of Water Commissioners.

Panama Canal Traffic.—The six principal commodities passing through the canal were, in order of their tonnage: Grain, nitrates, coal, refined petroleum products, lumber and cotton, and these six commodities together formed approximately one-third of the total tonnage. The grain shipments amounted to 303,124 tons, of which all but 15,73 tons were shipped from the east coast of the United States and Canada. Nitrates shipped from the west coast of South America to various ports in the United States and Europe amounted to 204,441 tons. Coal, all moving to the Pacific coast, aggregated 151,745 tons, of which 83,081 tons were shipped from the Atlantic seaboard and 68,664 tons from the United Kingdom. Shipments of lumber amounted to 56,078 tons. All but 600 tons were from the west coast of North America. Cotton shipments amounted to 38,239 tons, from the Atlantic seaboard of the United States to the Far East.

The toll levied during the six months period amounted to $2,126,832.

Increased Taxing Powers for Iowa Cities.—The last session of the State Legislature of Iowa enacted several laws that will permit cities and towns to increase their taxing power for public improvements. One law authorizes cities to increase by 2 mills the levy for the construction of sewer outlets; another authorizes the levy of a 2-mill tax for maintenance of street sprinkling, garbage disposal and the like districts.

Highway Construction near Portland, Ore.—It is probable that construction will be started before June 1 on road improvements to be carried out for Multnomah County, Oregon, under the $1,250,000 bond issue authorized on April 14. It is proposed to hard surface eight roads. These are the Columbia River highway, the Base Line Road, the Sandy Road, Powell Valley Road, Foster Road, Canyon Road, Capitol Road and St. Helen's Road. It is intended to start work first on the highways extending into the several sections of the country. This group includes all of the above mentioned roads, except the Columbia River highway, and comprises about 41 miles in all. John B. Yeon, Portland, Ore., is County Roadmaster.

NEWS LETTERS

St. Louis Items.

P. J. Murphy of Moberly, Mo., was awarded the contract for extending the yards of the Burlington R. R. Co. at Brookfield, Mo. Murphy is going to work his own teams on this job. In addition to this he was also awarded a small job of bridge filling by the Wabash R. R. at Albia, Ia.

The 'Frisco Railroad soon will spend approximately $50,000 for improvements between Birmingham, Ala., and Memphis, Tenn., in building concrete culverts and filling in at 10 bridges.

The plant to be erected by the Linde Air Products Co. of New York on Forest Park boulevard, adjoining the plant of the Mutual Brewing Co., will cost about $100,000, according to the Mercantile Trust Co., which handled the sale of the ground to the Linde concern. The ground which was sold by the Hawthorne Investment Co. has a frontage of 135 feet. The lot backs up to a switch running east and west through the block, and connecting with the Wabash tracks. The company will employ from twenty to thirty men. Construction work on the factory is to begin in May.

Geo. C. Smith & Sons have finished their drag-line work at Valmeyer, Ill., and are in the market for some more of the same kind of work. They have two crackerjack drag lines with a 70-foot boom and two-yard buckets.

Construction work on the proposed railroad between Springfield, Mo., and Mountain Home, Ark., will begin in six weeks, according to K. V. Loba, one of the promoters, who has been in the field getting the right of way and the bonus pledges from towns. Springfield capitalists are behind the project. The road will tap a region now without railroad facilities, which contains millions of feet of valuable timber.

List & Gifford Construction Co., Kansas City, Mo., was low bidder on the M., K. & T. R. R. work in Oklahoma the other day.

At Lookout, 10 miles northeast of Sedalia, Mo., $4,300 was subscribed for the construction of four miles of rock road from Lookout to the north line of the Sedalia 12-mile special road district. The Green Ridge neighborhood also is planning for an extensive rock roads campaign, and the Kautsman and Denny roads will be rocked early this spring.

Louis Rich of East St. Louis has moved onto a piece of team work near Kirksville, Mo.

The work of laying the pipe line to supply city water to the new industrial school at Bellefontaine Farms will begin Monday. The pipe line will be eight miles in length, extendind from the pumping station at the Chain of Rocks to the school site. Water Commissioner Wall estimates that its construction will be completed within two months.

W. D. Webb of W. D. Webb & Sons, 212 Marietta Ave., Burlington, Ia., was in town the other day looking up work for their ten teams and scraper outfit, which is idle.

C. W. Watson of the Hiram Lloyd Building & Construction Co., 404 Odd Fellows Bldg., St. Louis, Mo., was in the other day, wanting bids on a pile driving job across the river.

Wm. Nuttal of M. C. Connors & Co., Chicago, was with us a day last week. Nuttal is skirmishing around the country for work.

Mulvill Bros. of Alton, Ill., at the present time are working on the following contracts: 38,000 yards grading streets and parkway in Chessen Addition at Wood River, Ill. Excavating 9,000 yards subway and channel for the New York Central Lines one mile north of East Alton, Ill. 80,000 yards levee and railroad embankment work for the Wood River Levee and Drainage District 3 miles south of Alton, Ill. They are handling all this work with their own team outfits.

The Callahan & Walker Const. Co., Apex, Mo., has 15,000 cu. yds. of team work at Apex, Mo., to let. This work is in places where they could not get enough material on the south side with their drag lines to make fills. They now have got borrow pits on the inside which will make it a good team job. It is good material, but the job is too small to put one of their drag lines on it.

A. B. Koenig left here Monday with a party of friends for Poplar Bluff, Mo., to spend a wee kor ten days fishing and floating down the famous Black River. Among the party are Colonel C. G. Gillespi, assistant chief of police of St. Louis; Captain Kiefer, Lieutenant Peter Anton, and a half dozen local railroad and building contractors.

The Bondurant Construction Co. of Hickman, Ky., has 200,000 yards of new levee work opposite Hickman, Ky., to let. This work is in medium timber, light sandy loam material, under government specifications, and is to be completed by Dec. 31, 1915. They will sublet this work in quantities to suit outfits.

A. B. KOENIG.

PERSONALS

Mr. Harry M. Beardsley, formerly general manager for the Elmira, N. Y., Water, Light & Railroad Co., has been elected general manager of the municipal water system which was taken over by the city on May 1.

Mr. C. D. Shauver of Cheyenne, Wyo., has been appointed assistant state engineer of Wyoming. Mr. Shauver was formerly in the U. S. Reclamation Service for three years. For one year he was assistant city engineer at Sheridan, Wyo. Since that time he has been in private practice, specializing in irrigation and power plant construction.

Mr. H. C. Hawkins has been appointed city engineer of Oskaloosa, Iowa, succeeding Mr. E. F. Bridges. Mr. Hawkins was formerly connected with the South Park Commission at Chicago, and from 1907 to 1911 was superintendent for the Oskaloosa Water Co. In the summer of 1912 he was employed by the Ketchikan Light & Power Co., at Ketchikan, Alaska. He was assistant city and county engineer at Oskaloosa during 1913, and retained his county office during the past year. Mr. Hawkins is a member of the Western Society of Engineers and conducts a private civil and hydraulic engineering practice at Oskaloosa, specializing somewhat in drainage work.

Mr. David Harlowe has opened an office as consulting traffic manager at 35 Mack Block, Milwaukee. He is prepared to take charge of such matters as the routing of domestic and foreign shipments, booking, forwarding and insuring of ocean consignments, advising as to transportation of heavy or bulky freight, auditing freight bills, claims for overcharge, loss or damage claims, conducting cases before railroad commissions and other similar railroad problems. Mr. Harlowe was formerly a member of the State Railroad Commission, and at one time was traffic manager for the Allis-Chalmers Co. He is also experienced in the general freight department of the Chicago, Milwaukee & St. Paul Railway.

Mr. Heinreich Homberger, consulting engineer, specializing in hydraulics, particularly hydraulic power and irrigation, has removed his headquarters from 864 Pacific Bldg. to Mill Valley, Cal. Mr. Homberger has practiced in San Francisco since June, 1909. For seven years prior to that date he was assistant to the manager and chief engineer of the Abner Doble Co., which was amalgamated with the Pelton Water Wheel Co. of San Francisco and New York in December, 1911. Mr. Homberger is well known on the Pacific coast, having been retained by many of the most important power companies of that section as expert consultant, to prepare reports, plans, specifications, etc. He is a member of the American Society of Civil Engineers, the French Engineering Society and the German Engineering Society.

Mr. Gaylord C. Cummins has been chosen as city manager of Jackson, Mich., succeeding Mr. Claude Chappell. Mr. Cummins is a graduate of Cornell University, class of 1904. His first engineering work was that of instrumentman and locating engineer on the Oregon & Washington Railway. In January, 1907, he was appointed construction engineer for the Lewiston-Clarkston Co. of Lewiston, Idaho, and in June of that year became locating engineer for the Washington Northern Railroad at Spirit Lake, Idaho. For a time he was in private practice and in 1910 was with the Morgan Engineering Co. of Memphis, Tenn. The following year he was employed by the Medina Irrigation Co. at San Antonio, Texas. On January, 1912, Mr. Cummins was appointed city engineer of Dayton, Ohio, and retained that position until May, 1913, when he became assistant engineer for the Morgan Engineering Co. on Dayton flood prevention plans. In January, 1914, he was again made city engineer of Dayton, under Mr. Waite, the well-known city manager of that place, and has remained in that office until receiving his present appointment. Mr. Cummins is an associate member of the American Society of Civil Engineers.

Mr. Samuel T. Wagner has been chosen as chief engineer of the Philadelphia & Reading Railway, succeeding the late William Hunter. Mr. Wagner graduated from the University of Pennsylvania in 1881 with the degree of B. S. and received his C. E. degree in 1884. He entered the Phœnix Iron Company's shops at Phœnixville, Pa., in 1881 as draftsman, and remained in that service until 1893, holding the position of assistant superintendent and superintendent of shops, and in 1890, of resident engineer on construction of the Louisville and Jefferson bridges over the Ohio River. In 1893-94 he was in the Bridge Division, Bureau of Surveys at Philadelphia. From 1894 to 1900 he was assistant engineer in charge of grade crossing work in Philadelphia for the city. This work amounted to $6,000,000. From 1900 to 1902 Mr. Wagner was assistant engineer in charge of improvements, extension, and filtration of the water supply for Philadelphia. He entered the service of the Philadelphia & Reading in 1902 as assistant engineer on grade crossing elimination costing $10,000,000, and has held that position until receiving his present appointment. Mr. Wagner is a member of the American Society of Civil Engineers and of the American Association for the Advancement of Science.

Mr. Edwin S. Jarrett is president and treasurer, and Mr. Ralph H. Chambers is vice-president and secretary of the newly organized Jarrett-Chambers Company, Inc., contractors, 30 East 42nd street, New York City. Both are members of the American Society of Civil Engineers and both were formerly connected with The Foundation Company. The new firm will specialize in substructure work. Mr. Jarrett is a graduate of the Rensselaer Polytechnic Institute, class of 1889. For ten years he was with Sooysmith & Co. as engineer, and for two years following was in private consulting practice. He was one of the organizers of The Foundation Company and has been successively secretary, treasurer and vice-president, and a director until resigning on January 1. Mr. Chambers, also a civil engineering graduate of Rensselaer, class of 1893, was for five years engineer with the King Bridge Company of Cleveland. From 1900 to 1910 he was a member of the consulting engineering firm, Chambers & House, New York. In 1911 he joined The Foundation Company as assistant engineer, and became chief engineer in 1912. Since 1913 he has been chief engineer, general manager and director. He resigned on January 1 to establish an office as engineer and contractor, and in April, with Mr. Jarrett, he incorporated the present firm.

Mr. John Meigs, assistant director of the Philadelphia Department of Wharves, Docks and Ferries, has been made director of that department. An extensive program of port development is under way, involving the eventual expenditure of about $20,000,000 of which $2,000,000 is at present under contract or available. Mr. Meigs was born in the city of Washington, D. C., and received his civil engineering education at the Columbian University of that place. His first practical experience was that of draftsman for the Union Bridge Co. in 1906. He then entered the service of the Government as U. S. junior engineer on river and harbor improvements, Washington, D. C., district. From 1898 to 1900 he was inspector on pier construction, hydrographic surveys and dredging for the U. S. Navy Department at Key West and Tortugas, Fla., and Washington, D. C. For six years following he was in charge of bridge design and construction in the Washington district. In 1906 he was engaged by the Penn Bridge Co. as engineer of construction in charge of concrete bridge work. Two years later he was made principal assistant and engineer of the U. S. Engineer Department in the Baltimore and Philadelphia districts in general field charge of river and harbor improvements in the Patapsco River and Chesapeake Bay, and later, in the Delaware River and Bay. Mr. Meigs was appointed assistant director of the Department of Wharves, Docks and Ferries of Philadelphia in 1912. He is a member of the American Society of Civil Engineers.

OBITUARIES

Morton L. Tower, engineer in charge of Government jetty reconstruction work at Humboldt Bay, California, died April 17 from injuries received on the work, when a track passenger car in which he was riding leaped from a trestle. Mr. Tower has been in the Government service for 23 years, and has been connected with much of the harbor and river improvement work on the coast. Among these works were the Suislaw River improvement in Oregon, the Coos Bay jetty project, the San Francisco Bay improvement, Columbia River work, and the fortifications at the Presidio in San Francisco. He was at one time lighthouse inspector and was also on the Debris Commission. In 1908 he surveyed and started work on the breakwater in Honolulu Harbor. He was a member of the Technical Society of Engineers.

CIVIL SERVICE NEWS

The Philadelphia City Civil Service Commission will hold an examination for assistant engineer, local residence waived, June 4. Salary $4,000 per annum. Five years' experience in highway work required.

The New Jersey State Commission will hold examinations at Trenton and Camden on May 10 for the position of road inspector; $2.50 to $4.50 per diem. On May 22, superintendent of bridges, Hudson county, $3,000 per annum.

NEW CATALOGUES

Expansion Bolts Paper, 6x9 ins.; 4 pp. Steward & Romaine Mfg. Co., Philadelphia.

Flagg tapped concrete hangers or inserts, positive brass expansion bolts, etc., are shown, with prices.

Street Sweeper.—Paper, 9x9 ins.; 12 pp. Baker Manufacturing Co., Springfield, Ill.

Describes and shows views of Baker's dustless pick-up sweeper, sprinkling attachments, broom, pan and driving mechanism.

Expansion Bolts.—Paper, 6x9 ins.; 12 pp. A. C. Seaman, 124 N. Sixth St., Philadelphia, Pa.

Revised price list of positive expansion bolts manufactured by the above company. Illustrated.

Irrigation Meter.—Paper, 8½x11 ins.; 20 pp.; Builders' Iron Foundry, Providence, R. I.

Describes the Venturi irrigation meter, its installation and operation, materials, recording device, standard sizes, etc. Shows a number of installations with diagrams and data.

Motors.—Paper, 6x9 ins.; 64 pp. Evinrude Motor Co., Milwaukee, Wis.

Evinrude canoe and rowboat motors and their adaptations to various household or industrial uses are described and illustrated in detail in the 1915 catalogue. These motors are furnished with a centrifugal pump attachment and a pulley power attachment which makes them adaptable to various contractors' or small shop uses.

Expansion Joint Cushion Paper, 3¼x6 ins.; 4 pp. The Hydrex Felt & Engineering Co., 122 Liberty Street, New York City.

Describes Hydrex expansion joint cushion strip for pavements of concrete, brick, wood or granite block. Illustrated.

Forms.—3½x6 ins.; 24 pp. Vulcanite Portland Cement Co., Philadelphia, Pa.

Shows examples of typical simple forms used by the farmer for building farm structures. Includes diagrams of and instructions for using forms for walls, tanks, posts, chimneys, slabs, field culverts, etc.

Tractors.—Paper, circular. Knox Motors Co., Springfield, Mass.

Describes the new model Knox tractor and its special features and gives some capacity and cost data. The essential feature is the Knox patented double spring suspension.

Drill Mounting—Paper, 6x9 ins.; Ingersoll-Rand Co., 11 Broadway, New York.

Form 4032, covering drill mounting, especially adapted to accommodate the "Jackhamer," with or without water feed, for work where shallow holes are required, for breaking down coal and driving gangways in coal mines. Illustrated.

Pumps, Centrifugal.—Paper, 8x10 ins.; 8 pp. Van Wie Pump Co., 711 W. Fayette St., Syracuse, N. Y.

Bulletin No. 300, describing Van Wie gasoline motor driven water and dredge centrifugal pumps. Suggestions for using and list of equipment with applications. Illustrated.

Crushing Machinery—Paper, 7x9 ins.; 16 pp. Chalmers & Williams, 1452 Arnold Street, Chicago Heights, Ill.

Section T, of the general catalogue, devoted to modern crushing machinery, describing coarse crushing and fine grinding machines, and giving data on costs, etc. Illustrated.

Bituminous Surfacing.—Paper, 8x5½ ins.; 12 pp. The New Way Paving Corporation, 234 Broadway, New York City.

Describes the Finley method of cleaning the road by air and simultaneously applying a bituminous surface, thus assuring a close and permanent bond. Shows views of several roads thus treated.

Floors.—Paper, 3½x6½ ins.; 12 pp. Pittsburgh Wood Preserving Co., Commonwealth Bldg., Pittsburgh, Pa.

Booklet "B," entitled "Floors," describes Century creosoted wood blocks for interior use. Shows typical installations and method of laying. This type of floor is particularly adapted to factory use.

Clyde Iron Works.—Paper, 6x9 ins.; 38 pp. Clyde Iron Works, Duluth, Minn.

The April number of The Clyde Diamond is devoted to a "condensed chronicle of the Clyde Iron Works, Its Inception and Evolution." Shows photographs of the various structures, the men at the head of departments, and of some interiors of the plants.

Concrete Molds.—Paper, 7½x10¾ ins.; 32 pp. Raber & Lang Mfg. Co., Kendallville, Ind.

Catalogue No. 11, describing "Crescent" concrete sewer pipe and drain tile molds. Explains the method for using and the many applications. Gives table of costs and shows numerous photographs of "Crescent" plants.

Ford Profit-Sharing—Paper, 6x9 ins.; 28 pp. Ford Motor Co., Detroit, Mich.

Consists of a report of the investigation made by the Detroit Evening News, into the profit-sharing plan of the Ford Motor Company, and its results at the end of the first year, some editorial comments, statements by clergymen and police officials and letters from the beneficiaries.

Rust-Resisting Paints—Paper, 4x9 ins.; 16 pp. Semet-Solvay Company, 402 Milton Avenue, Solvay, N. Y.

Booklet on Solvay rust-resisting paints for protecting iron and steel. Describes the different kinds, including Crysolite, Solvay stack paint, hydraulic paint, concrete coating, etc. Shows some structures on which these paints were used.

Gravity Spiral Conveyor.—Paper, 6x9 ins.; 56 pp. Otis Elevator Co., 11th Ave. and 26th St., New York City.

Interfloor movement of merchandise by gravity is the subject of this book, which amply illustrates and describes the Otis system of delivery by spiral gravity conveyors. Single and double spirals, open or closed type, typical delivery room plans, complementary horizontal belt conveyors, and typical installations are shown.

Power Plant Oil Filter.—Paper, 8½x11 ins. 32 pp. The Richardson-Phenix Co., Milwaukee, Wis.

Engineering Bulletin No. 10, describing construction and operation of the new Peterson Power Plant Oil Filter and accessory apparatus for central oiling systems. Curves showing results of tests are reproduced, and a chapter on the necessity of using filters in connection with steam turbine oiling systems is included. Bulletin contains fifty illustrations showing installations.

CATALOGUE REVIEWS

Motor Trucks of America.—Paper, 7x10 ins.; 98 pp. The B. F. Goodrich Co., Akron, O.

The third annual edition of a handbook published by the B. F. Goodrich Co. in 1913 for the benefit of prospective purchasers of motor trucks. The book purports to be a complete summary of truck information, including illustrations and specifications of nearly a hundred leading power wagons. In addition it contains helpful material on such subjects as: "Questions Involved in Changing from Horse to Motor Delivery," "The Relation of Tires to the Cost of Maintenance of Motor Trucks," etc.

The chaif aim of the compilers has been to put together in convenient form for comparison the data for the more important makes of motor trucks, and incidentally to show the widespread popularity of Goodrich Wireless Truck Tires. The book is attractive in appearance, durably bound, and is arranged alphabetically according to the names of truck manufacturers.

Clean Streets.—Paper, 5x8 ins.; 80 pp. Studebaker, South Bend, Ind.

"How to Clean Streets" is the subject of a new booklet published by Studebaker of South Bend, Ind., which is intended for the use of municipal officials, managers of country clubs and estates, or others interested in the subject.

Many people are familiar with the booklets which this company has sent out for the past fifty years to farmers, giving information relative to stocks, seeds, soils, etc. The new booklet aims to serve city clerks, municipal engineers, etc., in the same way.

Street sweeping, sprinkling and oil distribution are worked out in simple formulas, the number of square yards sprinkled by different types and sizes of sprinklers, angles at which brushes of street cleaners should be set and similar subjects are discussed at length, cost data included, and a number of reports of street cleaning departments are given. Dump wagons, automatic oil distributors and gravity oilers come in for distinctive treatment. Studebaker is distributing the book free of charge to all who ask for it.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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A Spanish Trautwine.

Two generations of American civil engineers have been brought up on Trautwine. In each of its many editions, produced successively by the Trautwines—father, son and grandson—this manual has kept in the first rank of publications of its kind. Probably no engineering book ever published in English is so well known by so many engineers or has been carried to so many far places of the earth to give service. It has now been prepared for greater wanderings and to make friends of another people. Trautwine has been translated verbatim into Spanish. Every English term has been put into Spanish and every English measure has been converted to metric measure. The book is Spanish in every item and detail possible of change from English. One wonders that so tedious and expensive a task should be held warranted, but the translator says that: "Trautwine excels our Spanish handbooks in the quantity of matter which it contains, in the adequacy of its formulas, and in its simplicity and clearness of diction, which makes it serviceable alike to engineers and to laymen; and it is far superior to the French handbooks which are consulted by Spanish-American engineers." The editors have no knowledge that controverts these statements, and with other engineers to whose youth Trauntwine and Shunk and Searles were the only pocketbooks of the profession can only wish success to the new Spanish Trautwine.

Engineers and the New New York State Constitution.

The administration of public works and the regulation of public utilities by engineers are urged as essential measures of the new state constitution of New York. Committees of seven societies of engineers have planned the changes and drafted the recommendations which appear in another column. The occasion for this action is the meeting of a Constitutional Convention in New York to amend the state constitution. The action itself is one of the most significant that organized engineering has ever undertaken. It materializes the greatest function of the engineering society. It sets a standard in state public works administration and state public utilities regulation which measures the best thought and practice of the times. The hope of all engineers should be that its success will be complete.

The state engineer of New York is an elected official holding office for four years. A new state engineer is possible with every election and is certain with every change of political party elected to power. This is an objectionable thing in itself, but in New York there is also a department of public works with a superintendent, and between him and the state engineer exists an involved authority over public works. It is recommended that in the new state constitution the office of state engineer shall be eliminated and that a department of public works administered by three commissioners be substituted to have authority over and direction of all public works. The main idea is essentially sound. The public works of every state and, as this journal is inclined to believe, the public works of the federal government, should all be directed by a single department. It is a question with us whether it will not prove wise also to have a single department head instead of a commission head as is suggested for New York state.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

Passing this question, attention is directed to these provisions of the recommended New York State Department of Engineering and Public Works: First, a tenure of office of twelve years for commissioners; second, that one commissioner at least shall be an engineer, and, third, that each bureau of the department charged with responsibility for engineering work shall be headed by an engineer. All of these provisions are absolutely sound, and should be urged by all the power that is within the engineering organizations represented by the seven committees that have inaugurated the action so far taken. The twelve-year term of office is the provision most likely to encounter opposition, perhaps, and for that reason needs to be pressed the most persistently. Long tenure of appointive office is a thing that the politician consents to only with a wrench.

As all public works administration is centralized within a single department, so it is planned that a single Department of Public Utilities shall regulate all public utilities, both those privately owned and those owned by municipalities. The plan eliminates the present public service commissions and extends regulation to municipal utilities. A commission of five members directs the department work and two at least of the commissioners are to be engineers. All engineering bureaus of the department are also to have engineers as heads. The plan is substantially the same as that for the department of public works and it possesses the same merits and, to the mind of the editors, the same weak feature of a multiple head.

The remaining five recommendations of the engineering committees are general or conditional and no comment is required. The occasion should not be allowed to pass, however, without further emphasis of the idea involved in the main recommendations for single departmental administration of public works and single departmental regulation of public utilities. The great defect of all state public works administration is division of authority among from two to perhaps twenty bureaus or commissions or departments and in this defect the federal administration of public works surpasses any state administration that one calls to mind. The engineering societies of New York have performed a service in standing publicly for centralized administration and centralized regulation and for their definite expression of the engineer's right to position as directing head of all work involving primarily engineering knowledge and experience. It remains for these societies to project their influence into the proceedings of the New York Constitutional Convention by all the legitimate means within their power and thus not only to recommend but to procure the improvements that are so desirable.

Irregularity of Employment: Its Effect on the Workman and on the Contractor.

Irregularity of employment is a demoralizing factor with which both the employee and the employer are now contending. In certain kinds of work it is reasonably certain that workmen will be able to secure fairly steady employment, while in other lines men have become accustomed to viewing such employment as temporary. In a measure, the rate of wage is based on the duration-of-employment factor, and the employer attempts, by wage adjustments, to give proper weight to it. It is doubtful, however, if contractors realize the extent to which irregularity of employment affects the efficiency of workmen. In building construction it is such an important factor that contractors are beginning to realize a better solution of it is necessary if they are to maintain success in such work. As building work is now conducted it is customary to retain the services of workmen only until they have finished their work on a particular building. In fact, even foremen, and sometimes superintendents, are employed only for a certain job. In general, it is practically impossible to enforce such corrective measures as the employer deems necessary from time to time, because the employee does not fear discharge, realizing that at best his employment is only temporary. The average employee who follows building work reasons that he can only hope to secure employment during a part of the year, and he often reaches such a state of mind that he does not even desire steady employment. The different wage scales adopted as standard in various cities also tend to increase his unrest. Most general contractors endeavor to keep throughout the year a certain part of their working organization; they have in their employ certain superintendents and foremen whom they endeavor to give permanent employment—many of them, however, evidently do not realize that a serious attempt should be made to retain the most efficient workmen. It is a known fact that men become attached to certain foremen and will make sacrifices to remain under their direction. We have known foremen whose greatest asset was their ability to assemble and retain an efficient force of workmen personally known to them.

In an attempt to solve this problem the Aberthaw Construction Co., which specializes in reinforced concrete building construction, has issued to certain of its more efficient workmen a "Record of Service Book." The holder of such a book is guaranteed a certain rate of wage so long as he remains in the employ of the company—no matter in what section of the country he is employed. The company also agrees to give the holder of a service book employment whenever there is a position open which he is qualified to fill; and the man is kept informed of new work as it comes up. The method used by the superintendents in signing workmen "in" and "out" on a job tends to spur the men to efficient service.

When a man presents his book on a new job the superintendent fills in the left-hand page, giving the date on which work is started; when the job is completed the superintendent signs a statement that the man has completed his work on a given date. The book is then sent to the main office, where an officer of the company signs a "sticker" attached to the right-hand page, which indicates that the workman is in good standing. The service book contains a definite description of the man, to prevent its being transferred, a carbon copy of this description being kept at the main office.

It has been found that the use of this system has been effective in retaining good men and in making it easier to handle them to the best advantage. The possession of a service book by a workman is a recommendation of proficiency, and it can be used as such in case the workman is not given steady employment by the company, and finds it necessary to seek work elsewhere. Activity of this kind, which tends to encourage regularity of employment, is to be commended, and it is encouraging to note that more attention is being given to this important factor.

A Principle of Management: "Credit to Whom Credit is Due."

So long as selfishness is characteristic of men it will be difficult to prevent department chiefs from claiming credit for improvements effected by their subordinates. Nor does the difficulty end there. Even the highest officials are given to claiming, or, if not claiming, accepting credit for things accomplished by their superintendents and managers. This condition of affairs is so prevalent and so restrictive of economic progress that every possibility of its eradication by better managerial methods should be investigated.

Recently Mr. C. A. Whelan, president of the United Cigar Stores Co., addressed a communication to all the salesmen of the company telling them not to hesitate to go over the heads of their superior officers in making suggestions for improvements. He said:

> Recently an official of this company received an unsigned letter from one of our salesmen. The reason given for withholding the signature was, the writer said, that he 'was afraid if he were known it might cause hard feelings on the part of the sales manager.'
>
> I believe few of our men have this idea, but in case you are laboring under this impression I would like all of our men to know that they have the privilege of addressing by letter or communicating in person on any subject, with any one of our officials or heads of departments without fear of consequences due to the attitude of a sales manager or superior.
>
> I believe that our sales managers are broad enough not to take offense because of any difference of opinion between them and their men.
>
> "Should there be occasional instances of this kind, however, I can assure you that no harm will come to any of our salesmen because of the narrow view of a sales manager, or anyone else.
>
> Our officials and heads of departments are at all times glad to get criticisms and suggestions from our men on the 'firing line.'
>
> Let this be an invitation to you to give us your ideas freely and frankly.
>
> When you think you can improve the business or have criticisms which are either your own or have been made by your customers, come to us with them.

Unfortunately we can not agree with Mr. Whelan in his statement that a sales manager is not likely to take offense at attempts by salesmen to go over his head. The stubborn fact balks in the face of Mr. Whelan's optimism. Men are not so free from pride and selfishness as to make it probable that the average manager will be pleased with any act that looks to him like insubordination. If there is to be the harmony so essential where industrial "team play" is involved, some way must be devised to give credit where credit is due, without giving offense where offense should not be due.

As one looks over the periodic reports of superintendents, managers and presidents of organizations, it becomes noticeable how scant is the recognition given to those below them in rank. Investigation shows that this characteristic extends even below the written report to the word-of-mouth report. Has the gang boss utilized a good hint made by a workman? Then look to see the gang boss placidly accept all credit for it. Has the foreman of several gangs successfully applied a suggestion made by a boss? Look to see the foreman tell the manager about it without mention of the boss. And so on up the line, even to the president of a company reporting to its directors and stockholders.

There are, of course, some happy exceptions to this rule, for men are not all selfish, or, if selfish generally, are not so always.

As a first step toward proper recognition of each man's economic achievements it may be well to require periodic written reports from all managers, wherein are given brief statements of all suggestions for improvements together with the name of the originator of the suggestion. To make this plan most effective, not only should there be described the accepted suggestions but the rejected suggestions. To do the latter would be a decided innovation, but it would serve to bring to the attention of the highest officials many ideas of real merit that would otherwise die at birth.

Reports of managers are seldom seen by their subordinates, and this accounts in part for the failure of such reports to give credit where credit is due. Hence it is desirable to bulletin or otherwise publish reports of the character above outlined. In the case of some companies, it might be wise to read the reports before the assembled staff of employes.

Managers can soon be made to see that they need not themselves be very original men in order to be very valuable managers. The fact is that originality and managerial ability are not often found in one individual. A manager to be capable need have little other ability than the ability either to find capable subordinates or to arouse their latent powers. Couple this capacity with good judgment and you have a good manager.

A few establishments encourage employes to send in written suggestions, and for acceptable suggestions they give small prizes. The plan is good as far as it goes. It can be made to go much farther by incorporating such suggestions in a periodic report, and by subsequently paying the suggestor adequately for his idea. A petty prize of a fixed amount is some stimulus, but a real reward proportionate to the worth of a new idea would excite vastly greater activity of the wits of employes.

Most large industrial companies require their salaried employes in certain departments to sign a contract under which the employe is constrained to assign to the company any invention that he may conceive while on the company's payroll. Could any scheme be devised that would more effectually stifle an inventive man's inventiveness? Not a word is said in such a contract about any commensurate reward for an invention. Here again appears the same old selfishness and desire to seize all the credit save the mere paper crown that the patent office may place upon the inventor's head.

Can we not all work more strenuously toward the goal of "credit to whom credit is due"? And in doing so, can we not do our share toward bringing about a "credit" substantially expressed in dollars?

An Interesting Court Decision on the Inviolability of Test Boring Records.

The inadequacy of earth borings to determine the resistance to excavation of the materials indicated by the samples extracted is ancient knowledge. Perhaps the most hotly contested controversy that arose between engineers and contractors during the building of the Chicago Drainage Canal occurred 21 years ago this summer, and occurred because of the fact that the wash boring records of the engineers failed to indicate the difficulty of excavating the materials disclosed by the samples. It is not supposed that this was the first dispute of its kind, but it is recalled now not only because it was in connection with one of the greatest construction works of its time, but also because it, twenty years ago, gave premonition of a future procedure in equity which has just now been established by decision of the United States Supreme Court. In view of these facts and others to be mentioned an outline of the Drainage Canal controversy is perhaps of value, and we quote as follows from Hill's "The Chicago Main Drainage Channel," published in 1896:

> This section (Section F) is particularly notable as involving the first work of river diversion, and also as being the first section yet described which has been taken from the original contractors and relet. The original contract for the section was signed by Ricker, Lee & Co., of Galveston, Tex., Nov. 23, 1892, and called for the removal of 1,399,495 cu. yds. of glacial drift, and 45,900 cu. yds. of solid rock at 23¾ cts. and 80 cts. per cubic yard, respectively. Later estimates (Jan. 1, 1895), based on more accurate data, reduced the quantities on the section to 1,251,887 cu. yds. of glacial drift and 16,724 cu. yds. of solid rock. About 70,000 cu. yds. of the glacial drift excavation was on the river diversion channel.
>
> The contractors began work promptly after signing the contract, and on Jan. 1, 1894, were considerably ahead of the contract requirements in the amount of excavation completed. On April 3, 1894, however, they notified the Board of Trustees that a very hard material had been encountered in the glacial drift work, which could not be excavated at the price they were receiving—viz., 23¾ cts. per cubic yard—and asked that a readjustment of the price be made for this hard material. The argument made by the contractors in support of their request was that borings made by the engineers to determine the character of the material failed to indicate in any way the presence of this hard material, and were thus misleading.
>
> Similar complaints having been made by the contractors working the succeeding Sections E, D and C, the Board of Trustees appointed a special committee of adjustment to consider the question of the claim for hard material on the four sections named. As the investigations and decisions of this committee apply to Sections E, D and C, which will be described in future articles, as well as to Section F, now under consideration, and because they established the policy of the Board of Trustees in future disputes of similar nature, they are given here in some detail. It should be stated that in the very beginning the claims of the contractors for Sections D and C were set aside, so that in reality the following discussion refers only to Sections F and E.
>
> The investigations of the committee consisted in sinking a series of 6 x 6-ft. test pits at intervals along the sections in dispute; the investigation and report of a commission of seven engineers from the engineer corps of the Drainage District, and the testimony of a number of well-known contractors. The test pits which were sunk, in the words of the Chief Engineer's report, "disclosed the fact that the material to be excavated was of a more difficult character than was indicated by the sample borings." They also disclosed the existence of a large amount of a peculiar quicksand underlying the hard material. The commission of engineers was divided in its opinion. Four members, including the Chief Engineer, agreed that an increase in price to 41 cts. per cubic yard for the material remaining on both sections would be a just valuation of the work, and two members including the Assistant Chief Engineer held that there should be no increase in price for Section E, but considered that an increase of 6¼ cts. per cubic yard might be justly allowed on Section F. Some of the engineers also suggested that the quicksand which had been shown by the test pits could perhaps be handled by hydraulic dredges. The advice of a committee of contractors was secured to consider this question of dredging, and its opinion was in substance that dredging would not work satisfactorily, and perhaps not at all. The question of handling this quicksand, however,

assumed no importance, as the contractors on both Section F and Section E agreed to take their chances with it, providing the prices for hard material be raised to 50 cts. and 53 cts. per cubic yard, respectively, on these sections.

The committee of adjustment was divided in its opinion as to what action to pursue in the face of the testimony, but finally presented a majority and a minority report. The majority report recommended that no increase in price for hard material be allowed, and this report was adopted and acted upon by the Board of Trustees. The argument of the majority report seems to have been that any action granting relief would be a precedent which would involve serious annoyance from other contractors who might encounter material a little harder than they had anticipated, and claim an adjustment of prices. It was also considered reasonable to suppose that the contractors should have allowed for contingencies of this character in making their bids, and if by a mistake in judgment they had not made sufficient allowance, the Drainage District should not be expected to stand the loss.

The minority report, on the other hand, held that the early completion of the canal was paramount to questions of precedent, and that where grievous hardship devolved on the contractor on account of errors to which the Board of Trustees was a party, they were bound to do what equity might require. The test pits proved that the small borings had not indicated the true character of the material; to declare the contract forfeited and relet the section to new contractors would take at least six months. For these reasons the minority report recommended that relief be afforded to the contractors by placing the price of the hard material at 50 cts. per cubic yard, so that work might be continued without interruption.

The two facts of main significance in the account quoted are, first, demonstration of failure of wash boring samples to indicate the resistance to excavation of the strata sampled, and, second, pronounced opinion of a minority of the investigating committee of engineers that the employer was party to the error and in equity the contractor deserved not to bear alone the burden of error. To those who followed the discussion at the time there occurred from the incident another lesson. Early in the history of the Sanitary District, when internal dissensions were rife and one chief engineer was succeeding another at intervals of a few months, one of the chief engineers had condemned borings and demanded the sinking of test pits along the portions of the canal in earth. This was regarded by the Trustees as a technical requirement unworthy of tolerance by practical business men and the demand was vetoed. Because of this and similar interference in technical procedure the chief engineer resigned. That chief engineer was Lyman E. Cooley, and the fact is noted now because again, after a score of years, Mr. Cooley is confronted with loss of his position as consulting engineer of the Sanitary District of Chicago because again also of refusal to modify expert opinion unwelcome to the Trustees on certain technical questions on which his opinion was asked.

While this reminiscence is not without interest in itself, it is, as hinted above, given particular pertinence by the Supreme Court decision recently rendered in the case of Christie, Lowe & Heyworth vs. The United States. In this case the contention turned on the following paragraphs of the specifications:

> The material to be excavated, as far as known, is shown by borings, drawings of which may be seen at this office, but bidders must inform themselves as to the nature of the material.

In the hearing evidence was presented showing that in addition to sand, clay and gravel indicated by the records of borings the material included buried stumps and logs, cemented gravel and sandstone conglomerate, and that it cost some $6,000 more to excavate than it would have cost had the material been as recorded by the borings. The facts were also brought out: that time was not given the bidders to make borings to check those made by the engineers; that in making the original borings obstructions were met "which from the particles broken off and floating to the surface would indicate they might be logs"; that "when such obstructions were met the apparatus was moved elsewhere until a place was found where the drill would penetrate, and the result was recorded as if taken at the place staked out"; and that the boring records showed no material impenetrable to the drill.

On this evidence the court reversed the decision previously rendered by lower court, which disallowed damages to the contractor. The scope of the decision is not certain, but in general it indicates that specification clauses such as is quoted above are not immune to successful attack, and this is knowledge of decided value to contractors. To the engineer a bit of amusing naivete shows in the confession that when the drill struck obstructions it was moved about until a place was found where there were no such troublesome obstacles. It is but fair to note that the court "found" that in this act the engineers "did not have sinister purpose."

GENERAL

Methods and Cost of Levee Enlargement With a Tower Dragline Excavator.

(Staff Article.)

This article describes the organization and methods employed in operating a newly developed type of excavator on a 240,000 cu. yd. contract for levee enlargement on the Mississippi River near Waverly, Ark. The camp arrangement is shown and a history of the excavator developed by C. G. Oglesby is given. Approximate costs of accomplishing work with the Oglesby excavator are stated in detail.

GENERAL CONDITION AFFECTING THE WORK.

Waverly, Ark., is about 20 miles below Memphis, Tenn., and one mile from Womack's Landing on the Mississippi River. Supplies are generally shipped by boat from Memphis. Coal is obtained from Newark, Ark., and is handled by rail and barge, thence by train to the levee, where it is placed in piles spaced at convenient intervals for the machine. The soil is alluvial Mississippi bottom land varying considerably in type. For the most part the top soil for a depth of about 2 ft. is of a sandy nature, below that a buckshot clay. Some areas are made up entirely of buckshot clay or sand. The old levee is straight for the most part there being two bends in a distance of about two miles. The country around Waverly and along the line of the levee is well cultivated and little wooded land is encountered. The roads are poor, being ungraded and without bridges. No bayous intersect the work. Concealed stumps are frequently encountered.

The work involves the placing of 240,000 cu. yds. of earth along the face of an existing levee, the approximate cross section of which is shown in Fig. 4. The specifications require the earth to be obtained from a shallow borrow pit on the river side of the levee. The borrow pit must be left with a bottom slope of 1:50. A berm 40 ft. wide between the edge of the borrow pit and the toe of the completed levee must be left. The surface of the old levee and the portion of the old berm covered by the enlargement must be plowed prior to placing the new earth.

On this job the average height of the crown of the enlargement above the old levee top is 8 ft. About 2,300 cu. yds. of earth are required per 100 ft. of levee. A 25 per cent allowance for shrinkage is used, making about 2,900 cu. yds. of earth to be placed per 100 ft. of levee. Engineer's construction stakes are set so as to allow for a 25 per cent shrinkage.

CONTRACTORS' ORGANIZATION AND CAMP.

The organization employed by the contractor is quite small and contrary to the ordinary levee building organization includes only white labor. From the beginning C. G. Oglesby, the originator of the type of excavator employed on the work, has lived in the camp and directed the construction and operation of the machine and the earth excavation.

A foreman and twelve men are employed in operating the excavator. One team is used for plowing and odd jobs. At the camp a cook at $40 a month and a commissary clerk and camp flunky at $30 a month are employed. Board is furnished to day laborers at 75 cts. a day. Men hired by the month are boarded free. The fare provided is plentiful and well prepared. The average cost to the contractor for food supplies alone for a period of several months has been 60 cts. a man per day. Cooking and incidental camp costs amount to approximately 15 cts. a man per day.

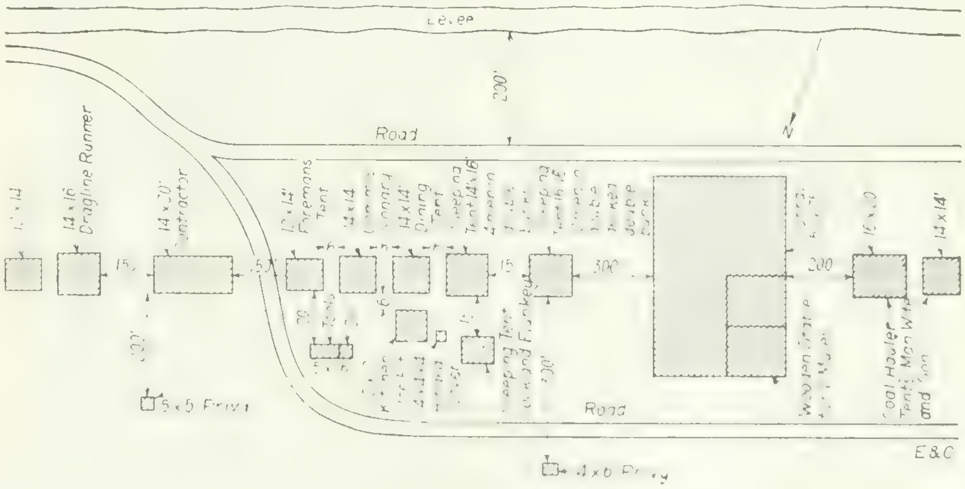
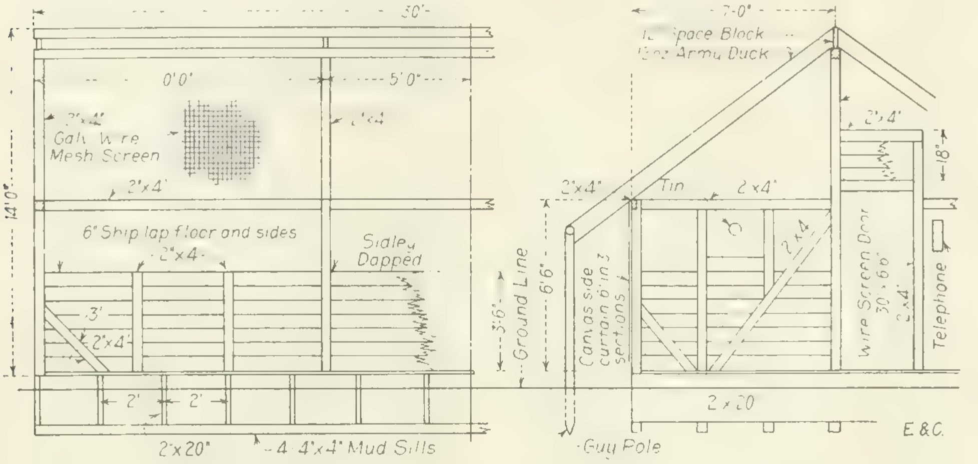


Fig. 1. Arrangement of Contractor's Camp.

The men have breakfast in camp and work begins about 6 a. m. At noon 30 minutes is allowed for dinner, which is brought out to the machine in a wagon and served on trestle tables. Work ends at 6:30 p. m. and supper is served in camp immediately after the arrival of the men.

The arrangement of the camp is shown in Fig. 1. The camp site is about ½ mile from the post office of Waverly on a well drained spot well away from timber land and standing water and adjacent to the land side of the levee. A road along the levee passes the camp.



Part Long Section

Part End View

Fig. 2. Details of Framing for a 14-ft. by 30-ft. Tent.

All camp structures except the mule stable and tool house are of canvass. Tents are of 12-oz. mildew proof army duck and are equipped with flys. The following method of tent erection was used: Sills of 4x4-in. pine were laid on the ground and covered with 6-in. shiplap flooring. Posts of 2x4-in. stock 6 ft 6 ins. long were erected upon this floor at the corners and half way between the corners and capped with 2x4-in. pieces dapped into the posts to make a flush joint. Knee braces 3 ft. long were used at the corners. Center posts to support the ridge were of 2x4-in. lumber erected from the floor. The side of the center post was used for one side of the door frame for a 2-ft. 6-in. by 6-ft. 6-in. wire screen door, another 2x4-in. piece 6 ft. 6 ins. long being erected and capped with a 2x4-in. piece spiked to the center post to complete the door frame. The sides of the tent frame were boarded 30 ins. from the floor with 6-in. shiplap. For the most part details were similar to those shown in Fig. 2, which gives the construction of the large 14x30-ft. tent used by the contractor. Tent ropes were fastened to a cross pole supported by posts securely set in the ground about 3 ft. from the tent sides.

The total cost of the camp equipment including tents, lumber, stoves, dishes, beds, etc., was approximately $1,000. The canvas alone cost $466. The cost of the 14x30-ft. tent, Fig. 2, erected in place, was as follows:

Canvas	$100
Lumber, 2,000 feet	25
Labor	25
Cost erected	$150

The ice pit (see Fig. 1) consisted of a 4x4x4-ft. box of 2-in. lumber set in the ground and covered with a 2-in. plank top hinged and counter weighted with a block chain and weights to facilitate opening. The box was about half filled with shavings.

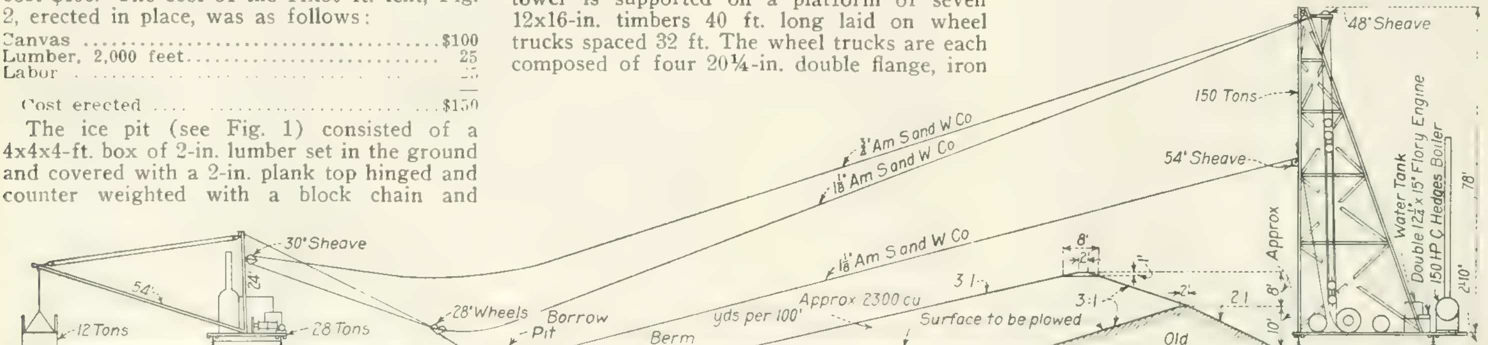


Fig. 4. Sketch Showing Method of Operating the Excavator.

THE OGLESBY TOWER DRAGLINE EXCAVATOR.

The tower dragline excavator, Fig. 3, developed by C. G. Oglesby for use in levee construction consists of two traveling towers between which a bucket controlled by a slackline cable is dragged back and forth, the propelling power being supplied by a dragline and a tail rope attached by a bridle to the front and rear of the bucket respectively and operated from the main tower. Figure 4 shows the general dimensions and the method of operating the plant.

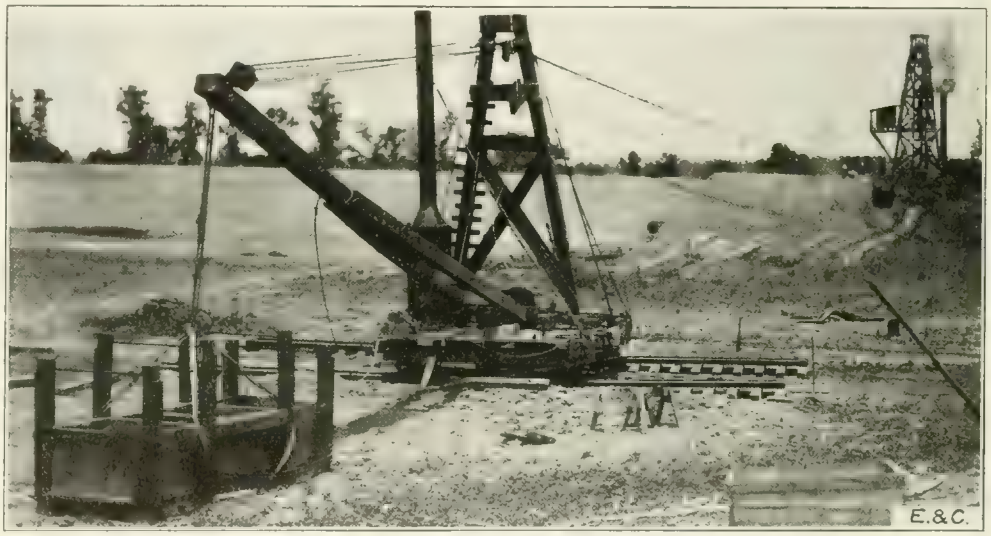


Fig. 3. The Oglesby Tower Dragline Excavator in Operation.

Main Tower.—The main tower, Fig. 5, consists of a timber tower frame, 78 ft. high of 10x14-in. timbers on a 24x27-ft. base. The tower is supported on a platform of seven 12x16-in. timbers 40 ft. long laid on wheel trucks spaced 32 ft. The wheel trucks are each composed of four 20¼-in. double flange, iron wheels running between two 12x16-in. timbers 24 ft. long. Upon the platform are mounted three 60-in. drums and a pony drum operated by double 12¼-in. by 15-in. Flory engines and a 150-hp. locomotive boiler manufactur d by the Casey-Hedges Co., Chattanooga, Tenn.

The operators platform is 26 ft. above the tower base. Control is secured through seven levers and six pedals connected with the drums by pipes to the platform. The dragline sheave may be raised and lowered to suit varying heights and slopes of levee. The slack cable and tail rope operate over sheaves at the top of the tower. The cableway is attached within the tower to a throw wheel double block the rope from which leads over the central drum. Track details are shown in Fig. 7.

Tail Tower.—The tail tower, Fig. 6, consists of a platform 20x20 ft. laid on five 12x12-in. by 20-ft. timbers supported on two three-wheel trucks spaced 16 ft. The gallows frame is 24 ft. high and the counterweight boom 24 ft. long. Timber seats are used for both the gallows frame and the boom. The boom seat is slightly rounded to the segment of a circle having a cord of about 6 ft. and a middle ordinate of about 8 ins. This joint is unique and bears an important part in facilitating the movement of the tail towers, as described later. A vertical boiler and second-hand hoisting engine are mounted on the platform. The counterweight consists of a timber box filled with earth. Track details are shown in Fig. 7.

This tail tower is a loose jointed structure and has an important function in absorbing shocks occasioned by sudden stoppage of the bucket. It acts as a safety valve in the operation of the machine.

Cables.—American Steel and Wire Co., wire cables are used throughout. The dragline and slack line are 1⅛ in. in diameter and the tail rope is ¾ in. diameter. These cables have handled 154,000 cu. yds. of earth up to the present time and very little wear is apparent. No trouble of any kind has been experienced with the cables. In this connection the sheave arrangement is worthy of note.

Bucket.—The bucket used was designed by C. G. Oglesby and made in Memphis, Tenn.

The bucket was originally designed for a 4-cu. yd. capacity but it was found later that the machine could handle a larger bucket and sides and back were added, increasing the water level capacity to 8 cu. yds. Figure 8 shows the old bucket in operation and Fig. 9 gives the principal dimensions and details of the bucket as at present used. The bucket has operated successfully except on one occasion in very wet buckshot clay when some sticking occurred and it was necessary to clear the bucket occasionally with a water jet. The present bucket is believed by Mr. Oglesby to be too narrow and the capacity too small; the machine could handle a 10-cu. yd. bucket. A 12-ft. bridle is used. An 8-ft. bridle was found to be too short. The shoe on the bottom of the bucket facilitates the control and reduces the wear on the bucket bottom.

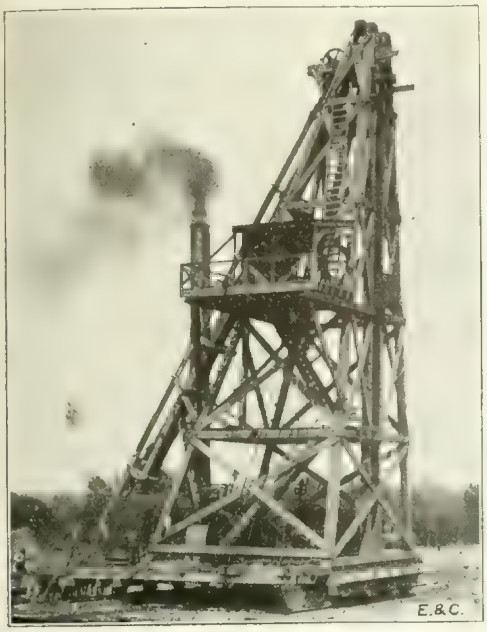


Fig. 5. Head Tower of Excavator.

Trolley.—The trolley consists of two 28-in. wheels between triangular steel plates. The tail bridle of the bucket is attached to a clevis, the load being transferred to a pin passing through the plates as shown in Fig. 8. The tailrope is attached to the pull bar on the trolley.

Water Supply.—A $3\frac{1}{2}$x$5\frac{1}{2}$x$6\frac{1}{2}$-in. Marsh Simplex pump supplied with steam by a 6-hp. vertical boiler pumps water to the tanks on the head and tail towers. Water is at present obtained from borrow pits filled by the high-water of last year. The pipe line consists of a main of $1\frac{1}{2}$-in. pipe about 2,500 ft. long to the main tower and a 1-in. branch main to the tail tower. More water is supplied than needed.

CONSTRUCTION METHODS AND OPERATION OF EXCAVATOR.

Straight furrows following the engineer's stakes marking the edges of the borrow pit and the toe of the new levee are plowed a distance of 1,500 ft. or more ahead of the machine with a 2-horse turn plow. The ground between the toe of the new levee and the top of the old levee is thoroughly plowed for a distance of 500 to 1,000 ft. ahead. The team also smooths little inequalities in the ground upon which the tracks for the tower are to be placed for a distance of 150 ft. ahead. A Mormon—or tongue scraper is used for this work.

Tall poles set on the center line by the engineer with their tops at elevation of the top of the new levee plus allowance for shrinkage furnish crown grade. Engineer's toe stakes are plowed out, the furrow furnishing a more readily distinguishable mark.

Track is snaked ahead by the team on the main tower and by a block and tackle working between a "dead-man" about 500 ft. ahead and the "niggerhead" of the hoisting engine on the tail tower. Three men are employed in moving and placing tracks. No track troubles have been encountered. The type of track used on the tail tower is considered quite satisfactory.

Both towers are moved by simple block and tackle rigging. Deadman consisting of a single 6 ft. cross tie buried about 4 ft. with a 16 ft. section of wire rope around the middle are placed in front and behind each tower. The main tower is moved through a block and tackle rigging between the deadman and a pony drum controlled by the dragline operator. On the tail tower the niggerhead of the hoisting engine furnished sufficient power for moving.

In moving the tail tower the counterweight remains stationary when the tower is moving. The wooden socket joint at the foot of the boom before described permits this motion. After the tower has moved the distance desired (as much as 15 ft. without lifting the counterweight) the counterweight is lifted by the hoisting engine and it swings around by gravity until in line with the cables, when it is again lowered to the ground.

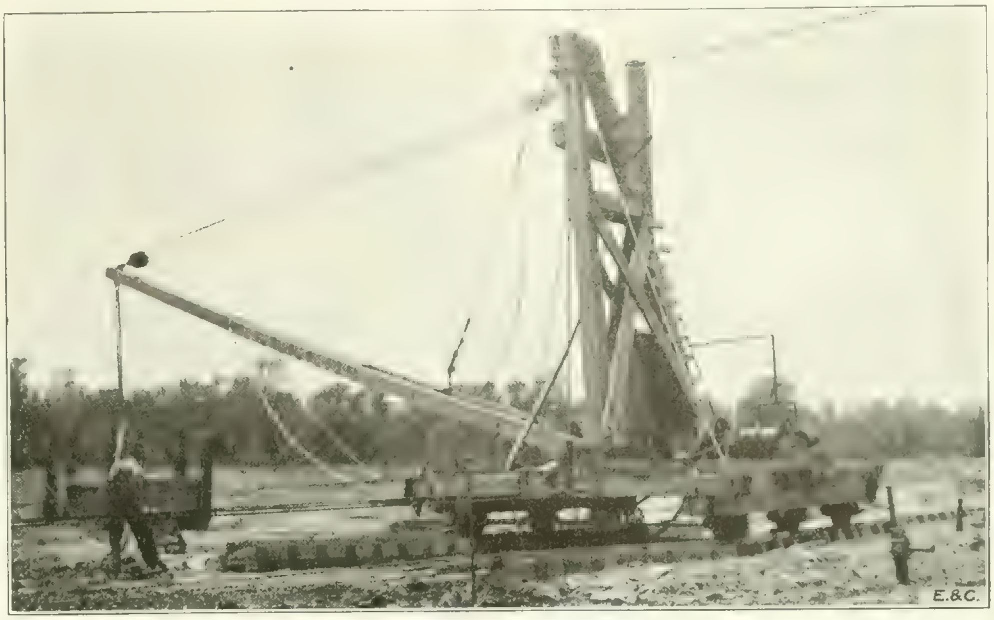


Fig. 6. Tail Tower of Excavator.

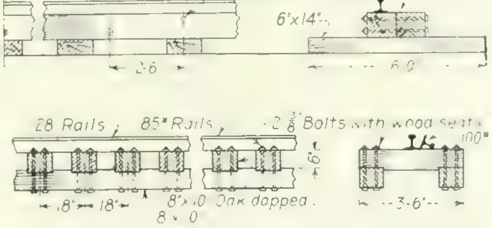


Fig. 7. Details of Track Used for Head and Tail Towers.

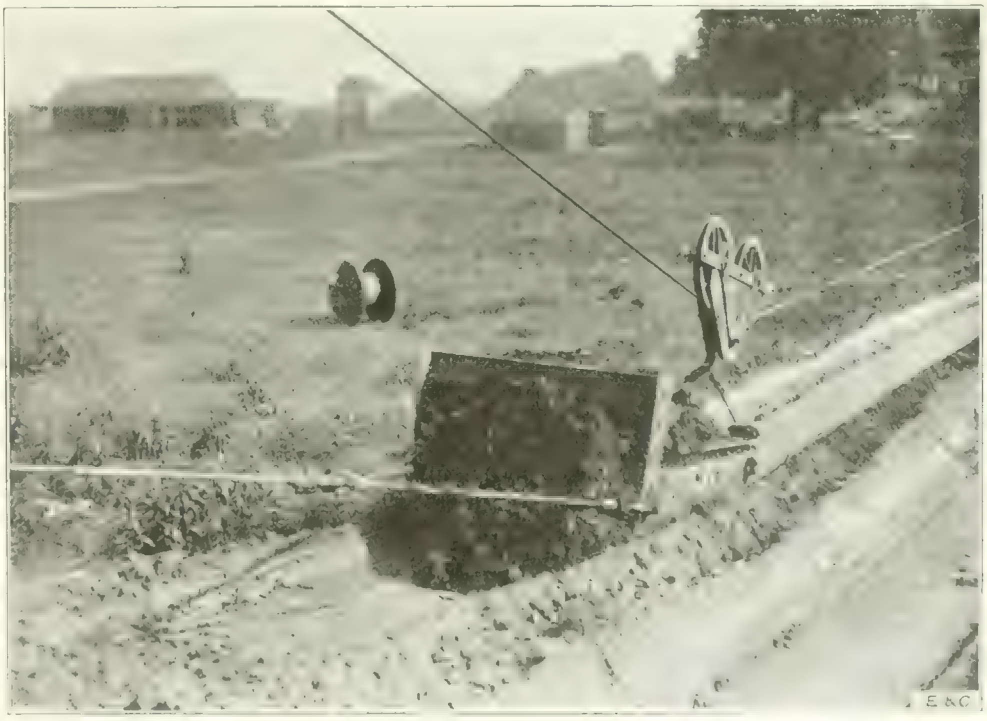


Fig. 8. Trolley and Bucket Before Sides and Back Were Added.

The method of digging, handling the bucket and placing the earth are illustrated in Fig. 10. In digging the manipulation of the dragline and the slack cable aided by the shoe which acts as a pivot permits perfect control of the bucket. The flexibility and ease of the control with this machine are worthy of note.

When starting a new runway a ridge about 6 ft. wide is generally left in the borrow pit on the first run. This ridge is taken out after the first run is completed. The bucket begins digging on the near side of the pit and eats back in sections about 30 ft. long.

The average time required for a round trip of the bucket from the back of the borrow pit is 3 minutes. As a rule the bucket pushes about 1 cu. yd. of earth in front, some of which falls off and builds up the berm. The amount of earth moved in a trip varies from 5 to 9 cu. yds. The average bucket load of a day's run is probably 6 cu. yds.

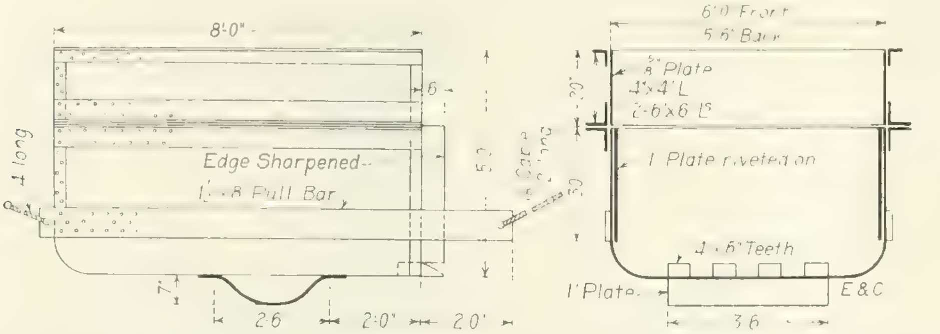


Fig. 9. Details of Bucket as Now Used.

For dumping the elevation of the dragline sheave has been so adjusted that the teeth of the dumped bucket follow naturally the face of the 1:3 levee slope. This face facilitates the use of the bucket in dressing the levee face. The bucket is dragged over the earth already placed in the levee to the dumping point. The compaction resulting from the repeated passage of the loaded bucket, the average weight of which exceeds 15,000 lbs., is an important factor in securing a stable levee.

In loading the bucket frequently takes dirt throughout the length of the pit and a more harmonious levee results when the earth is taken from one spot alone.

It is believed that the ridges left in the borrow pit, shown in Fig. 10, cause deposits in the borrow pits in high water, their action being similar to that of riffle boards. After the last high water a marked deposit of silt was noticed.

When the earth is wet the three stage method of placing is employed as shown in Fig. 11. Ordinarily the earth is placed the full height for each runway.

Two men with shovels are employed, finishing and smoothing the earth placed in the levee. If the earth is quite wet when placed and drys out in clods a Mormon scraper is used to advantage in smoothing.

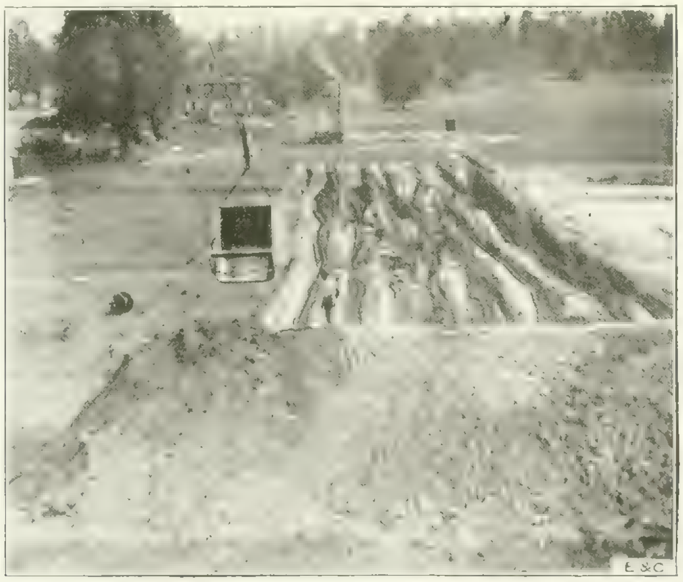


Fig. 10. Method of Excavating Earth and Building Levee.

APPROXIMATE COST OF LEVEE BUILDING WITH THE OGLESBY EXCAVATOR.

The costs given here are not representative of the cost of handling earth with the Oglesby machine since they include the cost of developing the machine to its present state. The costs given, moreover, do not include accurate repair or construction costs on the machine or the contractors' overhead cost. These costs are, however, estimated at $25 a day. The operating costs it is believed by Mr. Oglesby could be materially reduced by increasing the boiler capacity and thereby reducing the coal loss resulting from the use of forced draft on the present boiler and by using a 10-cu. yd. bucket. The amount of earth to be moved on the job does not, however, justify these changes. Table I gives the daily operating cost of the excavator.

The machine has operated up to Apr. 20, 1915, a total of 1,914 hrs. and has built 154,031 cu. yds. of compact levee, an average hourly output for the whole job of 80 cu. yds. The best day's work was on April 18, and amounted to 1,610 cu. yds. of compacted levee, a length of 70 ft. On that day the cost of building finished levee was approximately 8 cts. a cubic yard.

It must be borne in mind when comparing the costs of this work with team work that the average haul for wheelers would be not less than 400 ft. The machine is essentially long haul, shallow pit type of excavator.

Between Cairo, Ill., and New Orleans, La., levee work approximating 240,000,000 cu. yds. is projected, a large part of which will be shallow borrow pit work. The Bucyrus Company is now building an improved type of Oglesby excavator based upon the machine now in use.

TABLE I. — OPERATING COST OF THE OGLESBY EXCAVATOR FOR A 12-HOUR DAY.

Labor.	Daily cost.
1 foreman at $150 a month, 20 days	$ 7.50
1 runner at $150 a month, 20 days	7.50
3 trackmen at $2	6.00
1 fireman	3.00
1 tail tower engineer	3.00
1 tail tower helper	2.00
2 levee trimmers at $2.50	5.00
1 extra man	2.00
1 pump engineer	2.50
1 team and teamster	5.00
1 night watchman	2.50
Total daily labor cost	$ 46.00
Fuel.	
7 tons coal (used on 3 boilers) at $7.75, delivered at the boiler	54.25
Oil and waste	1.50
Total daily labor and fuel cost	$101.75
Repairs, depreciation and overhead expense estimated for normal conditions	24.00
Total daily operating cost	$125.75
Output April 11-20, 100 hrs. operated, compacted levee, cu. yds	8,754
Compacted levee per 12-hr. day, cu. yds	8,754
Earth actually placed in levee, allowing 25 per cent shrinkage per 12-hr. day, cu. yds	1,340
Approximate cost per cu. yd. compacted levee, cts	11.7
Approximate cost per cu. yds. earth moved (no shrinkage), cts	9

PROGRESS AND PERSONNEL.

The machine was erected early in 1914 and after numerous delays incidental to the development of a pioneer machine was well started Sept. 1, 1914. Work was interrupted by high water on the Mississippi for a month in 1915. On April 20, 1915, a total of 154,000 cu. yds. had been moved and it is estimated the job will be completed by Aug. 1, 1915.

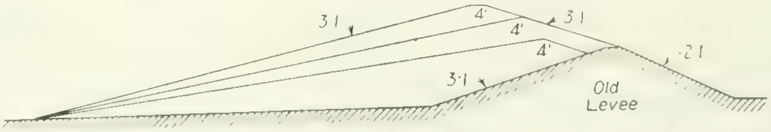


Fig. 11. Stage Method of Building Levee When Earth is Wet.

The work has been financed by R. H. and G. A. McWilliams, drainage contractors, 28 E. Jackson Boulevard, Chicago. C. G. Oglesby is the contractor and originator of the excavator used. Work is proceeding under the engineering supervision of E. M. Markham, Major, United States Corps of Engineers, Memphis, Tenn.

Relative Area Occupied by Diagonal and Parallel Roads.—W. S. Gearhart, state highway engineer of Kansas, in an article in the Kansas Farmer, stated that in Western Kansas, where the land has not been closely fenced, the roads are on the shortest line between two places, but these roads are rapidly disappearing to make way for the section or property-line roads. This policy is a short-sighted one, in which the interest of the public is being sacrificed to the interest of the individuals. A 60-ft. road on two sides of a section of land occupies 14.55 acres, while a road 60 ft. wide in a diagonal direction through the section occupies 10.28 acres of land. Thus there is a saving in the diagonal road of 4.27 acres and 0.587 mile of distance. The saving in the cost of right of way, assuming that the land along that section is as valuable as on the diagonal line, is $85.40 if the land is worth only $20 an acre. This amount in most cases would be sufficient to grade the 1.413 miles of diagonal line in first-class condition. If a man lives four miles north and four miles east of his market-place he is 5.657 miles on the diagonal line from it; that is, on the section-line road he must travel 4.686 miles farther in making the round trip than on the diagonal line.

Engineering Positions in Illinois With State Highway Commission and With State Utilities Commission.

(Staff Abstract.)

At the present time practically all of the engineering employees in the service of the State of Illinois are selected through examinations conducted by the State Civil Service Commission, the examinations usually being open both to citizens of Illinois and to nonresidents. The principal positions offered in state service are with the Highway Commission and the Utilities Commission, and the following data apply to the procedure used in conducting examinations and to the salaries and duties of these positions. The data were abstracted from a paper by W. R. Robinson, secretary, State Civil Service Commission of Illinois, presented before the annual meeting of the Illinois Society of Engineers & Surveyors.

MANNER OF CONDUCTING EXAMINATIONS.

While applications are being received for the examination to be held, the test itself is being planned and the questions prepared. In each case the Commission secures some one to make up the questions and grade the papers whose reputation as an engineer is such that his markings would be accepted without question. Sometimes engineers in the Federal service have helped in this work. Frequently use is made of men holding similar positions in other states and of prominent engineers in private practice. The candidates are notified to take the examination at the point most convenient for them to reach and the questions are sent to a monitor who conducts the test at that place.

These examinations are so planned that the candidate's name does not appear on any sheet of his answers to the questions. All sheets are identified by a number which has been assigned him. Then the written papers are sent in to the Springfield office and all those on each subject are sorted out and sent to the man who made up the questions. This man grades the answers without having any information as to the identity of the writer. Then the averages on all subjects are computed and the final weighted average obtained. At this time the envelopes which contain the candidate's names are opened, and a list is made of those who have secured a grade of 70 per cent or higher. Letters are then sent to each person whom the candidate has mentioned as a previous employer, or as one who is acquainted with his work or character. These men are asked specific questions as to the candidate and are also asked to name other persons who are in position to give information. In this way the Commission checks up every statement as to training and experience and often uncovers matters which were not mentioned in the examination but which are of vital interest to a prospective employer. If a candidate's record is bad, he will be disqualified and his name removed from the list, even though he received a passing grade.

When this work is completed the list of eligibles is made up and announced. As fast as vacancies occur the eligibles are consulted, in direct order of their standing on the list, as to their willingness to accept the position. After the appointment takes place the employe is on probation for a period of three months. This is really the final portion of his examination, and he may be discharged summarily at any time within that period. After serving the probation period it is presumed that his services have been satisfactory, and he cannot be discharged except after charges are preferred and an investigation made by the Civil Service Commission.

POSITIONS IN HIGHWAY DEPARTMENT.

Most of the men enter the Highway Department as Junior Engineers. The examination for these positions inquire into the applicant's education and experience, his knowledge of plane surveying, the use and adjustment of instruments of precision, the design of simple structures of plain and reinforced concrete, analysis of simple structures, and construction and maintenance of roads and pavements. During the past three years 162 persons have applied for the position of Junior Engineer, which pays $75 a month at the start; 105 have appeared for examination; and 71 have passed and have been placed on eligible lists at different times.

The next higher position is that of Assistant Highway Engineer, paying a starting salary of $105 a month. This examination has always been made promotional and is open only to men already in the service as Junior Engineer. The examination has been made promotional because the Commission feels that persons who have taken the trouble to satisfy the requirements for entering the service and have given satisfaction in their position should receive the preference over persons from the outside.

Last year an examination was held for the position of Road Engineer, with a starting salary of $175 a month. Because of the fact that there would be very few applicants within the boundaries of the State, and because qualified persons could hardly be expected to come any great distance to take an examination, the questions were made up so as to cover only education and experience along lines tending to fit the applicant for the position sought. These questions were sent to the candidates at their homes, and they made out their replies and sent them to this office, arranged in such a way that the identity of the person who wrote the answers was concealed until after the candidates had all been judged by the examiner. Then after the Commission had determined who made a passing grade, all the statements made concerning education and experience were carefully checked up. This method of holding what is called an "unassembled examination" is used in cases where the examination is thrown open to non-residents of Illinois and where there is strong probability that most of the applicants live at some distance.

POSITIONS WITH STATE UTILITIES COMMISSION

A line of work which has been developing recently, and which offers almost unlimited opportunity in Illinois for competent engineers, is in connection with the various activities of the State Utilities Commission. Starting with the position of Draftsman and Investigator of Safety Appliances and Crossing Accidents, there are numerous other positions offering a wide range in salary, all lying within classified civil service. Several of these positions are given below in some detail, as most of them are new.

Service Inspectors draw from $90 to $125 a month, and they make routine inspection of gas and electric properties to determine whether prescribed service standards are observed. The Assistant Utilities Engineer commands the same salary as the Service Inspector, and he performs duties involving the checking of inventories of utilities properties, investigation of operating methods and cost records to determine fair values of such properties.

The Assistant Railroad Engineer, who is paid from $160 to $200 a month, makes field inspections of railroad properties, interlocking plants and signal apparatus. The Railroad Engineer is paid $250 a month at the start, and he has entire charge of the investigation of railroad accidents, examination of dangerous crossings, inspection for approval of interlocking plants and signal circuits, the investigation of railroad service complaints, and the preparation of all orders of the Commission in connection with railroads.

The Gas Engineer, who is paid a starting salary of $250 a month, has charge of the investigation of gas properties, with regard to valuations for rate-making proceedings and special operating problems, and the preparation of the orders of the Commission in all gas-rate cases.

The Mechanical Engineer is paid $160 to $250 a month. He has charge of investigations of water works and steam heating properties, with regard to valuations for rate-making proceedings and special operating problems; he also prepares all orders in water-rate cases.

The Telephone Engineer is paid $200 a month at the start, and he has charge of the investigation of telephone properties, with regard to rate-making proceedings and special operating problems; he also prepares the orders of the Commission in telephone-rate cases.

The Electrical Engineer, who is paid the same starting salary as the Telephone Engineer, has charge of the investigation of electrical properties in connection with rate-making proceedings and special operating problems; he also prepares the orders of the Commission in electrical-rate cases.

The Service Engineer is paid from $200 to $300 a month. He has charge of all the service inspectors, directing routine service inspection of utilities properties, special investigations as to service, and preparation of orders in such cases.

The Assistant Chief Utilities Engineer is paid $300 a month at the start, and he has charge of special case work investigations, the preparing of orders in important railroad and rate cases; he also has charge of the entire engineering department of the Public Utilities Commission in the absence of the Chief Engineer.

For most of these positions the examination will be such as to require education equivalent to that necessary for graduation from an engineering school of recognized standing, together with thorough experience in the particular line of work covered by the position.

Recommended Alterations Affecting Engineers in the New York State Constitution.

The drafting of a new constitution for the State of New York is provided for by a Constitutional Convention about to assemble. To bring favorably before the convention needed improvements in the state machinery for administering public works and regulating public utilities committees of five engineering socities having homes in the state have drafted recommendations. These recommendations are of considerably more than local interest in their bearing upon the profession of engineering and we reprint them here:

RECOMMENDATIONS.

1. The elective office of the state engineer and surveyor should be abolished, and the duties should be transferred to the Department of Engineering and Public Works hereinafter proposed.

2. A Department of Engineering and Public Works should be created to be headed by three commissioners appointed by the governor, each to have a twelve-year term of office so arranged that a vacancy will be created every four years immediately after the inauguration of a new governor. Commissioners should be eligible for reappointment. At least one commissioner should be a professional engineer in good standing in his profession, and each should have had experience that would fit him for the duties of the office. At least one and not more than two commissioners should be residents of New York City.

This department should have charge of public lands and boundary surveys; of buildings, parks, highways, canals and other public works, including design, construction, maintenance and operation and of the conservation and development of state resources.

This department should be divided into suitable bureaus. Each bureau charged with responsibility for engineering work should be headed by a chief engineer selected by the commissioners with sole regard to his peculiar fitness for the duties of the bureau.

3. A Department of Public Utilities should be created to be headed by five commissioners appointed by the governor, each to have a ten-year term of office so arranged that a vacancy will be created every two years. Commissioners should be eligible for reappointment. At least two commissioners should be professional engineers in good standing in the profession.

Each appointee should have had experience in connection with public utilities which would fit him for the duties of the office. At least two and not more than three commissioners should be residents of New York City.

This department should regulate and supervise all common carriers, all water supply, irrigation, drainage, gas, power, lighting, heating, intelligence-transmitting and other public utility corporations operating within the limits of New York state, including similar activities on the part of any other state department or political subdivision of the state.

This department should be divided into such bureaus as may be essential. Each engineering bureau should be administered by a chief engineer selected with sole regard to his peculiar fitness for the office, and he should have power, subject to the approval of the commissioners, to select and appoint such division engineers as are essential to the proper conduct of his office.

4. In case provision be made in the constitution for the creation of one or more departments or commissions charged with responsibility for regulating, supervising and inspecting buildings and the equipment thereof, trades, mines, industries or labor, each such department or commission should include in its membership at least one professional engineer in good standing in his profession. Commissioners should be appointed by the governor. Each appointee should have had experience and should possess qualifications fitting him to perform the duties essential to the department or commission.

5. In case provision be made in the constitution for the creation of a Court or Board of Claims charged with responsibility for investigating claims against or on behalf of the state, one-third of the membership of such court or board should be made up of professional engineers in good standing in the profession, each to have practiced professional engineering for at least ten years and for at least five years to have had responsible charge of important engineering work either as to design or execution.

6. Removal by the governor of any commissioner should be made only after the filing of charges and after affording the accused an opportunity to be heard in the matter, provided, however, that at any time within the first six months after making an appointment the governor may exercise the power of summary removal. A successor to a commissioner who has been removed should be appointed to fill the unexpired term. Vacancies caused by removal or otherwise should be filled under conditions similar to those governing original appointment.

7. There should be no direct or implied prohibition against legislation which would permit the reference by a court of technical matters made the subject of, or incidental to litigation, to a referee expert in such technical matters, for the purpose of securing a determination concerning the facts, or which will prevent the court from selecting independent expert witnesses or advisers in matters of this character.

8. In order to make possible the reasonable development of state resources, the present constitutional prohibition against the use or sale of land and cutting of trees within the limits of the forest preserve should be removed in so far as such use or sale of land or cutting of trees is essential to such development (Article VII, Section 7), and similarly to permit the development of other natural resources by private enterprise, provision should be made for the condemnation of private property necessary to the construction and operation of works for irrigation, drainage, sanitation, water supply, agriculture, mining, forestry or power development, through the declaration of such project as for public use, subject, however, to the superior right of the state or of a subdivision thereof to condemn the same property or a portion thereof for state or municipal purposes (Article I, Section 7).

Licensing Engineers in Pennsylvania: Report of Committee.

The report of the special committee of the Engineers' Society of Pennsylvania, appointed to consider the subject of licensing engineers, is printed in the March issue of the Journal of that Society. The committee was composed of Wm. B. McCaleb, D. E. Tracey, and Willis Whited, chairman. A summary of the report follows:

We are opposed to any system of licensing engineers. We would not object to a system of licensing land and mine surveyors whose work forms a part of the public records of the boundaries of real estate. We would not object to a system of civil service certificates, tending to insure the competence and integrity of engineers responsible for the design and construction of public works, but this subject may be considered outside the province of this committee. If, however, it is decided that some form of licensing engineers is necessary, we would recommend that examinations be held and licenses issued under the authority of the state.

The principal objections to a system of licensing are as follows:

1. Defective engineering is caused at least as often by the parsimony of the owner or the fraud of the contractor or supply man as by the ignorance of the engineer.

2. If all engineers are required to hold license it might be construed that any wagon maker who built a new pattern of wheelbarrow or any carpenter who replanked a bridge floor should be punished for neglect to secure a license as engineer.

3. It hardly seems wise for the state to attempt to protect strictly private interests or to interfere with private affairs, except in the exercise of ordinary police powers, which are intended only to protect human life and health and the interests of the public.

4. If only the interests of the public are to be protected, which is the only excuse for public intervention, there are a very large number of cases in which it is impossible to determine beforehand whether they are seriously threatened or not, and it would often require a decision of the Supreme Court to decide whether an engineer was an honored citizen or a criminal.

5. If the public actually suffers there is no question of the hazardous character of the work and the responsibility of the engineer can best be determined by the extent of the damage.

6. It is well known that some repair work requires a higher grade of engineering skill and responsibility than was required in the original design of the structure, while other repairs require only ordinary mechanical skill. It would often be extremely difficult to differentiate between the cases.

WATER WORKS

Some Practical Suggestions and Data on the Installation and Operation of Air Lift Pumping Systems.

Contributed by C. M. Wetherill, Chicago, Ill.

While it is conceded that the air lift is not as economical as other systems for general pumping, under certain conditions it has proven economical and satisfactory; especially where the water is taken from a well that is less than 12 ins. in diameter and the pumping level of the water does not exceed 225 ft. above the lowest water level in the well. The advantage of the system is that the machinery is all above ground. There is nothing in the well to get out of order and so call for "pulling the well," which so often occurs with the plunger type of pump. The efficiency of the air lift after years of service remains the same, while wear of plunger pumps often causes a drop in efficiency of from 40 to 50 per cent, particularly if the water contains fine sand.

The air lift system has its principal use when the quantity of water is the chief concern, and where it is to be taken from small wells widely separated, and where the cost of operation is not a large consideration. It is the best system of pumping for taking a large amount of water from a small well.

The air lift is a desirable system in small towns securing their supply from deep wells of small bore, especially when electric power is used. The system may be installed to operate automatically, and the plant may be taken care of by the town marshal. In water works of this class the water is brought to the surface reservoir with air. Then it is taken up by a triplex or centrifugal pump, operated by an electric motor, and elevated to the gravity tank. Both of these machines can be operated by automatic float switches.

SUBMERGENCE.

In piping a well it is important to have the proper amount of submergence. This should be between 50 and 65 per cent of the total length of the eduction pipe; about 60 per cent seems to give the best results in general. This submergence regulates the necessary running air pressure.

Let us suppose the well is 400 ft. in depth. It is assumed that when pumping the quantity of water wanted the water level in the well will drop 75 ft. below the surface of the ground. The elevation above the surface of the ground is 25 ft., making the total lift above the water level in the well when pumping to the point of discharge a total of 100 ft. Assuming that the submergence should represent 60 per cent of the entire length of the water discharge pipe, this lift represents 40 per cent. Multiplying this total lift of 100 ft. by 1½ gives 150 ft., which is the 60 per cent submergence required. Adding the 150 ft. submergence to the 100 ft. lift gives the total length of 250 ft. of water discharge pipe.

EXTREME LIFT PRACTICABLE.

It must be borne in mind that the limit of practical utility to which the water can be raised by this system is 225 ft. above the lowest water level in the well. This covers the majority of cases, although under especially favorable conditions water has been raised as high as 260 ft. above the level of the well. It is not safe, however, to count on a higher lift than 225 ft. except under very favorable conditions.

"SLIP" AND HORIZONTAL PUMPING

The principle on which the air lift works is that the mixture of air and water in the discharge pipe is lighter per unit volume than the same volume of water outside the eduction pipe. Therefore the mixture in the eduction pipe will be forced to a much higher elevation than the depth of submergence. In the upward motion of the mixture, or alternate pistons of air and water, in the eduction pipe the air has a tendency, on account of its lighter weight, to come to the surface faster than the water. This causes what is known as "slip," and is one of the principal reasons for the low efficiency of the air lift.

The air lift system is not adapted to pumping horizontally a great distance, and for this reason the horizontal discharge should always be kept as short as possible. When the reservoir is some distance from the wells it is better to discharge into a small elevated tank and then allow the water to flow to the reservoir by gravity.

RATIO OF AIR TO WATER VOLUME.

When 60 per cent of the entire length of the water discharge pipe is sumberged the following ratio of air to water should be observed:

For lifts not exceeding	Volumes of air to 1 of water.
25 ft.	2
50 ft.	3
75 ft.	4½
100 ft.	6
125 ft.	7½
150 ft.	9
175 ft.	10½
200 ft.	12

Thus to ascertain the volume of air required, quantity of water and lift being known: Divide the required quantity of water in gallons by 7½ in order to reduce it to cubic feet; then multiply the quotient by the figure from above tabulation, representing the volume of air required for the lift necessary to raise the water. Assume, for instance, that 200 gals. of water are to be raised to the surface in a minute and that the water level will fall 75 ft. below the surface when pumping. 200 ÷ 7½ = 26.5 × 4½ = 120 cu. ft. of free air required per minute.

REQUIRED AIR PRESSURE.

The required air pressure is determined by the head of water outside of the water discharge pipe from the level in the well to the bottom of the water and air pipes. Assume, for instance, that the water level in the well stands even with the surface of the ground when not pumping, but that when it is pumped the water level will drop 50 ft. below the surface of the ground. This would make it necessary to have the air and water discharge pipes 125 ft. long. When starting pumping it would, of course, be necessary to raise a column of water 125 ft. in height, and allowing 0.434 pressure for each foot lift the starting air pressure required would be 125 × 0.434 = 54 lbs. As it has been assumed that the water level will drop 50 ft. after the well is pumped, there would then be a head of water outside of the water discharge pipe 75 ft. in height with which the air would have to contend, making the running air pressure 75 × 0.434 = 32.5 lbs.

TABLE I.—RELATIVE LIFT, SUBMERGENCE, AIR VOLUME AND PRESSURE, AND I. H. P. OF COMPRESSOR.

Lift, ft.	Submergence required, ft.	Air pressure, lbs.	Cu. ft. free air per gal. per minute.	I. H. P. per gal. raised per min.
25	38	17	0.3	.0156
50	75	33	0.4	.036
75	113	49	0.6	.07
100	150	65	0.8	.0925
125	188	82	1.0	.16
150	225	98	1.2	.212
176	263	115	1.4	.265
200	300	130	1.6	.318

Still an easier method of obtaining the volumes of free air, pressure, submergence and indicated horsepower is given in Table I. For instance, say it is desired to raise 210 gals. of water per minute 50 ft. high. This will require 75 ft. submergence, 33 lbs. air pressure, 84 cu. ft. of free air per minute and the compressor must develop 7.5 I. H. P.

Under favorable conditions the air consumption in Table I may be reduced as much as 15 or 20 per cent.

Efficiencies as high as 33 per cent have been obtained under favorable conditions when a fair-sized, first-class, two-stage compressor is used. This is the I. H. P. or the electric power at switchboard figured against the theoretical horsepower of water delivered.

Table II gives a list of the approximate size and capacity of side inlet devices for foot pieces now placed on the market by several companies and the size of wells they will go into.

Sometimes the size of the well does not permit the use of the side inlet piece; then the central air pipe system is used. If the well is cased far enough down to admit of 80 per cent submergence, the well casing is used as the water discharge pipe and the air pipe is put down into it. About 2 ft. from the bottom of the air pipe a number of holes are drilled for the air to escape from. The size of the pipe depends a great deal upon the size of the well and the quantity required, but the following figures will give a general idea:

Well casing, ins.	Use air pipe, ins.	Capacity, gals. per min.
3½	1¼	115
4	1½	150
5	2	240
6	2	360

In estimating the quantity of water that can be forced through a given size discharge with the best economy, the following rules should be observed:

25 ft. lifts 10 to 11 gals. to each square inch area of water pipe.

50 ft. lifts 12 to 13 gals. to each square inch area of water pipe.

All higher lifts 14 to 15 gals. to each square inch area of water pipe.

Usually this can be exceeded, but only at the expense of economy in air consumption. In pumping wells of 12 ins. or more in diameter, unless the well is crooked, the air lift does not give as good results as the deep well centrifugal pump that is now being placed on the market by several companies.

TABLE II.—DATA ON SIDE INLET DEVICES.

Air pipe, ins.	Water pipe, ins.	Size well, ins.	Maximum capacity, gals. per min.
¾	1½	4	25
1	2	4½	50
1	2½	5	75
1¼	3	6	105
1½	3½	7	145
1½	4	8	190
2	6	10	425
2	5	9	300

The data here given have been gathered during the past ten years by the author both from experience and observation. Some of the information has been obtained from water works superintendents and sales engineers who have had the opportunity of testing and watching the operations of this system of pumping. For general use the above figures have proven very satisfactory.

It is well to bear in mind, as pointed out in ENGINEERING AND CONTRACTING of March 17, 1915, that the air lift should not be installed without the advice of an engineer who has made a special study of the subject, and only after he has been given an opportunity to make trials with various lengths of air pipe and various speeds of compressor operation after the lift has been installed. The latter consideration is important, as by successive adjustments of submergence and compressor speeds the most economical operating conditions may be found.

New Jersey Supreme Court Upholds Decision Awarding Damages for Illness Contracted from Drinking Impure Water Supply.

(Staff Abstract.)

The New Jersey Supreme Court recently handed down a decision in the case of B. Henry Jones, plaintiff, vs. Mount Holly Water Co., defendant, sustaining the verdict of a lower court awarding damages to Mr. Jones on account of the illness of his children, brought on by drinking water supplied by the company. The following facts and arguments are based upon the Supreme Court decision. The nature of the defense is indicated in the decision.

The Mount Holly Water Co. supplies water for domestic consumption to the inhabitants of Mount Holly, including the Jones family. Mr. Jones paid the company $25.90, in advance, for a year's supply of water from April 1, 1911, to April 1, 1912. On January 19 three of the Jones children became ill of typhoid or para typhoid fever. Mr. Jones claimed the illnesses were attributable to the drinking water, the water being in an impure and unwholesome state, in that it was permeated with filth and contained para typhoid germs in large quantities, which the defendant knew or ought to have known in the exercise of due and reasonable care.

The plaintiff sued the defendant to recover the money spent for medical services, medicines and nursing and for the loss of his own time. He recovered a verdict for $750. The defendant carried the case to the Supreme Court and sought to have the verdict set aside for the reasons here referred to and considered. No claim was made that the verdict was excessive.

The first reason assigned in the brief of counsel of the defendant is that the case does not show any contractual relation between the plaintiff and defendant, and that the complaint is one founded upon contract with an imperfect allegation of negligence. But no point is sought to be made of this and we cannot very well perceive how a successful attack can now be made on the nature and character of the pleadings, since it appears that the parties to the controversy treated the action as one of negligence, and that the cause was tried out and submitted to the jury in that aspect.

The second reason relied on by the defendant for a new trial is that the plaintiff had failed to establish any negligence of the defendant which proximately resulted in the illnesses of the plaintiff's children.

There was plenary testimony from which a jury might have reasonably inferred that the water furnished by the defendant company was polluted with fecal matter and other filth and contained germs indicating the presence of typhoid germs in the water. This testimony came from witnesses, who spoke of the polluted condition of the water along the sources of supply of the defendant company in the month of December, 1911, and before that time and prior to the breaking out of a typhoid fever epidemic in Mount Holly in the months of January, February and March, 1912.

From the testimony it is also apparent that the bad condition of the water supply and the nature and character of the sources of the pollution were matters which were so open and above the surface that they would give rise to the fair inference that those conditions were known to the defendant company or, at least, ought to have been known by it before January, 1912.

Besides all this there was proof of actual knowledge of the defendant company of the pollution of the water and the sources of its pollution extending back a period of 3½ years prior to the outbreak of the typhoid fever epidemic. The letter written by the defendant company under date of March 12, 1912, to the State Board of Health is evidence of that fact.

In addition there were 23 cases of typhoid fever in a population of 6,000, from Dec. 1, 1911, to Feb. 26, 1912, a majority of the cases occurring in January, and all of which persons so afflicted with two or three exceptions had been using and drinking the water supplied by the defendant company.

The testimony relating to the cases of typhoid fever prevailing after the plaintiff's children were taken ill was objected to on the ground that it was immaterial and irrelevant, but we think that it was material and relevant on the question whether or not the water supplied by the defendant company, which was drunk by the persons, who had been afflicted with the fever, was the source of the disease.

It must be borne in mind that the defendant company was in the water supply business for profit. The plaintiff had paid for the supply which he was to receive in advance. Hence it became the duty of the defendant company to give to the plaintiff water fit for domestic purposes, including fitness for drinking.

Water is a necessity of life and one who undertakes to trade in it and supply customers stands in no different position to those with whom he deals than does a dealer in foodstuffs. He is bound to use reasonable care that whatever is supplied for food or drink shall be ordinarily and reasonably pure and wholesome.

The case of Tomlinson vs. Armour & Co. (75 N. J. L. 748) is cited, in which damages were awarded plaintiff for contracting ptomaine poisoning from eating unwholesome canned ham.

The legal principle laid down in that case is only applicable to the facts of the present case insofar as it requires the exercise of reasonable care that the water furnished shall be reasonably pure and wholesome, and that negligently furnishing water which is deleterious to the human body or health, will furnish a valid cause of action to a customer injured by the use of the water.

Actual notice or knowledge of the unwholesomeness of the water of the defendant company was not an essential element to be proven, in order to establish the defendant's liability, it was sufficient if there was testimony tending to show that the defendant in the exercise of reasonable care might have discovered the unwholesomeness and dangerous condition of the water.

And the case sub judice differs from the case cited in this essential particular, that the streams from which the water supply is taken are not under the immediate supervision and care of the water company, and covering many miles in area may be easily polluted and contaminated without the knowledge of the water company, whereas in the canning of the ham, that was done in the factory of the Armour & Co., and by its servants.

We think that the plaintiff properly met the burden of establishing that the defendant either knew, or in the exercise of due and reasonable care would have ascertained that the water it was furnishing its customers in Mount Holly was impure and contaminated with germs deleterious to the human body and health.

The duty resting upon the water company was to furnish its customers for consumption pure and wholesome water.

In Jersey City v. Flynn, (74 N. J. L., E. 104, 135-136) the contract requirement of the water company was "that the water delivered should be pure and wholesome and free from pollution deleterious for drinking and domestic purposes."

We think that this contract stipulation aptly states what a public water supply should be.

And in Peffer v. Penn. Water Co. (221 Pa. 578; 70 Atl. Rep., 870), it was held that the obligation of a water company to its customers is to furnish water that is ordinarily pure and wholesome; that pure and wholesome water necessarily means such as is reasonably free from bacteria and coli, or any other infection or contamination which renders the water unfit for domestic use and unsafe and dangerous to individuals.

Viewing the facts of the present case in the light of the duty resting upon the defendant company, the plaintiff met the burden of establishing the defendant's liability, by the introduction of testimony which tended to prove open and notorious pollution and contamination of streams connected with the defendant's sources of water supply.

But it is claimed that there was no proof of any typhoid germs in the water and that, therefore, there is no tenable ground for imputing the typhoid fever to the drinking of the water.

This argument does not commend itself to us as sound. There was proof to the effect that for a long period of time before the outbreak of the typhoid fever epidemic there were discharged into the sources of the defendant's water supply large quantities of fecal and vegetable matter, which the scientific experts testify are indicative of the presence of the bacillus coli and which in turn indicate the presence of typhoid fever germs but not necessarily so. And where there are bacilli coli in any considerable quantity there is a probability of the presence of the typhoid fever germ. Furthermore it appears that the president of the defendant company came before the board of health in response to a communication sent to the defendant by the town clerk relating to the water supply, and made statements relating to the condition of the water before the outbreak of the fever. * * * * * *

From his statement it appears that bacilli coli were found in the tests made of the water after going through the filtration plant of the defendant company.

The plaintiff was not legally required to prove by positive testimony and with absolute certainty that the drinking of the water was the cause of the typhoid fever.

The plaintiff satisfied the burden which the law imposed upon him by proving such facts and circumstances from which it was made to reasonably appear that the drinking of water was the probable efficient cause of the typhoid fever. (Wilkins v. Standard Oil Co., 78 N. J. L. 524.)

It is only where it appears that the injuries were occasioned by one of two causes, for one of which the defendant is responsible but not for the other, the plaintiff must prove such facts and circumstances as will exclude the equal probability of the injury having resulted from the cause for which the defendant is not liable. (Stumpf v. D. L. & W. R. R. Co., 76 N. J. L., 153.)

The present case is barren of any testimony from which a reasonable inference can be drawn that the illnesses of the plaintiff's children were due to any other cause than that of the water supplied by the defendant.

The defendant makes the further contention that the plaintiff's case must fail because the allegation in his complaint is that the illness with which each of his children was afflicted was typhoid fever, whereas it appears by the testimony that it was not true typhoid, but was what is known in medical learning, para typhoid, a much milder form of disease.

We think that it is a matter of no consequence whether or not the illnesses which the plaintiff's children had were true typhoid fever, the crucial question being, whether their illnesses were due to the unwholesomeness of the water supplied by the defendant.

We do not find anything in the defendant's criticisms of the judge's charge or in the exceptions taken to the admission or rejection of testimony in the cause which would warrant a disturbance of the verdict.

The rule to show cause will be discharged.

ACKNOWLEDGMENT.

The opinion from which we quote was handed down by Judge J. Kalisch. It was filed for record by Wm. C. Gebhardt, Clerk of the New Jersey Supreme Court, on April 15, 1915.

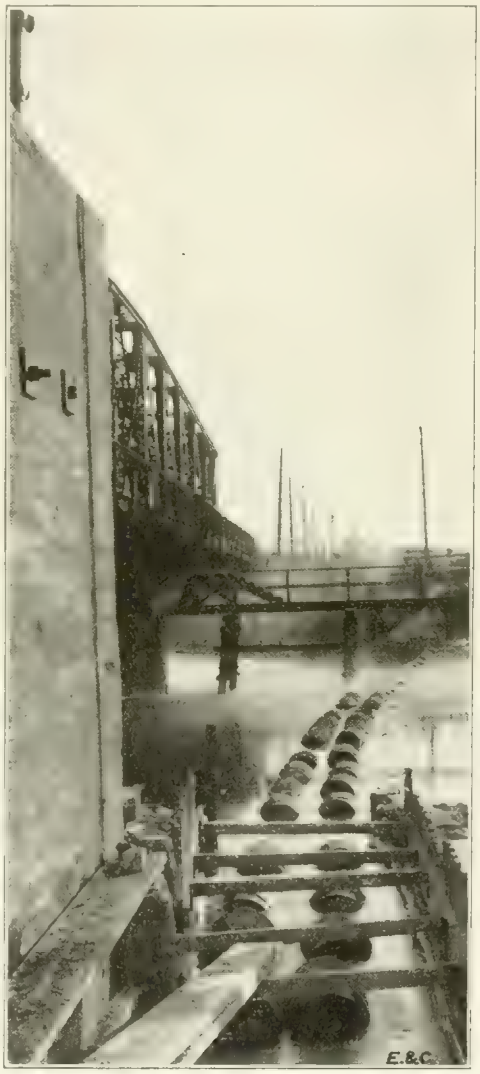
Method of Laying Submerged Water Pipe Line Across Little Calumet River in Chicago.

(Staff Article.)

When it became necessary to lay a water main across the Little Calumet River at 134th St. and Indiana Ave., in Chicago, the department of water pipe extension decided to lay a submerged main of Universal cast iron pipe. This type of pipe was selected because the city's engineers believed that the joints would be sufficiently flexible to permit of the pipe line adjusting itself to the slight irregularities in the stream bed. Another reason for the choice of this pipe lay in the belief that the bolted joints would obviate the possibility of having the pipe pulled apart in case of settlement.

The width of the river at the point crossed is about 160 ft. and the average depth is 25 ft. The stream bed was prepared to receive the pipe by means of a water jet from a fire hose. All obstructions were removed so as to give the pipe line a firm support.

In order to lay this pipe in the bed of the river barrels were provided to float the line at the surface of the stream, as shown in the accompanying view. A small bay or channel was dug on the north side of the river in line with the proposed location of the main, and in this bay the barrels, with the pipe between them, were launched. The barrels were air-tight oil casks and two were lashed to each 6 ft. length of the pipe, which was 12 ins. in diameter. The lashing was passed around the barrels and pipe in such a way as to securely fasten them together. As each length of pipe was added, with the barrels supporting it, the whole line was pushed farther into the river until finally the end of the line reached the opposite shore.



View of Laying of Submerged Water Main Across Little Calumet River, in Chicago, by Means of Floating Oil Casks.

After the pipe line had been floated into the desired position enough barrels were removed to allow the pipe to sink slowly, taking the barrels which were not cut loose down with it. The diver then went down to cut the lashings of the balance of the barrels and allowed the barrels to rise to the surface.

Cofferdams were then built at each end of the pipe and connections were made between the submerged pipe and the city mains at each side of the river. The stream section was laid in December. In February, 1915, the new line was subjected to a test pressure of 100 lbs. to the square inch. All joints were shown to be tight and in good condition.

This pipe line was laid for the city of Chicago, under the supervision of the city engineer's office. The work was under the immediate charge of the department of water pipe extension, of which Mr. R. S. Spalding is engineer. The Universal pipe used was furnished by the Central Foundry Co. of New York, whose interests on the work were looked after by Mr. W. E. Holland of the Chicago office.

Sanitation in Canada.—According to advance notes on a report to be issued by the Commissioner of Conservation on the Water Works Systems of Canada there are 61 sewage disposal plants in operation in Canada. There are 57 inland river systems receiving raw sewage from 159 municipalities. Water supply systems for 111 municipalities still obtain water from streams or bodies of water into which raw sewage has been discharged above the intake points.

Experiences in Metering the City of Boston.

(Staff Abstract.)

At the time the water meter law went into effect in 1908 the city of Boston had about 95,000 service pipes, of which only 5,000 were metered. It had previously been the practice to meter railroads, wharves, large business buildings, hotels and large apartment houses; in fact, practically every business building had been metered for a number of years. No attempt had, until that time, been made to meter premises where water was being wasted continuously and carelessly. The present article describes the results of and some of the experiences in metering domestic consumers.

At first there was no way to forecast whether the introduction of meters would increase or decrease the revenue. It was desired to restrict waste without reducing too heavily the income. Finally it was decided to meter large tenement houses and buildings containing saloons, because it was thought great waste would be found in them. This was true in many cases. It is also true that great waste was later found in small houses.

During the year 1908 only a few meters were set, although under the law about 4,500 old service pipes and all new services should have been metered. In 1909, however, the department hastened to make up for lost time, because of the penalty which the Legislature of 1909 added to the meter act for failure to comply with its requirements. A force of ten plumbers under the direction of a foreman was engaged in setting the meters. One or two plumbers were sent into each district to meter the buildings selected. Each plumber had a helper and a team with a driver; the team carried the men and the stock from house to house, the houses being very often widely separated. This method was used in 1909 and 1910. In 1909 6,584 meters were installed, and 6,615 in 1910.

In 1911 the Public Works Department was created, and under the direction of the Commissioner of Public Works the installation of meters by districts was begun. It was decided to send the larger part of the plumbing force into one district and meter every house. Each district was divided into sections and the men were supplied with meters and fittings of all kinds from a portable storehouse, which was moved with the men from section to section. By this method the work was done more quickly and economically, and, furthermore, important data were obtained.

The first district metered was East Boston, where 5,000 meters were set in the year 1911. In 1911 the consumption in this district was 95 gals. per capita per day; after complete meterage this figure fell to 58 gals. in 1913. This district went under meter rates in 1912. The second district metered was Charlestown, where 4,000 meters were installed in 1912. The per capita consumption in 1912 in this district was 168 gals. In 1913, when fully metered, this figure fell to 107 gals. This district went under meter rates in 1913.

GENERAL EXPERIENCES

Campaign of Education.—By metering every house in a district, the co-operation of the owners was secured and a campaign of education was started among themselves. Everybody wanted to know something about meters. The department co-operated with the residents in every way. Before a district was placed under meter rates each meter was read at least twice, and if leaks were found on the premises the owners were notified in due season. If very bad leaks were found, for sometimes the waste was enormous, and the owner did not stop the leaks, an inspector was detained to hunt him up and inform him of the waste and to advise him further that if the waste was not stopped immediately the water would be shut off. Circulars were distributed throughout the district advising the people that meters had been installed in every house and that it was necessary to watch the fixtures in order that the water bills might be satisfactory, and special notices were printed in the local papers giving the same general information.

Early Opposition.—Much opposition was encountered when the district installation was begun, because of the many wild and extravagant statements of individuals in regard to the meter water bills. No attention had been paid by these dissatisfied individuals to the notices given them of the great waste on their premises. They had become accustomed to ignore the notices of the waste inspectors and, therefore, failed to heed the warning that the premises were under meter rates and that the leaky fixtures would cause large bills. When they received their first meter bill they had their first awakening as to the great quantity of water that was being wasted on their premises. Even after they had received their first meter bill many of these people failed to make the necessary repairs, and received a second and a third large bill. Finally they began to realize that if they were to get normal bills it would be necessary for them to keep their fixtures in order. In each district there were the same general difficulties. Some people in each district refused to admit inspectors or offered some plausible reason for not allowing the meter to be set inside; this was for the purpose of preventing the installation of the meter. But when they realized that every house must be metered they were glad to have the meter installed on the inside in order that they might read the meter and keep control of their consumption.

Multiple Services.—One of the greatest difficulties to overcome was where one service pipe supplied several houses which were built and owned by one man, but now owned by several individuals. To install one meter and render one bill would cause no end of trouble. Therefore the corporation counsel was appealed to, and he advised the department to lay a separate service pipe for each house and meter it, without cost to the owner. Then, again, in private ways two or more houses were supplied from one private main. In following the practice of the department to control underground leaks in private ways the meter should have been installed at the head of the place. However, this would not do, as the department would be unable to determine how much water each house had used. Again the advice of the corporation counsel was sought, and he suggested that the department secure a right of way in these places and assume control over the pipe and services and to set a meter in each house. This was done to the satisfaction of the department, because in case of leaks the department now has the right to make repairs or replace the service pipe with a more suitable one.

Most frequently, and especially in the old houses, the service pipes run the length of the house to the rear under the floor and the plumbing is very complicated. It requires the most careful examination to discover where the branches are located in order that the meter will measure all the water used in the house. Very often the branches are taken off close to the wall, and if a careful inspection is not made the meter may be apparently installed in the proper position and yet not cover important branches.

Very often two and sometimes three service pipes have been found in a dwelling house. Of course, several service pipes are often found in a large building where formerly there were several smaller buildings. Wherever several service pipes are found the department endeavors to eliminate all but one. Sometimes it is necessary to lay one large pipe and abandon the smaller ones. In this way there is but one meter to install and repair and to read, and but one account to open for the building. Generally the department does not abandon the surplus service pipes without the consent of the owner, although it has been done without his knowledge and without any inconvenience to the occupants of the building. The plumbers are expected to make a very careful preliminary inspection of the premises before installing a meter. Needless to say, however, sometimes their inspections are rather faulty and some of the fixtures are overlooked.

After a district has been metered an inspection of each house is made by special inspectors, to make sure that every fixture is covered and also to see that every house has been metered.

Iron pipes, and a great many of them are found, are causing the department much trouble, because after a meter has been installed and the water turned on the owners complain that the supply is insufficient. Of course, it is true that in these cases the supply is very often greatly diminished; and to improve the supply the pipes must be cleaned as thoroughly as it is possible to clean iron pipes.

Many stopcocks had not been used for years until operated by the plumbers when setting the meters, and whenever an owner is obliged to use one and fails to find it in satisfactory condition the department is charged with poor workmanship. There was a wholesale attempt at one time to have the department install new stopcocks where the least defect was found in the old ones; but this, of course, the city refused to do because the department had not damaged them. In many instances the plumbers noticed that the stopcocks were very defective, and instead of shutting the water off in the cellars went outside and shut the water off in the street. This did not prevent the owners from asking for new stopcocks; but when they were convinced that the department men had not used the stopcocks in the cellars they withdrew their claims.

Meter Setting.—On Jan. 1, 1914, the department had 41,168 meters in service, about 36,000 having been installed since 1909; 5,000 of these meters are set in outside boxes in the sidewalk. The meters are generally set in the cellar, either on shelves or in ground boxes, where the meters are protected by wooden boxes 14 ins. deep with a light iron frame and cover. The meters set on the outside are 4 ft. from the surface in concrete boxes with iron frame and cover; these boxes are large enough to allow a man to enter and remove or change the meter without removing the box.

Meters Affected by Frost.—During the year 1912 about 900 meters were affected by the frost; about one-fourth of these were eventually condemned as useless and the others, after repairs of one kind or another, were redeemed for service. In 1913 about 1,600 meters were affected by frost; some were but very slightly affected and others were removed when the pipes in the houses became badly frozen, even though the meters were not affected. In 1912 about 170 meters in outside boxes were affected, mostly in East Boston, where there were about 1,200 outside meters. In 1913 only 30 outside meters were affected.

The city has installed about 20 Hersey Detector meters, ranging from 4 ins. to 10 ins. in size, on lines furnishing water for both fire and other purposes. No other type of meter would be allowed by the fire underwriters.

TABLE I. RESULTS OF METERAGE IN BOSTON.

Year.	No. Services.	No. Meters.	Per Cent of Services Metered.	Population.	[illegible]	[illegible]
1908	94,960	[illegible]	5.7	[illegible]	98,379,300	[illegible]
1909	96,132	[illegible]	12.5	659,110	[illegible]	143
1910	93,780	[illegible]	19.7	674,400	87,346,700	130
1911	95,037	25,206	[illegible]	[illegible]	85,571,500	124
1912	99,700	[illegible]	34.8	[illegible]	90,037,500	125
1913	101,100	[illegible]	40.7	726,975	79,391,600	108

All meters are set by employes of the department. The only work done by contractors is the trenching and backfilling, and the hauling and setting of boxes for outside meters. In addition to the work of repairing and testing meters which have been in service, the department tests every new meter before it is installed. During 1913 4,000 meters were changed, 600 discontinued, 11,000 tested, 4,000 repaired in the shop and 600 in service, and 7,400 meters installed.

Table I gives the number of services, etc., and shows the wonderful results obtained from meters in the past six years in Boston.

In Table I it will be observed that, while the city is only 40.7 per cent metered, the per capita has been reduced from 153 gals. per day in 1908 to 108 gals. in 1913.

Many complaints are received about large bills. The causes are generally defective fixtures, underground leaks, carelessness and cold weather. Underground leaks cause much annoyance to the city and the consumer. They are very difficult to find at times, and the city sends a special inspector to locate them as nearly as possible for the owner. When these leaks are repaired 50 per cent of the excess consumption is allowed. This amount is allowed by all the departments in the country. In no other cases are abatements allowed, although during the past two winters the commissioner has made small abatements on excessive bills caused by very cold weather, and his ground for doing so was because of the many buildings, still unmetered, where great winter wastage occurs.

On the introduction of meterage in Boston the public expected large bills and the city expected a large reduction in its income from the sale of water. It now appears that meters are giving satisfactory bills to the public and, at present, are providing more than enough revenue for the needs of the water department.

ACKNOWLEDGMENT.

The foregoing information is from a paper before the New England Water Works Association, published in the March, 1915, Journal, by Mr. James A. McMurray, engineer in charge of the income branch of the Boston water department.

A Comparison of Four Methods of Estimating Future Population of a City.

(Staff Abstract.)

For a variety of reasons municipal and sanitary engineers are frequently called upon to estimate the population of a city, or of a section of a city, at some future time. All such estimates are based, largely, upon the past rate of growth. Special conditions tending to increase or decrease this rate must also be considered. It is not always safe to apply percentages based on past growth in determining future growth, for with an increasing population the percentage growth usually decreases although the yearly increment be constantly increasing.

The present article considers four methods of estimating future growth and compares their application to a given case. These methods are as follows: Arithmetical progression; comparative; incremental increase; and geometrical progression.

Arithmetical Progression Method. — This method is applicable only in rare cases and almost uniformly produces estimates which are too low. The method, as its name implies, involves the assumption that the future rate of increase from year to year will be constant, and the same as has obtained in the past, or for some period which may be selected at the choice of the computor.

Comparative Method. — The comparative method involves the selection of cities, similarly situated, whose population, say 20 years ago, was practically the same as the present population of the town under study. The past growth of such towns is then taken fairly to represent the probable future growth of the one in question.

Incremental Increase Method.—By the incremental increase method, the population of a town by decades is ascertained as far back as records have been kept. The actual gross increase in population from decade to decade is determined. Then the increase in the increase is determined, or the increment of increase for each decade. The actual increase as determined for each decade is averaged, and also the increment of increase. In making the estimates of future population, the population at the end of the first future decade is obtained by adding to the present population the average increase plus the average increment per decade thus found, and the future population at the end of the second decade by adding to the estimated population at the end of the first future decade, the average increase, plus twice the average increment, and so on.

Geometrical Progression Method.—The geometrical progression method involves the determination of the compound rate at which the population of a city has increased in the past, then applying this compound rate to the present population, to determine the future growth.

COMPARISON OF METHODS.

The curves on Fig. 1 give the results of applying each of the four methods outlined to the population of a typical city. The population between 1880 and 1910 as expressed by the curve is that returned by the census. The populations from 1910 to 1930 are those computed by the four methods.

It will be noted that the incremental increase method is about a mean of the several methods, and experience has shown that it frequently falls in this way in towns of normal growth. No single method, however, is applicable to all conditions and judgment must be exercised in estimating future population.

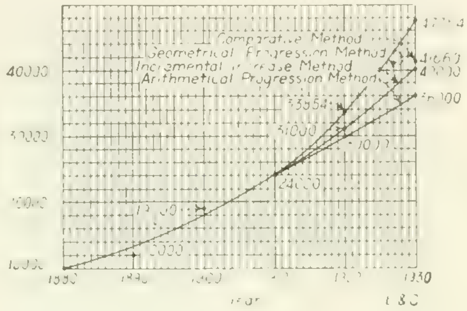


Fig. 1. Diagram Showing the Past, Present and Probable Future Population of a Typical City as Determined by Four Methods.

ACKNOWLEDGMENT.

The foregoing matter is based upon a paper on Pipe Distribution Systems, by Nicholas S. Hill, Jr., published in the Journal of the American Water Works Association for March, 1915.

State Regulation of Municipally Owned Water Works in Wisconsin.

(Staff Abstract.)

The propriety of regulation of municipally owned plants is at once apparent when it is borne in mind that the question of service rendered is of more importance than the rates charged. The following discussion of the subject is limited to the regulation of municipally owned water works in Wisconsin. On June 30, 1914, there were 26 privately owned and 163 municipally owned water works in Wisconsin.

Local managements do not, as a rule, understand the principles underlying the making for fair and equitable rate schedules. The commission in Wisconsin requires that each utility submit schedules of rates for approval. A great many so submitted are based on erroneous principles, as noted in the following case. In January, 1913, a municipality submitted the following schedule for water rates:

	Per 1,000 gals.
1,000 gals. or less per month.........	$0.60
1,000 to 2,000 gals. per month.........	0.50
2,000 to 3,000 gals. per month.........	0.40
3,000 to 4,000 gals. per month.........	0.30

Minimum charge $7.20 per year.

This schedule appears to be based on equitable principles; apparently there is a fair minimum charge and the rates to the consumer decrease as his consumption increases, but if these rates be plotted into a curve there at once appears a woeful amount of discrimination. If consumers "A," "B" and "C" use 2,000, 2,500 and 3,325 gals. respectively, they each pay $1 per month. If "A," who pays $1 for 2,000 gals., uses 2,100 gals., he falls into the second group and pays only 84 cts. Therefore, by consuming 2,100 gals. instead of 2,000 gals. his bill becomes 84 cts. instead of $1.

The above is simply an illustration recited as a type of what the smaller plants, whether private or municipal, must contend with largely because of inability to employ expert advice.

SERVICE.

Efforts have been made to prescribe equitable service requirements with respect to the operation of water plants and tentative rules have been drawn, but thus far no definite instructions have been issued. High standards of service have, however, been insisted upon. Briefly these requirements are: an adequate supply of good, pure water, accuracy of meters, and adequate provision for fire protection.

In one instance complaint was brought before the commission of the condition of the water supplied by a municipal water plant in a large city. After investigation the commission decided that it was necessary to seek an entirely new supply. The water had been taken from a river and pumped into the mains without filtration. The commission made extensive investigations and discovered that a very satisfactory supply of water could be obtained from wells driven on some vacant land within a short distance of the city. The city was required to purchase this land, drive the wells and install a new pumping system with the result that it now has a very good sanitary supply of water.

TABLE I.—NUMBER OF WATER PLANTS IN WISCONSIN MAKING GOOD, FAIR AND POOR REPORTS TO THE RAILROAD COMMISSION ON JUNE 30, 1914.

	Private				Municipal			
Class.	G.	F.	P.	Total.	G.	F.	P.	Tl.
A	7	1	1	9	5	6	2	13
B	3	1	4	8	8	9	20	37
C	2	0	0	2	8	8	8	24
D	1	1	1	3	7	22	22	51
Cond.	2	1	1	4	15	14	9	38
Total	15	4	7	26	43	59	61	163
Per cent...	58	15	27	100	27	36	37	100

Tables II and III show the financial data with respect to the municipal plants making the reports referred to in Table I.

TABLE II.—SUMMARY OF FINANCIAL DATA OF MUNICIPAL WATER UTILITIES IN FOURTH-CLASS CITIES AND VILLAGES* JUNE 30, 1914.

	Property and plant.	Operating revenues.	Operating expenses.
Good reports....	$1,354,879	$147,881	$ 86,319
Fair reports.....	2,109,048	238,797	158,062
Poor reports.....	1,481,500	172,495	104,584
Total	$4,945,427	$559,173	$348,965

*Twenty-five cities are omitted because of incomplete reports or unavailable data.

TABLE III.—SUMMARY OF FINANCIAL DATA OF MUNICIPAL WATER UTILITIES IN CITIES OF 10,000 POPULATION OF OVER, JUNE 30, 1914.

	Property and plant.	Operating revenues.	Operating expenses.*
†Good reports..	$9,652,303	$1,171,884	$357,367
Fair reports....	2,342,542	202,969	90,764
Poor reports...	726,931	96,570	41,261
Total	$12,721,776	$1,471,423	$489,392

*Excludes interest, depreciation and taxes.

†Includes Milwaukee, the values for which are more than three-fourths of the total.

UNIFORM ACCOUNTING SYSTEM.

Proper accounting aids in the understanding of operation conditions which is essential to the making of fair and equitable rates. All water utilities in Wisconsin are required to keep accounts according to certain prescribed forms. The forms required vary with the class of utility and with the size of the community served. In general, class A reports are required from cities of 10,000 population or over; class B reports from cities with a population of from 3,000 to 5,000; class C reports from cities with a population of 1,800 to 3,000; class D reports from cities and villages with a population of 700 to 1,800; and a report called the "condensed" report for utilities in towns and villages having a population less than 700.

A great deal of objection is raised by municipalities in Wisconsin against these requirements for the keeping of uniform records, due largely to a lack of appreciation of their value for the purpose for which they are intended. Little difficulty has been experienced by the commission in persuading the private utilities to keep such records properly, but some of the municipalities have been hard to convince. Several years ago one city in Wisconsin, having a population of about 17,000 people, took over its water plant from a private concern as permitted under the provisions of the public utilities law. The commission has ever since been trying to induce the city to keep accurate operating records as well as construction costs. Recently a complaint on rates was made against the city; the engineers visited the place to obtain records of construction costs and found the bookkeeping in very poor condition. All items of expense of the city, including water works and construction, operation, etc., were on consecutively numbered vouchers. In order to determine what had been spent for construction and operation of the water plant it was necessary for the engineer to look through every voucher passed by the city in the years since the plant was taken over. The cities do not appear to comprehend the fact that accurate records of the financial transactions of the utility are necessary as a basis for the determination of equitable rate schedules.

There have also been before the commission many other cases of a similar nature which it was found impossible to handle in a satisfactory manner because of lack of proper operating statistics. This question of proper operating data is in a sense independent of the question of state control, but without some centralized regulating body requiring these reports there is very little reason to think that either municipal or private utilities will keep records in such form as to be of use for these purposes.

The reports received by the Railroad Commission of Wisconsin from various utilities for the year ending June 30, 1914, have been divided into three classes—good reports, fair reports, and poor reports. These are given in Table I for water plants, separating between private and municipally owned properties and further separating as between the various classes of utility according to the size of the city served.

From Tables I-III it is shown that in the municipally owned water utilities in fourth class cities and villages 74 per cent of operating revenues are in plants from which unsatisfactory reports are received; and in the municipal water utilities in cities of 10,000 population and over, 21 per cent of operating expenses are in plants from which unsatisfactory reports are received. This latter per cent would be considerably higher were it not for the fact that the city of Milwaukee makes a good report and its values are some two-thirds of the total values in the entire group.

Recently the commission's accounting department has been giving a great deal of assistance to municipalities as well as private owners of utilities for the purpose of starting them out on a proper accounting basis. It is found that when not required to do so by the commission, municipal utilities seldom keep records in proper shape for adjustment of rates. Construction costs are confused with operating expenses; in many cases no distinction is made between repairs and replacements. Many times the records of the utilities are not separated from those of the general business of the city as was illustrated in the case above cited. Not only is it impossible from such records to make a fair determination of the cost of the different classes of service but even the total cost of the service cannot be obtained. Such records must be kept properly whether rates are to be controlled by the central commission or by the municipality itself. Under supervision of the Railroad Commission of Wisconsin uniform accounting is insisted upon and is being obtained.

In order to illustrate an important use to be made of operating statistics there is given Table IV, showing the total operating expenses in dollars per 1,000,000 gals. pumped for Class A municipal water utilities, taken from the annual reports for the fiscal year ending June 30, 1912.

TABLE IV.—WISCONSIN MUNICIPAL WATER UTILITIES—CLASS A.—DETAILED AND TOTAL OPERATING EXPENSES IN DOLLARS PER MILLION GALLONS PUMPED FOR YEAR ENDING JUNE 30, 1912.

Location of company.	Million gallons pumped.	Total pumping.	Total distribution.	Total commercial.	Total general.	Total undistributed.	Total operating expenses.
Appleton	513	$16.58	$2.85	$0.62	$1.75	$0.75	$22.15
Eau Claire	730	7.80	5.18	2.12	1.31	.55	16.96
Kenosha	1,161	11.50	3.89	1.21	1.23	.17	18.00
La Crosse	1,025	15.91	5.05	.39	.84	.34	22.53
Madison	688	38.21	6.86	4.50	2.14	.61	52.32
Manitowoc	332	19.51	5.90	.38	1.88	.77	28.44
Milwaukee	17,024	6.69	3.66	3.32	1.34	.90	15.91
Sheboygan	1,121	11.52	2.62	.33	2.54	1.17	18.18
Watertown	304	25.25	6.99	2.23	4.35	.86	37.45
Waukesha	264	54.59	27.47	.33	7.38	....	91.67
Wausau	841	12.64	2.07	....	1.18	.38	16.60
Average	1,495	$20.94	$5.53	$1.85	$6.05	$0.89	$35.32

Table IV shows the total cost per 1,000,000 gals. pumped as well as the various items which compose this total, such as cost of pumping, distribution, etc. This has been determined upon a uniform basis and shows the particular plants which are operating at a cost far above the average. In one case the total cost per 1,000,000 gals. pumped is $91.67 and in another $52.32. The normal cost exclusive of these two plants is approximately $25 per 1,000,000 gals. pumped. These figures are of course not conclusive evidence that the two plants mentioned are being inefficiently operated, but it opens a line for careful investigation of these plants. Add to the above a definite knowledge of local conditions surrounding each situation and it is then possible to make a proper decision in each case. Such methods of keeping records permit an investigation not only of the total actual cost but of each particular item of cost, which thus permits the matter to be attacked in the necessary detail. In the accounting required by the commission the accounts are still further subdivided in order to assist in detecting the various items which go to make up the particular cost in each class.

In a case in which water rates were under investigation comparisons with other utilities showed that the cost of fuel used for pumping was considerably above normal. In that way it was determined that a reduction of about 40 per cent should be made. As a result this reduction was actually made in computing rates. Since that time the expenses for fuel in the operation of this plant have been within 5 per cent of the amount determined upon by the commission.

These illustrations of course are applicable to municipal as well as to privately owned utilities and are cited for the purpose of emphasizing the necessity of accurate accounting methods.

The commission has had before it many cases involving rates and service of municipal plants. An investigation of the various reports and files of the commission shows that these complaints are on a variety of subjects, such for instance as the following: Excessive and unwarranted rates, unsatisfactory water resulting from failure to flush out mains, sand and dirt in the mains, unsanitary supply, inadequate supply, lack of pressure for fire protection, entire discontinuance of service, discrimination between metered and flat rate customers, unjustifiable rates, application for increase in rates, application for equalization of rates, application for adjustment of individual rates, installation of meters and proper manner of paying for same, refusal to permit use of certain types of meters, inequitable distribution of rates, refusal to furnish rates, refusal to extend water mains, classification of certain services, complaint against council for changes in rates, excessive charges due to leakages, and application for valuation for purchase of works.

ACKNOWLEDGMENT.

The foregoing matter is from a paper before the Illinois Section of the American Water Works Association by C. M. Larson, Chief Engineer, Wisconsin Railroad Commission.

BUILDINGS

A Mast and Boom Concreting Plant.

Contributed by R. C. Hardman, Colorado Springs, Colo.

A unique plant for mixing and placing concrete at Fort Crockett, Galveston, Tex., is illustrated in Fig. 1. The work under construction consisted of a large number of concrete buildings, placed along a line about 2,000 ft. long. As the buildings contain no massive concrete, but consist mainly of thin walls and floors, a portable type of plant was desired in preference to chuting from a number of towers. A small tower and plant, supported on a flat car, was first considered, but it was finally decided that the plant shown in Fig. 1 would be more efficient, due mainly to the elimination of chutes and the consequent loss of time which would necessarily result in changing them.

By referring to the illustration it will be noted that the plant consists essentially of a braced mast with boom attached. The mast, which is a 12x12-in. timber, is pivoted at both top and bottom so that it can be turned through an angle of about 300°, or until it comes in contact with the inclined braces. The boom, which also is 12x12 ins., in section, has a length of about 60 ft., being rigidly connected at right angles to the mast, at a height of about 45 ft. It is supported from the top of the mast, at three points along its length, by means of rods equipped with turnbuckles. Along the top of the boom there is a steel track upon which the trolley runs (see Fig. 1).

The mast is mounted at the apex of a large triangular frame, the inclined braces from the top of the mast being carried to the other apices of the triangle. This supporting frame is carried on three wooden trucks, located at the apices of the frame, each truck being fitted with four solid wooden wheels of very wide tread.

The equipment on the frame consists of a "Smith" mixer, mounted near the apex of the triangle at the base of the mast, together with a hoisting engine and boiler and a crude oil tank, placed at the base of the triangular frame. The boiler furnishes steam both for the mixer and for the hoist.

In operating, the bucket is placed under the discharge end of the mixer. After being filled, it is raised to a height just sufficient to clear the forms and other obstructions, and the trolley then run out along the boom the desired distance. The bucket is then lowered and dumped, after which it is brought back to the mixer by reversing the operations. It was necessary to use great care in performing these operations, especially when the bucket was suspended at a considerable distance from the trolley (as in Fig. 1). If the horizontal motion of the trolley was started or stopped too quickly a dangerous swinging of the bucket resulted.

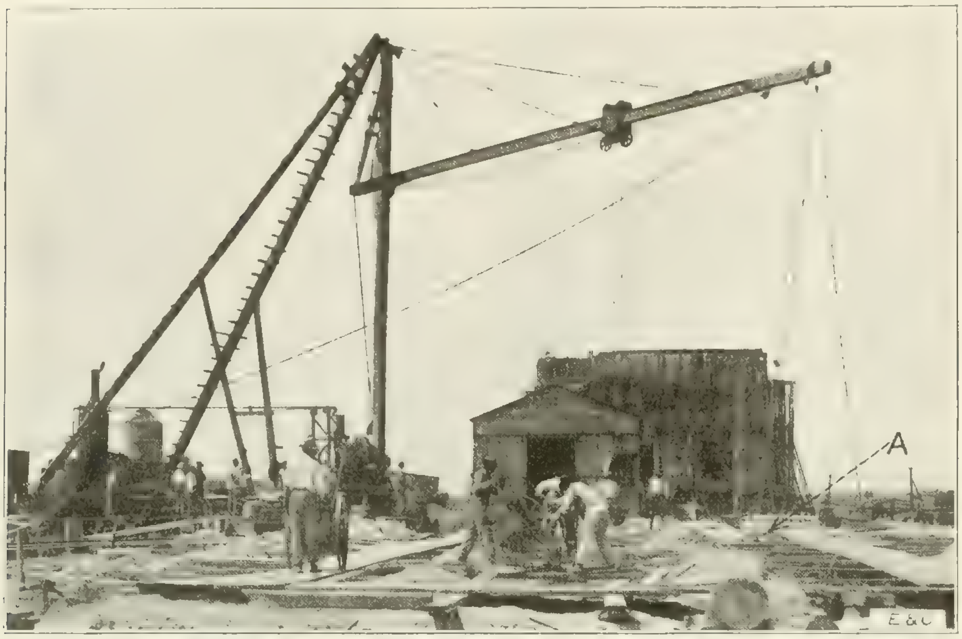


Fig. 1. View Showing Mast and Boom Concreting Plant in Operation—Note Arrangement of Lines and Positions of Hoisting Engine and Mixer.

The arrangement of the cables, by which the bucket and trolley are operated, is shown in the illustration. The boom is moved laterally by a modified tag line. By means of this arrangement one man can handle the boom with ease, by holding the line at the middle bight, at the point where it is shown tied to the stake (at A, Fig. 1). The entire plant is moved by block and tackle attached to a dead man and to the nigger-head of the hoist.

The plant is also used to drive piles, a pair of leads and a steam hammer being suspended from the boom for this purpose. After being placed the leads are held in position by spuds. With this arrangement it is easy to spot the hammer in position for driving the piles.

The equipment described was designed and used by James A. McGonigle & Son, contractors, of Leavenworth, Kan.

Construction of Column Piers in Western Union Telegraph Building, New York.

Contributed by W. F. Schaphorst,
New York City.

In constructing the piers for the columns in the east wing of the Western Union Telegraph Co. building, corner Dey St. and Broadway, New York, the contractor departed somewhat from the methods used in constructing the foundations for the other two wings. In these wings air caissons were used to reach bed-rock in every case. In building many (although not all) of the piers in the east wing, however, a considerable quantity of 7-in. straight web "Lackawanna" steel sheet piling, in 18-ft. lengths, was used in the following manner:

After sinking the outer water-tight concrete foundation walls to bed-rock the material over the entire area was excavated to a depth of 60 ft. below the street level. From this level the steel sheet piling was driven through the soft soil into hardpan, to form eight piers, the average size of which was 8 ft. 6 ins. square.

After the piling was driven the enclosed material was excavated, down to the surface of the hardpan, the piling being braced as the excavation proceeded. Upon reaching hardpan wooden cofferdams were driven to bed-rock, the material being excavated and the cofferdams braced. Wooden forms were then built within the cofferdam walls, and the concrete piers for the interior columns were poured. Figure 1 is a view of a portion of the excavated area showing the manner of constructing these piers. The view also shows some of the caissons in place and a portion of the system of timber bracing used within the excavated area.

The piling wall shown adjacent to the concrete pier in Fig. 1 encloses an area 5x10-ft. in plan, and was driven as a form for an engine foundation pier. It did not extend to bedrock, and no wooden form was used in constructing this pier. A total of seven such piers was built for engine foundations.

In some cases the steel sheet piling was driven, pulled and redriven five times without deforming it. Although boulders were sometimes encountered no difficulty was experienced in driving the piling, and an even alignment was easily maintained. The piling was pulled by the use of derricks.

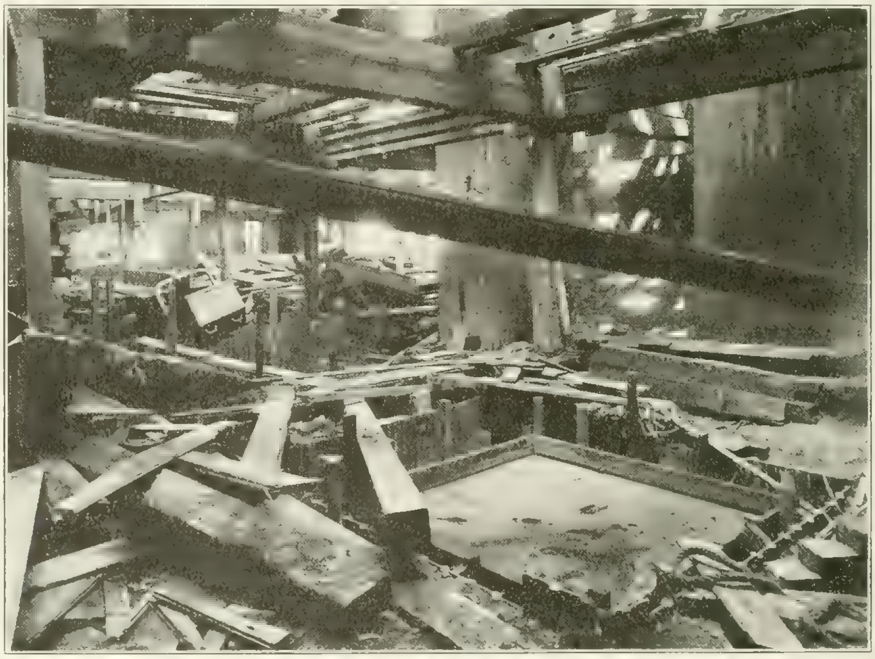


Fig. 1. View Showing Manner of Constructing Piers in Western Union Telegraph Building, New York—Pier Shown Is 60 Ft. Below Level—Also Note Caissons and Bracing.

Scientific Methods of Management and Their Application to Construction Work.

(Staff Abstract.)

Although managers of shops and factories have for some time given considerable attention to scientific methods of management, only a comparatively few contractors have applied such methods to construction work. There is, however, a marked tendency on the part of contractors to apply, at least in part, scientific principles of management to their construction operations, as it is being realized that economics in construction methods are necessary to meet increases in the wages of skilled and unskilled labor. The following data, which explain the details of a system of scientific management applicable to building construction, will be found of value. They were abstracted from a paper by Sanford E. Thompson and William O. Lichtner, presented before the Western Society of Engineers. In our abstract we have omitted much of the discussion of principles, but have emphasized the application of these principles.

Improvements in construction methods involve:

(1) Introduction of improved machinery where machinery is economical.

(2) Introduction of improved methods of handling labor and machinery and standardizing these methods.

(3) Reduction in waste of material.

(4) Elimination of unnecessary operations of the workmen.

(5) Relieving the skilled worker of duties which the unskilled man can do.

(6) Increasing the productive capacity of each man.

The most convincing proof of the value of any plan is the fact that it has been successfully carried out. As a result of actual experience in construction work it has been proved that scientific methods of construction give:

(a) Low unit costs.
(b) High wages to the workmen.
(c) Completion of work in a minimum time.
(d) Uniformly high quality of work.

When a work is planned out and handled systematically, greater skill and effort is required on the part of the management, and the question naturally arises whether the results produced are simply smoother working of the labor mechanism, or whether it actually pays in dollars and cents.

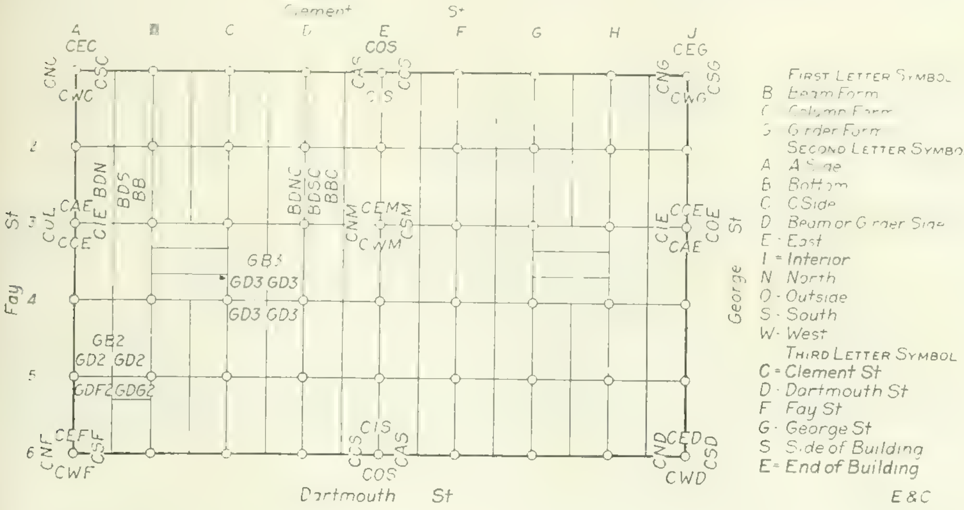


Fig. 1. Key Plan for Form Work for Reinforced Concrete Building Showing Notation Used.

METHODS.

Cost keeping has been developed recently by contractors to a marked degree and the advantages of knowing what each part of the work is costing from day to day is apparent in providing an opportunity to follow up the heads of the various branches where costs are running high. This, however, is really the limit of its effectiveness since a mere record of costs does not in any way show how to handle the work in a less expensive manner.

The aim of scientific management is to find the best and cheapest way to accomplish a piece of work and provide means for doing it in this fashion.

Formerly much construction and even shop work were carried on with no detail structural drawings, and many of the directions were given by word of mouth. Nowadays a question as to whether or not the making of designs or construction drawings reduces the cost of work, would be considered absurd since the economical advantages of the drafting room are obvious. Yet we frequently handle construction work in a most haphazard way with no definite plan and no definite arrangement of men and materials except as the occasion requires from day to day or from hour to hour.

To handle work systematically it is necessary to:

(1) Plan the work in advance.
(2) Determine the best methods to employ in construction.
(3) Lay out individual or gang work for the various men.
(4) Train the men to accomplish their duties in the best and shortest way.
(5) Provide an incentive so that each man will be glad to do a full day's work without being driven to it.

Many construction companies are carrying out a part of these principles, but few are developing all of them with anything like the effectiveness possible.

To illustrate in detail the methods that have proved successful, we may take the construction of a reinforced concrete building. To confine still further the description and give more details of the work, we will consider simply the making of the form work. In taking this special case, however, it is recognized that the same principles have been found by experience to apply to various other types of engineering construction both in private contract and municipal work. As a matter of fact, the fundamental principles are identical with the principles required in shop work.

In discussing in this paper the phases of the work, emphasis is placed on methods that are in whole or in part comparatively new rather than those which are basic in all work regardless of the method of management adopted. These newer methods involve special construction designs, planning and routing the work, standardizing methods, and a study of time in which each small element of the work should be done.

In any construction company the duties of the engineer, aside from his relation to the financial interests, may be two-fold:

(a) Duties involving the structural design and engineering features of the construction.
(b) Engineering which relates specifically to the construction plant and the methods of handling the details of the construction work.

Instead of both of these functions devolving on one man, the chief engineer, the duties in a large construction company can best be separated, the chief engineer handling what may be termed civil engineering while the treatment of the construction organization and methods in full detail requires the services of a new man termed the "production engineer." It must be understood that his services do not entail an extra cost to the job because his duties actually replace the work usually done by men less competent to perform the high class of work required, and result in improvements in methods and cutting down the number of employes so as to save a far greater amount than the salary of this officer. In a company handling a small amount of work one man may serve both functions. In another case a member of the construction company may act as chief engineer.

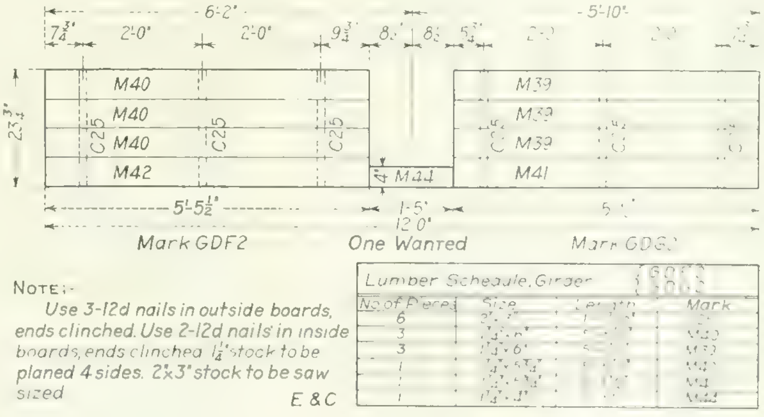


Fig. 2. Typical Girder Form Details for Reinforced Concrete Building.

Design.—Under scientific methods of management the work of the designing engineer is increased because in order to lay out properly the work he must prepare detail drawings or sketches for the concrete, the reinforcing steel, and the form work. In other kinds of construction similar detail designs have been found economical. For example, in house construction complete framing plans should be made. It is appreciated that many construction companies follow such methods to a limited extent, but it is the object of this paper to show how these may be extended with economy of cost. A more extended discussion of the details of certain features of this work is taken up further on in this paper.

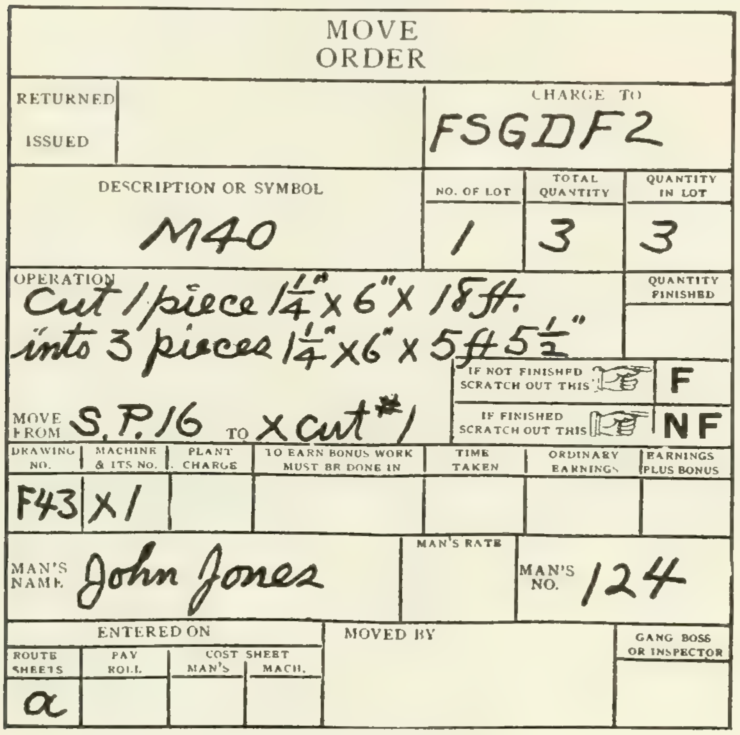
The making up of all material lists follows the making of these detail sketches, the lists being worked up in such a manner that they can be used not only for ordering materials but for checking their receipt upon the job. In addition to this work, the designing engineer must, with the advice of the job superintendent, actually design on paper the plant which is to be built for handling the construction.

These various features of design, that is, all of those that relate to the method of work, handling of materials, and listing the materials, are under the supervision of the new production engineer.

Planning and Routing.—One of the most important features under the new type of management is what is termed the "routing" of the work, which is also under the supervision of the production engineer. This involves planning out in detail and in writing all work connected with the construction of the building just as we plan the structural design and for a similar purpose, usually to save time of the workman and insure a higher quality of work. This means planning just how each part of the work is to be done, in what sequence the various parts of the work will follow each other, the size of gangs of different trades required from day to day to get the work done in schedule time, and the schedules for ordering materials so as to have them on hand when required. After the work has all been planned, graph charts are made for the home office and for the job, designed so that the home office and the superintendent can see at a glance just how far ahead or behind a job is at any time.

It takes time to plan out the work in detail, and may even slightly delay starting the actual construction, but it pays in the long run, for when the work does start it will go along far more quickly and at a much less cost than if it had been done by ordinary methods. Experience has proved what a short sighted and costly policy is that sometimes followed by construction companies, which requires the superintendent and some workmen to be on a job 24 hours after the contract is signed to indicate their good will to finish the work in the minimum length of time.

As the name indicates, the route man directs the movements of all materials of which the structure is to be made, in minute detail, so that they shall be delivered at the right place with a single handling and at the minimum of expense. In order to do this he must be a practical construction man of experience, who possesses the ability to visualize the job from beginning to end and to record this in such a manner that the superintendent and field force can carry out the details as planned. The location of the jobs with reference to the home office and their size determines whether all the routing can be done by one route man at the home office or whether only the main details shall be handled there and the other details consigned to a job route man. In the case discussed the job is assumed to be handled direct by the route man at the home office.



MOVE ORDER

RETURNED ISSUED		CHARGE TO FSGDF2

DESCRIPTION OR SYMBOL	NO. OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
M40	1	3	3

OPERATION Cut 1 piece 1¼" x 6" x 18 ft. into 3 pieces 1¼" x 6" x 5 ft 5½"

QUANTITY FINISHED

IF NOT FINISHED SCRATCH OUT THIS ☞ F

IF FINISHED SCRATCH OUT THIS ☞ NF

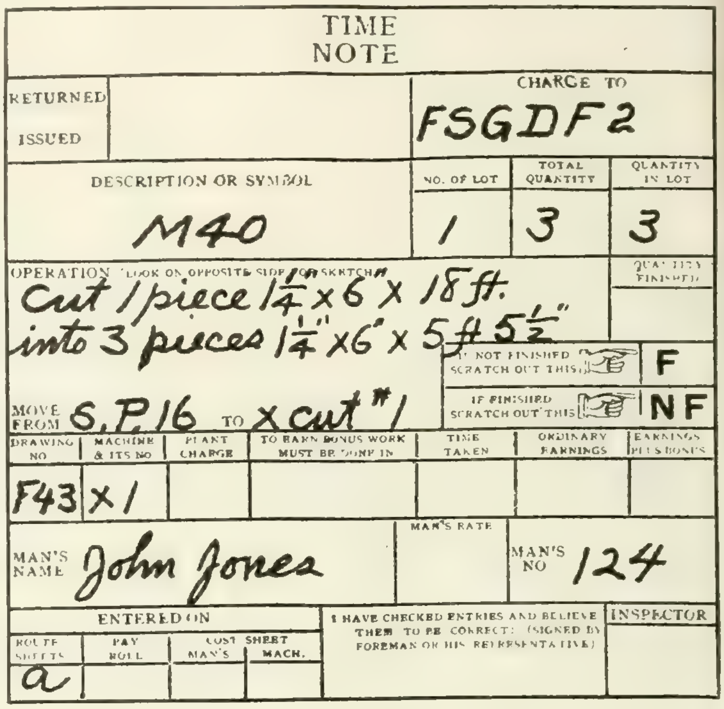
MOVE FROM S.P.16 TO x cut #1

DRAWING NO.	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	x1					

MAN'S NAME	MAN'S RATE	MAN'S NO.
John Jones		124

ENTERED ON				MOVED BY	GANG BOSS OR INSPECTOR
ROUTE SHEETS	PAY ROLL	COST SHEET MAN'S	MACH.		
a					

Fig. 3. Move Ticket for Piece M 40.



TIME NOTE

RETURNED ISSUED		CHARGE TO FSGDF2

DESCRIPTION OR SYMBOL	NO. OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
M40	1	3	3

OPERATION (LOOK ON OPPOSITE SIDE FOR SKETCH) Cut 1 piece 1¼" x 6" x 18 ft. into 3 pieces 1¼" x 6" x 5 ft 5½"

QUANTITY FINISHED

IF NOT FINISHED SCRATCH OUT THIS ☞ F

IF FINISHED SCRATCH OUT THIS ☞ NF

MOVE FROM S.P.16 TO x cut #1

DRAWING NO.	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	x1					

MAN'S NAME	MAN'S RATE	MAN'S NO.
John Jones		124

ENTERED ON				I HAVE CHECKED ENTRIES AND BELIEVE THEM TO BE CORRECT: (SIGNED BY FOREMAN OR HIS REPRESENTATIVE)	INSPECTOR
ROUTE SHEETS	PAY ROLL	COST SHEET MAN'S	MACH.		
a					

Fig. 4. Time Ticket for Piece M 40.

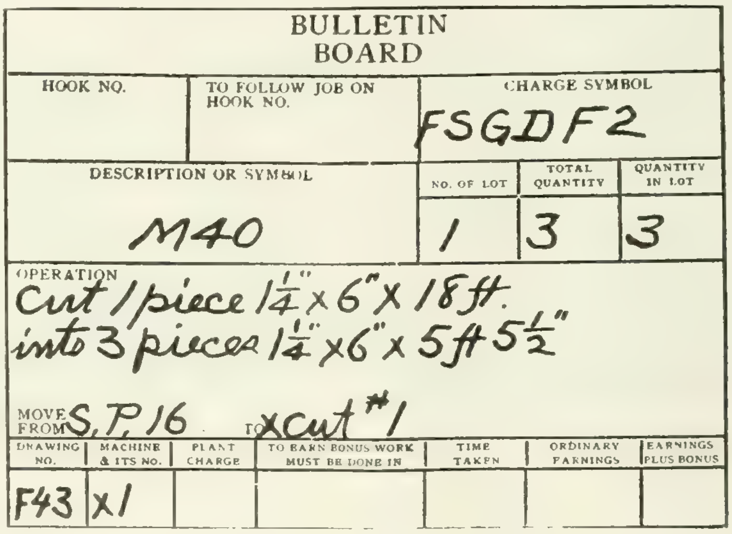
The route man first visits the job with the job superintendent, assuming that the production engineer and designing engineer are already familiar with the project, and by a careful study of the surroundings decides on the location of the job office, mill saws, stock piles, tool sheds, track sidings for railroad cars, location of concrete mixers, and any other necessary things which will need ground space. He then works up a ground plan on a fairly large size scale showing the location of all features of the plant. This preliminary planning saves considerable money over the old plan of waiting for materials to arrive on the job before considering the placing of them.

Take, for example, the locating of the lumber piles. The route man receives from the designing engineer the schedule of the lumber to be used in the form work. From this list he lays out the piles of lumber, separating each thickness, width, and length, and designates on the ground plan where each pile is to be placed so that when the lumber arrives on the job every stick of lumber is carried direct from the car or the wagon to its proper place and located as conveniently to the sawmill as practicable. When a stick 1½x8 ins.x 12 ft. long is wanted it will be found in a certain pile. This saves much rehandling of lumber and much lost time hunting for a piece of a certain size, to say nothing of the loss of material and time cutting up large stock because suitable small stock is buried under it.

The kind and quantity of equipment on any particular job is generally determined by the available equipment owned by the company, but it often pays to rent or buy a certain equipment in order to get the work done more quickly or at a cheaper cost. For instance, it is usually found to be a paying proposition to install a power-driven circular saw on any job using considerable form work, because of the saving in time and lumber. A consideration of such matters involves also the best methods of operating.

From the details furnished by the designing engineer, the route man plans the work and has the necessary material issued, and the operation tickets made out, as described further on in this paper. In this way the material lists gotten out by the designing engineer are all checked before the job is started. The route sheets and graphical charts next made up are the key to the successful carrying on of the work in accordance with the route man's plans.

The route man sends to the job superintendent the field plan showing the location of the job office, mill saw, stock piles, etc., so that he can do all preliminary work while the route man is arranging the routing. The superintendent gets together his organization of foremen, job-order-of-work men, office and engineering force. The plans, route sheets, graph chart and tickets are sent to the job as soon as finished. These must be studied carefully by the job superintendent, and he must enforce the work in every detail according to schedule. This does not, as might appear at first thought, take the individuality away from the superintendent, but simply relieves him of much detail which can better be handled by the route man in the office. The route man, of course, must keep in close touch with the superintendent and avail himself of his experience in all matters while the plans are maturing. Having planned the work, it is absolutely necessary for the job superintendent to follow instructions explicitly, otherwise confusion will arise.



BULLETIN BOARD

HOOK NO.	TO FOLLOW JOB ON HOOK NO.	CHARGE SYMBOL
		FSGDF2

DESCRIPTION OR SYMBOL	NO. OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
M40	1	3	3

OPERATION Cut 1 piece 1¼" x 6" x 18 ft. into 3 pieces 1¼" x 6" x 5 ft 5½"

MOVE FROM S.P.16 TO x cut #1

DRAWING NO.	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	x1					

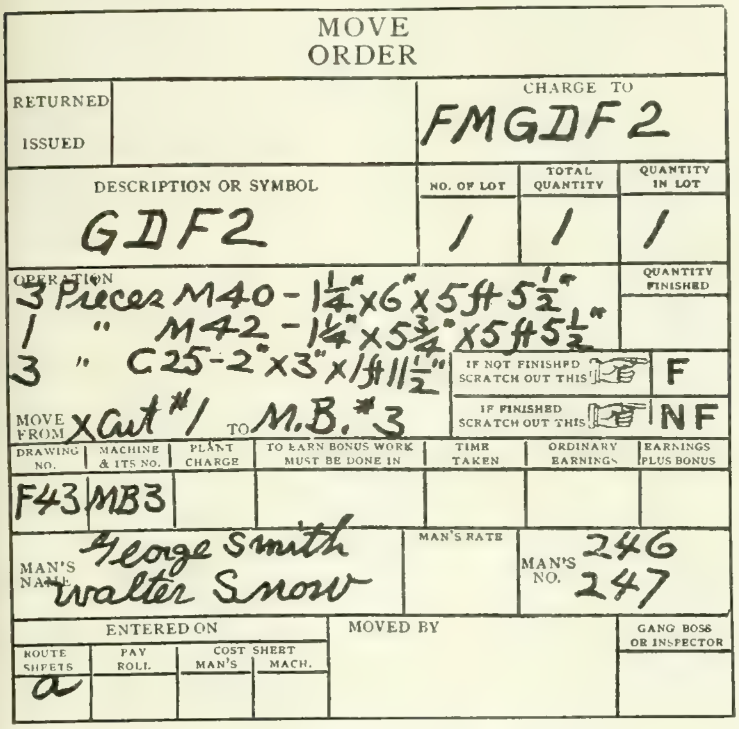
Fig. 5. Bulletin Board Ticket for Piece M 40.

It is evident that the duties of the job superintendent under the new methods are somewhat changed, in fact the title "superintendent" might well be changed. He is not given free hand as when he was allowed to run the job pretty much according to his own notions. Formerly, so long as his costs were within the original estimate, he was not taken to task. This practice is not fair; in fact, one may cite case after case where the superintendent has been commended for some good costs he has obtained and then reprimanded for high costs on some other job which were not due to his methods of management but to the estimator figuring the cost on the first job too high, while on the second job he did not allow enough for the special construction or difference in design. Under the newer methods of management such a feature as the design of the form work is standardized and separated into units so that the cost of the labor on one job is accurately comparable with that on another job.

The job superintendent is responsible for the correctness of the work. He is the construction company's representative who deals with the owner and architect and settles all small differences which arise on every job.

DETAILS OF OPERATION.

To handle properly on the job such work as form making, plans showing the design must be given to the individual carpenter, means must be arranged for providing necessary material, and the quantity of work done by each man must be recorded.



MOVE ORDER

RETURNED ISSUED		CHARGE TO FMGDF2

DESCRIPTION OR SYMBOL	NO. OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
GDF2	1	1	1

OPERATION
3 Pieces M40 - 1¼"x6"x5ft 5½"
1 " M42 - 1¼"x5¾"x5ft 5½"
3 " C25 - 2"x3"x1ft 11½"

QUANTITY FINISHED

IF NOT FINISHED SCRATCH OUT THIS ☞ F

IF FINISHED SCRATCH OUT THIS ☞ NF

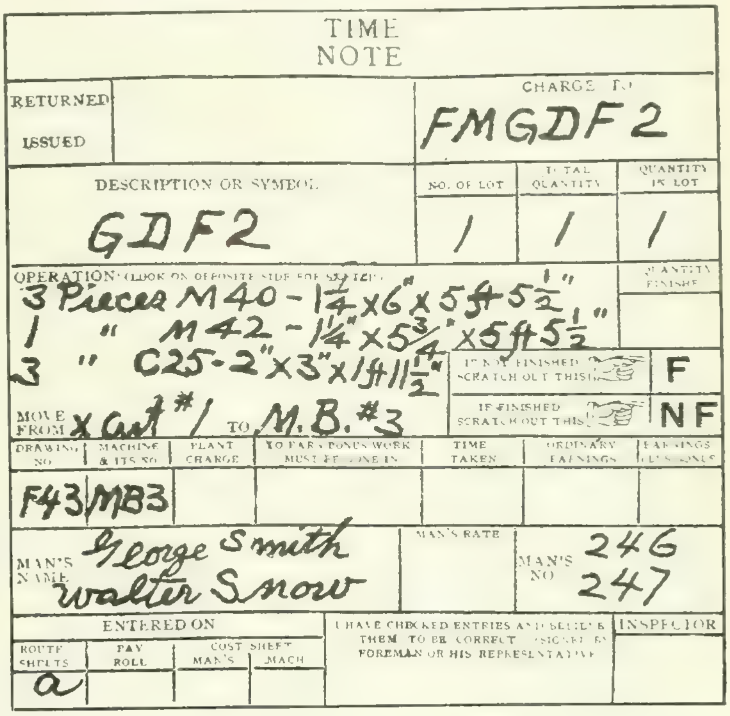
MOVE FROM X Cut #1 TO M.B. #3

DRAWING NO.	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	MB3					

MAN'S NAME	MAN'S RATE	MAN'S NO.
George Smith Walter Snow		246 247

ENTERED ON				MOVED BY	GANG BOSS OR INSPECTOR
ROUTE SHEETS	PAY ROLL	COST SHEET MAN'S	COST SHEET MACH.		
a					

Fig. 6. Move Ticket for Girder Form G D F 2.



TIME NOTE

RETURNED ISSUED		CHARGE TO FMGDF2

DESCRIPTION OR SYMBOL	NO. OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
GDF2	1	1	1

OPERATION (LOOK ON OPPOSITE SIDE FOR SKETCH)
3 Pieces M40 - 1¼"x6"x5ft 5½"
1 " M42 - 1¼"x5¾"x5ft 5½"
3 " C25 - 2"x3"x1ft 11½"

QUANTITY FINISHED

IF NOT FINISHED SCRATCH OUT THIS ☞ F

IF FINISHED SCRATCH OUT THIS ☞ NF

MOVE FROM X Cut #1 TO M.B. #3

DRAWING NO.	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	MB3					

MAN'S NAME	MAN'S RATE	MAN'S NO.
George Smith Walter Snow		246 247

ENTERED ON				I HAVE CHECKED ENTRIES AND BELIEVE THEM TO BE CORRECT (SIGNED BY FOREMAN OR HIS REPRESENTATIVE	INSPECTOR
ROUTE SHEETS	PAY ROLL	COST SHEET MAN'S	COST SHEET MACH		
a					

Fig. 7. Time Ticket for Girder Form G D F 2.

The necessity for detail form designs made up under the direction of the designing engineer has already been mentioned. Although these are naturally made up in the drafting department of the home office, they affect the actual operation of the job so intimately that they are best described at this point.

Form Design.—Unless the forms are designed so as to use the smallest amount of material in the best possible way, economy is, of course, impossible. The layout must take into account not only the labor cost but also the quantity of lumber.

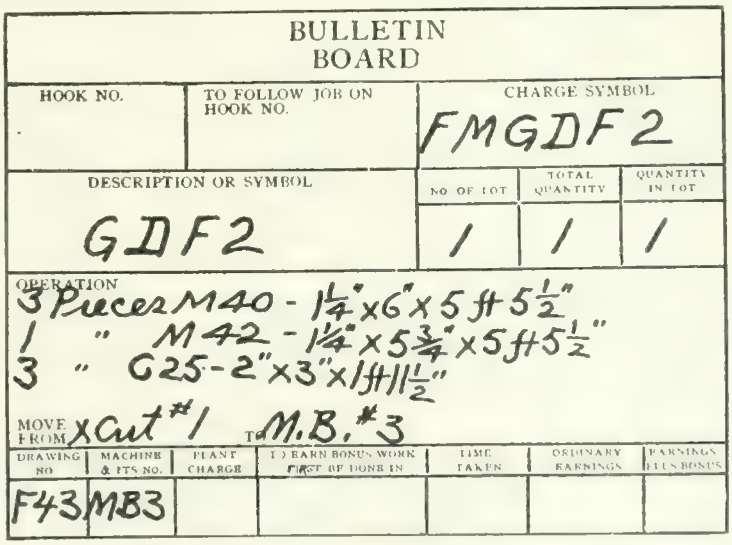
The customary practice of most construction companies has been to leave the selection of type of forms to the job superintendent, who in turn leaves it to his carpenter foreman already overburdened with executive work. On the other hand, while the design should always be discussed with the job foreman, a different type of mind from that ordinarily possessed even by a first-class foreman is required to present plans or sketches in such detail that they can be read by an ordinary carpenter without trouble.

To simplify the methods, therefore, it is necessary that the plans for the forms be made in the drafting room.

Labeling Forms.—To locate each form readily it must be numbered or lettered in such a way that it will not get mixed up with other forms or parts of forms of different dimensions. The plan used is shown in Fig. 1, which is a key plan for the form work. All forms of a given dimension should be marked alike so that they can be used interchangeably.

The mnemonic symbols (i. e., memory symbols) have been found to be the most satisfactory way of designating the forms. These symbols are shown in Fig. 1. The notation at the bottom of the figure gives the key to the symbols, and it will be noted that so far as possible the letter used in the symbol is the first letter in the word. It will also be noted that the position of the letter has a meaning, also that the letter *B*, when the first letter in the symbol, stands for beam, while *B* as the second letter stands for bottom. The figure between the letter generally indicates location. Take the symbol *G D F 2* as an illustration. This symbol reads as follows: First letter G for girder; second letter D for side; third letter F for Fay St.; and the figure 2 for No. 2 girder.

To illustrate how each form is detailed, girder forms *G D F 2* and *G D G 2* are shown in Fig. 2. These sketches are made on sheets 6x12 ins. and are only penciled on white drawing paper which can be readily blue printed. Each drawing is made complete in detail together with the material list. The lines for the cleats are shown dotted as the cleats are placed on the "make benches" first, and the form boards are then thrown on top of them and, after being clamped in position to draw the boards together, are nailed to the cleats.



BULLETIN BOARD

HOOK NO.	TO FOLLOW JOB ON HOOK NO.	CHARGE SYMBOL
		FMGDF2

DESCRIPTION OR SYMBOL	NO OF LOT	TOTAL QUANTITY	QUANTITY IN LOT
GDF2	1	1	1

OPERATION
3 Pieces M40 - 1¼"x6"x5ft 5½"
1 " M42 - 1¼"x5¾"x5ft 5½"
3 " C25 - 2"x3"x1ft 11½"

MOVE FROM X Cut #1 TO M.B. #3

DRAWING NO	MACHINE & ITS NO.	PLANT CHARGE	TO EARN BONUS WORK MUST BE DONE IN	TIME TAKEN	ORDINARY EARNINGS	EARNINGS PLUS BONUS
F43	MB3					

Fig. 8. Bulletin Board Ticket for Girder Form G D F 2.

Figure 2 shows also that each board is marked with a number preceded by *M*, and each cleat is marked with a number preceded by *C*. This is to differentiate between the form boards and cleats so that the move men and carpenters looking at a certain number will know whether to look for a cleat or a form board. An *M* number is assigned to a board of a certain thickness, width, and length, and it does not matter where this certain dimensioned piece goes into a beam, or girder, or column; it is always (on this job given that particular number. A list of all the *M* numbers is kept, and in this way a cross-index is made up between the *M* numbers and the dimensions.

The symbols serve not only as instructions to the workmen, but they also provide a means for scheduling readily the material lists, in some cases making it possible to order the lumber in advance to exact lengths. The plans show the workman exactly what he is to do, so that he can go ahead with the actual work of carpentry without paying attention to the way the form is to be built and without running about the yard after lumber, as is frequently the case on a concrete job.

Operation Tickets.—The next operation is to convert the information on the plans to such form that it will serve as a guide, in the concrete job under consideration, for the handling of the materials, the sawing of the lumber, and the layout of the sequence and times of work for each carpenter or pair of carpenters.

From the plan, therefore, operation tickets, are made out. Figures 3, 4 and 5 show three operation tickets, which are known as the move ticket, the time ticket, and the bulletin board ticket, respectively. The tickets are made out in triplicate, by means of carbon paper. For convenience in spotting these various tickets a color scheme is used: the time tickets are yellow; bulletin board tickets pink; and the move tickets white. By making them in triplicate with carbon paper, time is saved and the clerical errors avoided. These tickets, all made out at once, constitute written instruction for cutting so many pieces of a certain size of lumber and calling them *M*—, moving these same sticks, and making them up into forms.

The method of procedure to accomplish this is substantially as follows:

The move man, that is, the laborer who handles the lumber, goes to the field office and receives the white move ticket for, say, one board from pile No. 16 in the yard, which is the pile for 1¼ x 6 in. x 18 ft. lumber. (In most cases, of course, a number of boards are scheduled and handled together.) He carried this to the cross-cut saw No. 1. The move man marks a tag with *M 40* in large figures and takes it to the end of the pile of lumber. As soon as this is done the move man signs this move ticket and returns it to the office. This is equal to a receipt or statement that *M 40* boards of the required number have been delivered to the saw. The cross-cut saw man next calls at the office and is given the time ticket which corresponds to the move ticket just returned, and goes back to his saw and finds the pile of *M 40* lumber which he saws to the length indicated on the ticket. When the man in the field office gives this ticket to the cross-cut man he keeps the corresponding pink bulletin board ticket in front of him, so that he knows what job the cross-cut saw man is working on. When the cross-cut saw man finishes cutting up these boards he returns the yellow time ticket to the office and signs it, which shows that he has sawed these boards to the correct length. The inspector examines the work to see if it is properly done, and if not the workman is required to do it over again. By stamping on the ticket the time when it was taken out and again when it is returned, the time for doing a particular job is accurately kept, which makes the cost-keeping system as well as the time-keeping accurate and reliable.

The ticket for the sawing of the *M 42* boards and the cleats *C 25* are handled in the same manner. The field-office man checks off his route sheet each time an operation is done so that he can tell as soon as he has all the lumber required to make up that girder form. He now issues a move ticket to the move man to place this lumber to make-bench No. 3 (see Fig. 6). After all the lumber is delivered to bench No. 3 the carpenter from bench No. 3 goes to the field office and gets his time ticket to make girder form *G D F 2* (see Fig. 7). Figure 8 shows the bulletin board ticket for girder *G D F 2*. The route sheet is again checked off to show when the girder is finished. All forms which are alike are made at the same time with one operation ticket.

Bulletin Board.—For convenience in handling the time tickets and displaying them so that the job order-of-work man can get at them quickly, and so that any one connected with the work can see exactly what is being done by the different workmen, a bulletin board containing three lines of hooks is made, which is hung on the wall of the planning room of the field office. The top line is labelled "WORK IN PROGRESS"; the second line, "Work to be done, READY," and the third line, "Work to be done, NOT READY." Each man or gang of men, if more than one is to work on a particular job—as where carpenters work in pairs—has a set of three hooks in a vertical row to receive his tickets.

Task and Bonus Based on Time Study.—To obtain complete advantage of the methods which have been described, the work should be handled with some definite incentive, such as a bonus to be paid when a man accomplishes a piece of work laid out for him in the required time and manner. In this way the workman receives a fair reward for doing his work well and faithfully.

To determine the time required to do a job, detail time studies are necessary to find the unit time required for each individual operation, so that these unit times may be added up to fit any piece of work.

In a paper of this kind it is impossible to go into the details of the methods of making the studies so as to lay out in advance the work of each man. These studies have been made and used with great success for work of almost all kinds and types.

System vs. Red Tape.—Perhaps the most radioal departure from ordinary contractors' methods is the introduction of the "Operation Tickets" described. To many, especially of the older school of engineers and contractors who have accomplished such excellent work by rule-of-thumb methods, the practice of so much detail will doubtless savor of red tape and will be criticised as a needless overhead expense. The fact is, however, that you cannot increase output to a large extent, you cannot keep all the men busy all the time, unless you have some such system as this to indicate definitely the work each man has to do, to know just what each man is doing at all times, and to insure both against loafing and delays which, although usually considered unavoidable, can be entirely prevented. The plan of operation tickets described is the simplest and easiest way to obtain these results.

It must be remembered, furthermore, that if change in methods of handling and performing the work cuts, say 25 per cent from the cost of all the labor and an equal sum from the material quantities—and these are reductions that have been made over and over again and can be normally expected—this saving pays for any extra clerical assistance many times over. Moreover, the plan is subject to modification on different types of work, and is readily adapted without changing the essential features.

The advantages in the use of operation tickets are:

(a) They are written instructions to the workmen instead of verbal.

(b) Each ticket is signed by a workman, which makes it possible to trace back errors and determine who made them.

(c) Every minute's time of every workman is charged to some definite operation.

(d) Each division of work is charged with the correct amount of time actually spent on it.

(e) The workman, knowing that the time spent on each job is recorded accurately and compared with similar work of other workmen, sees to it that the ticket is returned when the job is finished without wasting time.

(f) The company has a means for determining the best methods of operating and the cheapest type of construction, such as in the design of form work.

(g) The really good workman is distinguished at once from the self-assertive type who frequently receive undue credit.

(h) Bonuses can be paid dependent upon output of each workman so as to give the workman more money, while the company gets the work done for less money, quicker, and of better quality, than by any other means.

Other Types of Construction.—Although the description of methods applies chiefly to reinforced concrete building construction, the principles, as has been emphasized, already, are applicable to nearly every kind of construction work. Sometimes, although this must be avoided if possible, the work must be distributed to gangs instead of individuals or pairs of men. In some classes of work, such as earthwork, the routing may be of a very simple nature and stress must be laid on the standardization of tools or the measurement of material or both. In other cases, such as pipelaying, the training of the men is of the greatest importance.

Whatever the class of construction, it must be recognized at the start that results cannot be obtained in a minute, nor can they be obtained without a considerable initial expense. An organization must be developed, men must be trained to handle properly the work, and the management, that is, the members of the company, the superintendent and the foremen, must be brought to realize that a proportionally large number of office men, "non-sweaters" as they have been called, means a great diminution in unit cost, provided these office men are engaged in work which is really productive by eliminating labor on the part of the skilled and unskilled workmen.

Use of an Injector as an Emergency Pump.

Contributed by S. K. Eastwood, Owego, N. Y.

After the excavation had been completed for the basement of a power house, and the forms for the basement walls had been set in place, a sudden, heavy rainstorm filled the excavation to a depth of about 4 ft. before the contractor was able to place the concrete. As there was no pump available except an ordinary ditch pump, and as its use would result in idle men on the job, an injector was fitted up in the following manner to remove the water:

A steam line was run out from the power-house, and connected up to the intake pipe of the injector. The injector was then lowered to the bottom of the pit, being supported only by the pipe lines connected to it. The outlet pipe of the injector was run along the ground to a nearby catch basin. By means of this equipment the water was quickly lowered to such a level that a man could work within the excavation. A small hole, of sufficient depth to permit the injector to drop below the basement floor, was then dug, and the water removed from the excavation with the injector in this position. The injector was left in the pit until the job was completed and was found invaluable in taking care of water from subsequent storms.

ROADS AND STREETS

A Comparative Study of Pavements Based on Chicago Conditions.

(Staff Abstract.)

There are many types of wearing surface, but they fall within the limits of the nine kinds enumerated in Table I. This table is a condensed summary of other tables based on conditions obtaining in Chicago. Cost figures are based on the average prices bid. This table is based on the character of streets for which the type of pavement is most suitable and usually specified.

Referring to Table I. The second column is derived from the values given by the U. S. Department of Agriculture (Circular 141), which are based on the pavement qualities of cheapness or first cost, durability, ease of maintenance, ease of cleaning, low tractive resistance, non-slipperiness, favorableness to travel, acceptability, and the most important, sanitary quality, such as noiselessness and healthfulness. These values will vary depending on circumstances and are interesting in a comparative way only.

Column five gives the average of "expected" life of the wearing surface. Column nine gives the annual cost per square yard to provide for maintaining the road through proper and timely repairs, interest on the first cost and amount to be set aside, which, compounded at 5 per cent, would pay for rebuilding

TABLE I.

Type of pavement.	Compare value of wearing surfaces.	Where used as a general rule.	Average cost per square yard.	Est. life, years.	Average annual cost repairs.	Interest cost at 5 per cent.	Depreciation for sinking fund.	Total annual cost per sq. yd. or cost ratio.	Per cent.
Granite block	71	Heavy traffic	$3.90	50	$0.02	$0.19	$0.17	$0.28	100
Creosoted wood block	80	Business streets	3.00	15-20	.02	.15	.13-.08	.30-.25	105-88
Brick	75	Alleys and car line streets	2.10	20	.03	.10	.06	.19	67
Sheet asphalt	76	Residence streets	1.70	16	.04	.08	.06	.18	63
Asphalt, concrete, or Type 8 asphalt	69	Residence streets and blvds	1.50	12-20	.03	.07	.07	.17	60
Water-bound macadam	56	Not used since 1911	1.15	(4)	(.10)	.06	(.15)	(.31)?	108
Tar or asphalt macadam	64	Light traffic	1.20	8	.08	.06	.12	.26	90
Plain concrete	70	Alleys and light traffic streets	1.50	6-10	.07	.08	.10	.24*	85
*Average.			1.80	..	...	...	...	...	..

both foundation and top as they wore out. Column ten shows the relative annual costs in percentage, with granite block assumed at 100 per cent.

An inspection of Table I reveals many interesting things. Considering the traffic it is subjected to, granite block pavement is the most "economic" pavement. Were macadam used where the granite block is necessarily specified, it would probably cost four times as much as the granite block. A macadam pavement is not a "cheap" pavement, because of the base or foundation.

There are three pavements: brick, asphalt and asphaltic concrete that cost about the same. The selection of the proper one for a given street, then, will depend on other qualities, such as noiselessness, sanitation, good foothold, ease of maintenance, general acceptability, and local conditions.

The data quoted are taken from a paper on the Design of Pavements, by H. J. Fixmer, before the Illinois Society of Engineers and Surveyors. Mr. Fixmer is division engineer in charge of paving, Board of Local Improvements, Chicago, Ill.

Organization and Equipment of Convict Camps in Georgia: Methods and Cost.

Contributed by John C. Koch, 1332 N. Broadway, Baltimore, Md.

PART I.

ORGANIZATION.

As each county maintains a separate, independent organization of its road forces, there will be found wide differences in the details of operation of its convict road construction camps. These differences arise, not only through differences in the personnel of the county officers, but in the topography and other variations that are local and require appropriate, special consideration. However, the details and costs that are presented in this article give, with reasonable accuracy, the essential features of the organization and operation of a typical Georgia county convict camp.

The general construction program, type of road construction and method of maintenance is determined by the Board of County Commissioners, and executed by the County Superintendent of Roads. The superintendent has immediate charge of all road and bridge construction under the jurisdiction of the County Board. He is usually also appointed county warden and as such is responsible for the care and safe-guarding of the misdemeanor convicts of the county as well as all felony convicts transferred to the county, upon application, by the State Prison Commission. Generally, the county poor farm is also placed under the charge of the superintendent, and is operated by convict labor. The principal products raised on the poor farm are hay, corn, oats, cotton and garden vegetables. In this manner the cost of maintaining the poor farm as well as feeding the convicts and the live-stock belonging to the county is reduced appreciably, and that, too, without detriment to the road construction work.

The superintendent of the county roads should be a man with some little experience in road construction and the handling of men; in addition to which he must be possessed of tact and executive talent. Upon his judgment and efficiency will depend the efficiency of the entire force under his direction; the cost of work done and the success of any program of road improvement undertaken by the road board will be largely dependent upon the superintendent. The more important of his duties are to direct the actual construction of roads, culverts and bridges; planning ahead the work in order to locate at the most favorable places the temporary camps; proper supervision of the guarding and care of the convicts, and the maintenance of discipline; obtaining rights of way when necessary in the relocation of old roads; and purchasing supplies and equipment as approved by the road commissioners.

With so many duties devolving upon the superintendent, it is wise to have a capable foreman in direct charge of the convict camp. The foreman should also be skilled in handling labor, live-stock and road machinery. In all matters connected with the management of the camp as well as the construction and other work undertaken, the foreman should be in full charge, acting under such instructions as may be issued to him by the superintendent. It is almost impossible to operate convicts economically if there is divided authority for guarding and for directing the labor; there must be one responsible head in full control of the guards and prisoners, in order to avoid friction in the details of camp life. The foreman and guards are appointed by the superintendent with the approval of the road commissioners. Self-interest will usually force the superintendent to appoint capable men as his assistants in order that best results may be secured, as the term of office of the superintendent is largely determined by the results he produces.

The salaries paid for these positions depend on the amount of work done in the county, the size of the convict force employed, etc., so that the salaries vary to some extent. Leaving out of consideration the counties in which the large cities are located, average salaries are as follows: Superintendent $75 to $100 per month, with subsistence when in camp; foremen, $60 to $75 per month, with quarters and subsistence; guards, $30 to $40 per month, with quarters and subsistence.

PERMANENT CAMPS.

The camps are of two kinds: the permanent, or headquarters camp, and the temporary camp which is shifted from place to place, as the work in progress and weather and other conditons may require.

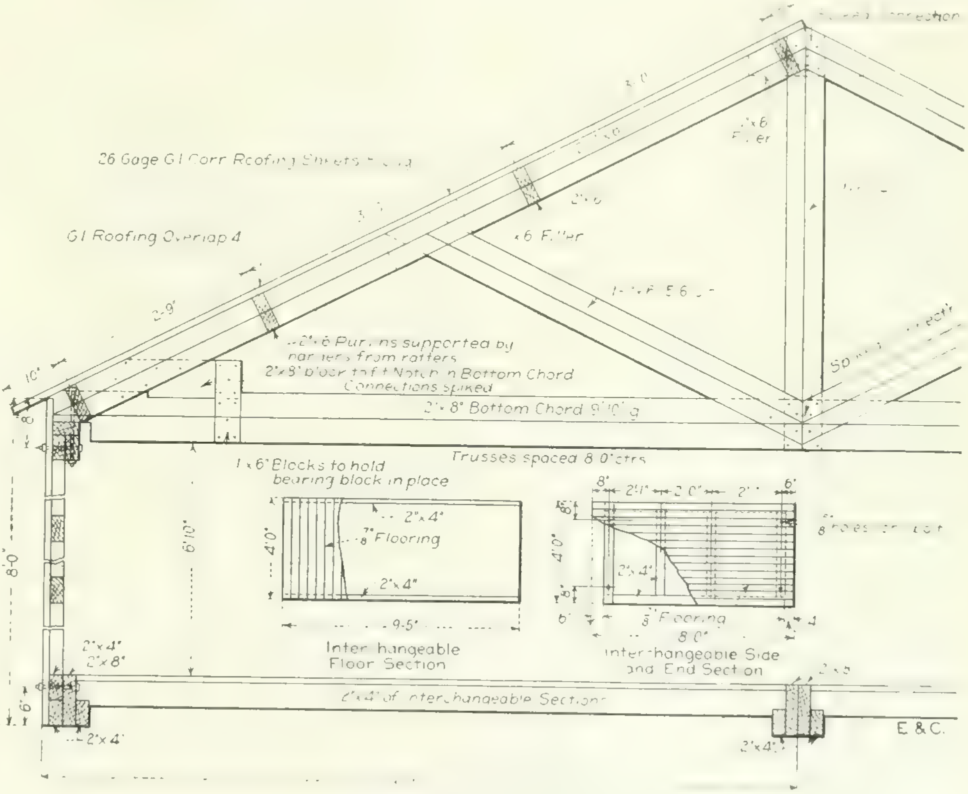


Fig. 1. Details of Portable Sleeping Quarters.

The permanent camp is usually placed on the poor farm, which is nearly always situated within a few miles of the principal town or city of the county. This arrangement permits of using the convicts during the most severe part of the year on construction work in the principal town, on the streets of which a large amount of work is done by the county forces in recognition of the large proportion of county revenue derived from the taxation of city property. When the weather is too severe for outdoor work or too wet, the convicts are employed indoors at the camp in making and repairing harness, clothing, painting wagons and overhauling and placing in good repair tools and other equipment, making bolts for bridge work, repairing camp building and in doing such work as can be done to any advantage under such conditions. In this manner the amount of lost time is kept to a minimum and the rainy-day work is probably as productive of results as any done at other times.

The permanent camp is arranged so as to provide safe, clean, sanitary quarters for as large a convict force as seems likely to be used by the county. Proximity to a good supply of pure water is an essential to economical operation of the camp.

Fig. 2. Temporary Convict Camp in a Pine Woods.

In some cases gasoline pumping engines, hot-air engines or windmills have been installed in such camps to pump water from well or spring into elevated tanks. Such improvements, when properly selected with reference to the local conditions, are very economical in providing sufficient pressure for distribution to all parts of the camp for drinking, bathing, sewerage, watering livestock and even for fire protection. A hot-air engine with a pumping capacity of 1,200 to 1,500 gals. of water per 10-hr. day, raised 50 ft., will consume about 3 gals. of kerosene per day. Gasoline pumps are probably a little more economical in operation, but require a higher degree of skill to operate and are somewhat more expensive in first cost.

Housing.—The principal building in the permanent camp is that for the accommodation of the convicts. The floor of this building is placed 4 ft. above the ground, in order to secure ventilation and facilitate the removal of night-soil. Where flush water closets are not used this building is equipped with cast iron stools, having close-fitting tops, and emptying through the floor into metal receptacles.

In winter heat is supplied by stoves, usually one at each end of the building. The distance from the floor to the ceiling is made 10 ft. Windows 2x3 ft., with sliding sash and iron bars over the opening, are placed at 10-ft. intervals. The bunks or cots are made either of dressed lumber with wooden slats, or of iron with woven wire matresses; they are at least 3 ft. wide by 6½ ft. long. A center aisle 5 ft. wide is maintained from end to end of the building and the bunks are separated from each other by a space of 2 ft.

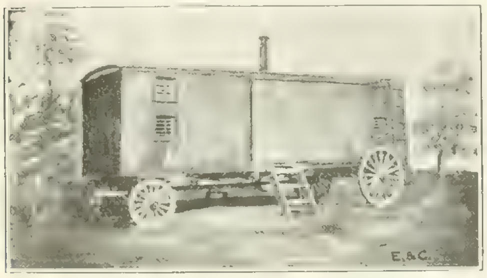


Fig. 3. Type of Wooden Car for Housing Convicts When Away From Headquarters.

Other Buildings.—A mess hall of sufficient size to comfortably seat all the convicts at one time is provided with tables and benches. A kitchen near the mess hall is supplied with all necessary equipment, including covered waste cans which are emptied, cleaned and disinfected daily.

The hospital is made large enough to take care of four persons, or not less than 10 per cent of the convicts. A bath house of proper size, fitted with showers or tubs, is provided. Warm water is supplied in cold weather.

Stables large enough to shelter all the livestock and provide storage for forage, are placed convenient to the camp and to some suitable water supply.

A stockade 12 ft. high surrounds all of the buildings except the guard house, which is near the main entrance and outside of the stockade. The guard house provides suitable eating and sleeping quarters for all the guards, and office quarters for the foreman and superintendent.

Cost of Permanent Camp Equipment.—The cost of the equipment of a permanent camp to accommodate 30 convicts, with foreman, guards and live-stock, based on the experiences of a number of counties in Georgia, is as follows:

Barracks, with guardroom and office, 20 ft. x 60 ft. over all	$ 225
Guard quarters, 16x20 ft.	65
Isolation hospital, 16 ft. x 20 ft., with equipment	85
Mess hall with benches and tabes, 18x20	70
Cookroom, with storeroom, 18x20 ft.	90
Stockade, 12 ft. high	265
Stables for 20 animals	80
Blankets, bunks, bedding, etc.	100
Large hotel range and cooking utensils	150
20 sets convict chains, 1 long chain, 60 ft.	36
Water supply (optional)—	
Hot-air engine, 1,200 gals. per day	150
50-ft. steel tower, 1,000-gal. metal tank, piping and fittings	350
Bath and other outhouses	50
Total cost of equipment	$1,316

All the buildings are built of rough lumber with galvanized iron roofs, all labor required being furnished by the convicts under the direction of one or two competent carpenters. The mild climate does not require expensive construction of stables, hence the low cost of this item. The price of rough lumber will vary from $8 to $15 per thousand, delivered. The price of lumber in the estimate above is taken at $10 per thousand.

TEMPORARY CAMPS.

The selection of the site for a temporary camp is of great importance and should be based upon accessiblity to the work to be carried on and to a plentiful supply of good water. The ground should be nearly level with sufficient slope to drain well. A shady grove furnishes an excellent camp site. Arrangements can often be made for the use of pasture land already fenced in, for the stock to graze in on Sundays and other days when only part of the stock can be used to advantage. A 5 or 6-strand barbed wire stockade should surround the prisoners' quarters, the guardhouse and foreman's quarters should be placed in an advantageous position for the observation of the prisoners' quarters and the temporary stables.

Housing.—The quarters of the foreman and guards can be most economically provided by the use of 8x8 ft. tents. The best type of quarters for the prisoners is a vexed question. Wooden cars mounted on heavy wagon wheels have been used with some success. Such a car 20 ft. long with bunks in two tiers will accommodate 12 prisoners, but is stuffy and unsanitary and productive of much complaint in some counties. This car can be hauled from place to place with from 6 to 10 mules, depending upon the road surface and grades. Another type is a kind of steel cage, 20 ft. long, mounted on wheels, and with bunks in three tiers will provide quarters for 18 men. This is more sanitary, but very cramped. Both of these types are well-adapted to reduce risk of escape at night, but a number of escapes have been made from the wooden cars at night.

Tents have been used with more or less satisfaction, a single large tent being used to shelter 20 to 30 men. To enable it to be guarded with a small force it is necessary to fasten each prisoner to a chain passing through the middle of the tent. Lanterns are hung at intervals in the tent so that a single guard can have all of the prisoners in view all the time. In wet weather the tents are difficult to keep sanitary, although for small squads of about 15 men on well-drained ground they are very satisfactory.

Portable Houses.—Portable "take-down" houses have been used in a few counties and give promise of being the most economical type of housing for stays of 6 weeks or more in any one place. A house of this type has been in use in Hall County for nearly two years with excellent results.

A brief description is given below of a house of this type, designed by the writer for temporary camps, as well as for storage purposes, which has given great satisfaction during a period of more than two years.

The sides and ends are composed of interchangeable sections 4x8 ft., every fourth section having a 2x2 ft. iron-barred window. These sections are bolted with ½-in. dia. bolts to a floor sill 6 ins. wide made up of a 2x8-in. piece with a 2x4-in. piece bolted to each side, all three pieces having their lower edges in one plane, as shown in the figure. These sills rest on wooden blocks spaced 8 to 10 ft. apart, which support the structure at a height of at least 1 to 2 ft. above the ground, the sills being brought to a level all around. The roof plate is joined to roof trusses and the side sections as indicated in the figures. The floor sections are 4 ft. wide by nearly 10 ft. long. The unit arrangement of the sections of floor and siding, together with roof trusses, permits of the erection of a house 20 ft. wide and varying in length by 4-ft. intervals up to any desired length. The details of this structure are illustrated.

A house as described above, 20x60 ft., would cost about $200 on the basis of rough lumber at $15 per thousand. This is about the same as a tent of much smaller size would cost, which could be made to answer the same purpose. The life of the tent is figured as two years and of the portable house from five to ten years. In rainy weather the tents furnish very poor protection, and are difficult to keep in sanitary condition.

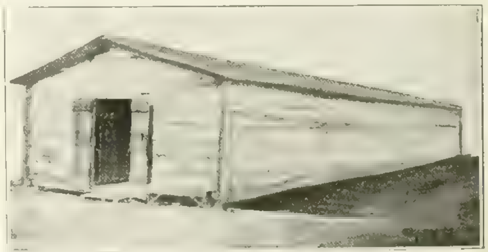


Fig. 4. Type of Cheaply Built Portable Sleeping Quarters.

Cars.—Wooden cars with bunks in three tiers accommodating 18 men cost about $200. Steel cars of similar size cost about $350. The latter are constructed of flat steel bars latticed so as to form 2½-in. to 4-in. square openings, and the entire car is formed of this latticing except the floor, which is made of heavy oak planks. Both wooden and steel cars are mounted on wheels so as to be easily moved from place to place. The ventilation in the steel cars can be regulated without difficulty by the use of the canvas roof and sides which cover the steel cage.

Tents.—For the temporary camp quarters of the guards and foreman the most satisfactory arrangement is to use 8x8-ft. tents. For office quarters and accommodation for three guards and a foreman, three such tents will be ample.

In addition to the foregoing there must be provided in the temporary camp a mess hall, kitchen, bath and stables. Tents of proper size provide satisfactorily for all of these except the stables. The latter need merely be a simple shelter having a roof and boarded up on the two sides most exposed to prevailing winds. In spring and summer only a roof is needed as a shelter for the animals.

For a squad of 30 convicts the following wall tents would be required: For mess hall, 12x20 ft.; kitchen, 12x12 ft., and bath room 8x8 ft. Tables and benches for the mess hall are easily made of rough or dressed boards supported by wooden horses of suitable height, which can be readily transported.

Cost of Equipment of Temporary Camp.—The temporary camp can be equipped largely from the articles in the permanent headquarters camp. The chief items that must be purchased for the temporary camp are the tents, cars or portable house, water barrels, camp stove, lanterns, barb wire for stockade, materials for tables, benches, etc., extra cooking utensils, and a number of other supplies that are not expensive but may vary with local conditions.

The following list of equipment, in addition to that supplied from the equipment of the permanent camp, would be required for a temporary camp of 30 convicts. This includes quarters for guards and foreman.

"Take down" house, 20x60 ft. (as above described)	$225
Wall tents—	
4, size 8x8 ft., at $14	56
1, size 12x20 ft. (mess hall)	60
1, size 12x12 ft. (kitchen)	34
Wooden shelter for stock	15
Large camp cook stove, $35; extra utensils, etc., $12	47
10 water barrels, at $1.50	15
Stockade fencing	25
12 lanterns	9
Miscellaneous supplies for camp	24
Total cost of equipment	$510

(Part II of this article, describing methods of furnishing subsistence and supplies, etc., will apear in a later issue.—Editors.)

Method of Applying Oil for Dust Prevention.

(Staff Abstract.)

The method of application and the amount of oil that should be applied will depend upon the kind of oil used, the condition of the surface of the road on which it is to be used, and other local conditions. The light oils should be applied more frequently and in smaller quantities than the heavy oils. The crude or the refined oil may be applied either cold or hot, according to its quality. Most crude oils, and some refined oils, have been applied cold; but it is necessary to heat the heavier oils before they are applied.

The oil is shipped either in barrels containing from about 30 to 50 gals. each, or in steel tank cars containing from 6,000 to 10,000 gals. each. If a heavy oil is used, it is necessary that the car tank be equipped with steam coils in order to heat the oil, that it may be drawn or pumped from the tank.

When the material is shipped in barrels it is customary to heat it on the roadside in heating kettles holding from 4 to 10 bbls., from which it is applied to the road surface by the use of hand pouring pots of about 4 gals. capacity. It is important that these pots be provided with spouts that will spread the oil in such a way as to produce an even distribution, as in this lies the secret of the success of its application. The ordinary water sprinkling spout with the holes punched larger with an 8 d. or 20 d. wire nail, depending upon the grade of material being used, will usually give very satisfactory results.

When the oil is shipped in tank cars, it is usually applied to the road from tank wagons, holding from 400 to 800 gals. Tank wagons used for this purpose may be classified under two heads: (1) Gravity tanks, which allow the oil to flow by gravity through a perforated pipe, which sprinkles the oil onto the road. (2) Pressure tanks, which spray the oil under pressure onto the road through perforated pipes, or a series of nozzles, or a single large hose and nozzle. The pressure is produced either by steam or compressed air in the tank itself, or by pressure in the distributing pipes only, induced by some form of pump.

When the oil is applied to the road surface in the form of a fine spray, which can be done with the pressure tank wagon, a more even distribution and better penetration is secured. The pressure tank wagon is particularly valuable when it is desired to use a very light application of oil. By the use of such a wagon, so light an application as ⅛ gal. per square yard can be evenly spread, while about ⅓ gal. per square yard is as small a quantity as can be uniformly distributed with a gravity tank. The use of the pressure tank has an additional advantage; when the oil under pressure comes into contact with the stone with some force, it blows the dust from the surface, and thus by cleaning the stone secures a better adhesion of the oil. This is very beneficial with the heavier asphaltic oils where it is absolutely essential that the surface of the large stones be exposed and clean in order to insure a good bond. However, if the oils are not too heavy, and the road is gone over several times with the gravity tank and a very light application given each time, a very even distribution can be secured and fairly good results obtained. The tank wagon is sometimes provided with a heating arrangement either in the form of a fire box underneath, or in the form of steam coils to be attached to the roller boiler. With such an equipped tank, the heavier grades of materials may be applied.

In general, it is better to give the middle of the road a heavier application than the sides. This is especially true in the case of the lighter oils and emulsions, and calcium chloride solution, owing to the tendency of these materials to being carried to the sides of the road by gravitation and running water. While in the case of the lighter oils, no cover is necessary after the oil is applied, yet better results are usually secured by covering the oil with a layer of coarse sand. When the heavier oils that require heating are used, it is essential that they be covered with either screenings or coarse sand. Stone, slag or gravel screenings are best suited for this purpose. The screenings should be dry and clean and free from dust, and of a fairly hard material. A size that will pass a ½-in. circular mesh and be retained on a ¼-in. mesh is usually very satisfactory. A size that will pass a ¾-in. screen and even a 1-in. screen is sometimes used with perfect satisfaction. The heavier the grade of oil that is being used, the coarser the screenings may be. If the surface is afterwards rolled, larger screenings can be used than where traffic alone compacts them. Unless a heavy oil that stiffens quickly upon exposure to the air is being used, it is best to allow the oil from 5 to 36 hours' time to be absorbed by the road surface before applying the screenings. It often happens, however, that the road cannot be closed to traffic so long, in which case the screenings are put on immediately after the oil is applied, with very good results. If the oil stands in little pools on the surface after it is applied, it should be gone over with hand brooms and the puddles of oil broomed evenly over the surface before the screenings are spread. This will aid in producing a more uniform surface, and *uniformity of surface* is not only one of the essentials in building a road, but it is also one of the essentials in maintaining a road.

Dust prevention is so closely associated with road preservation that the two should usually be considered together, for any method of preserving the surface will invariably reduce the dust. It might be well to state, however, that such surface treatments of oil do not constitute the building of a road. At its best, it constitutes merely a maintenance proposition. It is a false notion to hold that an old wornout, rough road surface can be made good by the application of a little oil. In order to maintain a good surface, it is essential that the surface be put in a good condition previous to the application of the oil. Therefore, unless it is merely intended to temporarily allay the dust, the holes and ruts should be eliminated from the surface before any oil is applied. The depressions in the road should be cleaned of all dirt and foreign material, the edges cut vertical and the bottoms loosened by picking. The depressions should then be filled with stone, slag or gravel of the same quality and size as the remainder of the road surface, and this material thoroughly compacted by hand ramming or rolling.

Poor results in the use of oil treatments frequently come from the fact that the surface had not been previously cleaned in a proper manner. The practice of some small villages of putting oil on a road surface already covered with several inches of dust and filth, cannot be too severely condemned. When such practice is followed, the street, after every rain, will be covered with a black, oily mud, which may be as objectionable as the dust itself. Before the lighter oils, such as are put on cold, are applied, the surface should be comparatively free of all loose dust and foreign material. Before the heavier materials, such as require heating, are applied, it is very important that the surface be cleaned of all matted dirt, dust and foreign material, so as to expose the large stones in the surface of the road. If possible, the surface should be swept with horse sweepers, and afterwards with hand brooms so as to remove the dust from between the stones to a depth of from ¼-in. to ¾-in. The heavier the grade of oil used, the more important it is to have a clean surface on which to apply it. The surface should be dry and the warmer the air temperature the better.

There has been considerable discussion during the past year concerning sprinkling of the stone with water before applying the bitumens, it being claimed by some that better results are secured. While during a dry, dusty time, better results may be obtained by first lightly sprinkling the stone with water before applying the bitumen, this information is likely to be misleading; for it is believed that it is not the presence of water that might cause the better results, but the effect the water has in cleaning the dust from the stone which gives a better adhesion of the oil. Hence, we would conclude that if sprinkling with water before applying the oil is done, it should be on only hot, dry days, and then sufficient time given after the sprinkling for the water practically all to evaporate before the oil is applied. Therefore we are still warranted in saying that bitumens should be applied only to dry, warm surfaces. During June, July and August is the best time of the year to apply such materials to the road surface.

The amount of oil that should be applied to the road at any one time will depend upon the condition of the road surface, the quality of the oil used, and the nature of the traffic. In general, it may be said that a couple of light applications during the year will give better results than a single heavy application for the same amount of oil. For the lighter oils, on a comparatively smooth surface, an application of not to exceed ⅛ gal. per square yard may be all that should be applied at one time, while on a rough, pitted surface (with the binder swept from the top surface of the road to a depth of from ¼ in. to ¾ in. as much as ¾ gal. per square yard of the heavier oils might give more satisfactory results. Pre-

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caution should be taken, however, that there is not an excess of oil applied, as too heavy a coat of the lighter oils is objectionable because of the formation of a black, frothy mud after a rain, while an excess of the heavier oils will form a thick mat on the surface which will be peeled and picked up by the horse-drawn traffic. The heavier the automobile traffic, the greater the amount of oil that can be applied up to a certain limit. The aim should be to put on just sufficient oil (and screenings) to form a thin mat over the surface of the road. This mat should not be of any appreciable depth over the surface of the larger stones, but sufficient to well seal up the voids between them. This will hold the binder in the stones and make the road surface water tight.

The cost of oils varies according to the quality of the oil. Also the price of the same oil fluctuates from time to time. The cost of applying the cold oil varies from ½ ct. to 1 ct. per gallon, while the cost of applying the hot oil will vary from 1½ ct. to 3 cts. per gallon.

The preceding information is abstracted from a bulletin on Dust Prevention, issued by the Highway Department, State of Ohio.

Cost of Concrete Pavements in Twenty States in 1914.

(Staff Abstract.)

From detailed costs kept on 95 concrete road contracts by the inspectors of the Association of American Portland Cement Manufacturers the average costs of work in 20 states in 1914 were computed as in Table I. These data are taken from a paper by H. E. Hilts, road engineer for the Association in the "Cornell Civil Engineer" for March-April, 1915.

TABLE I.—AVERAGE COST OF CONCRETE PAVEMENTS (1914).

State.	Labor.	Teaming.	Mechanical equipment.	Materials.	Miscellaneous.	Total.	Number sq. yds.
Connecticut	$0.181	$0.142	$0.046	$0.752	$0.010	$1.088	200,056
Florida	.108	.628	.003	.838	.014	.991	13,000
Indiana	.134	.130	.044	.777	.022	1.017	89,794
Illinois	.136	.101	.033	.528	.016	.814	17,970
Iowa	.213	.084	.028	.789	.036	1.116	90,364
Kansas	.396	....	.026	.819	.007	1.248	1,503
Kentucky	.146	.214	.020	.477	.018	.875	4,144
Maryland	.111	.127	.065	.716	.057	1.077	36,211
Massachusetts	.195	.104	.039	.600	....	.947	26,200
Michigan	.222	.032	.021	.655	.050	1.028	92,217
Mississippi	.261	.085	.150	.642	.004	1.232	12,031
Missouri	.209	.133	.027	.656	.059	1.045	22,376
New Hampshire	.126	.097	.032	.907	....	1.152	6,066
New Jersey	.179	.089	.016	.797	....	1.091	8,356
New York	.156	.085	.055	.666	.050	1,027	730,782
Ohio	.181	.091	.067	.642	.009	.946	58,968
Pennsylvania	.279	.091	.031	.742	....	1.269	10,072
Texas	.316	.117	.007	.668	.016	1.123	6,640
West Virginia	.098	....	.060	.912	....	1.070	10,045
Wisconsin	.188	.110	.045	.682	.023	1.033	61,879
Grand average	$0.183	$0.104	$0.040	$0.717	$0.046	$1.058*	1,498,883

*Exclusive of profits and overhead charge.

Concrete Roads and Frost Action.

To the Editor:—The paper presented by Mr. Lovis before the last annual convention of the American Concrete Institute and reprinted in your issue April 21 was read with much interest. The writer, however, feels that equally good and safe results may be obtained at much less cost by other methods, and lest the conclusions therein given may cause some to incur a large needless expense in the construction of concrete pavements, the writer hopes to be allowed to question the wisdom and economy of the method suggested by Mr. Lovis to eliminate the usual longitudinal crack in such pavements.

His conclusion may be summed up in his statement that "We must TRY and make permanent the foundation." And to accomplish this he recommends a V-drain of gravel or cobbles, aggregating in amount about 1/3 cu. yd. per lineal foot of 15-ft. pavement. This specification, if followed, will add, in most localities, from 50 to 60 cts. per lineal foot, including the extra excavation, which amount is equal to the cost of two additional inches of concrete. It may be shown by experience, experiment, or computation that the 2 ins. of additional thickness will give the pavement sufficient strength to avoid cracking longitudinally, regardless of the condition of the foundation or the action of frost in upheaving it within the limits of all known movements due to such action.

The case of the Andover Road pavement 19½ ft. in width and 8 ins. in thickness is then cited. A portion of this pavement was constructed having a well prepared earth foundation, but under the upheaving action of frost, the pavement cracked longitudinally near the center, both in the sections where reinforcement was used and where it was not used. Under a portion of the pavement, a thick gravel foundation was used, costing from 70 to 80 cts. per lineal foot. It is not definitely stated that no longitudinal cracks occurred where the gravel base was used, but granting such was the case, the cost is sufficient to have added a thickness of at least 2½ ins. of concrete to the pavement, making a total thickness of 10½ ins., which may be shown both by example and computation to be a thickness sufficient to resist rupture by the forces of frost upheaval in any amount. As an example, the State Highway at LaSalle, Ill., may be cited, having a width of 18 ft. and a thickness of 11 ins., which has not cracked longitudinally. It would therefore seem to be quite as efficient and economical to put the extra foundation expense into the superstructure. But as against either of the above methods of insuring an absence of cracks, the writer wishes to cite the case of High St. of this city, which is also 19 ft. in width, only 6½ ins. in thickness, and which has passed through two winters without developing a single longitudinal crack. The foundation was prepared in a very ordinary manner at small expense, and a protected longitudinal joint was constructed down the center of the pavement at a cost of about 10 cts. per lineal foot. This joint is in good condition, showing much less wear than the adjacent transverse joints, demonstrating that a protected longitudinal joint will stand the abrasion of traffic much better than transverse joints, and will certainly wear much less than the unprotected, irregular crack caused by rupture. Such a protected central joint will in all cases eliminate the unsightly cracks, and obviate the necessity of expending excessive sums on the foundation, or of increasing the pavement thickness beyond the amount needed to meet the requirements of traffic which produces shear, wear and abrasion. This required thickness is about 6 ins., and any thickness in excess of this amount is simply useful in producing a continuous, unbroken beam across the roadway.

A comparison of the cost of the method of eliminating longitudinal cracks proposed by Mr. Lovis and the cost of so doing by the use of the protected longitudinal joint shows the former will cost $5,000 per mile more than when the latter method is adopted in the construction of a 19½-ft. pavement. Equal freedom from cracks is secured by either method, for it has been shown by a multitude of examples that a concrete pavement slab 10 ft. in width and as much as 6 ins. in thickness will not crack longitudinally under the stresses produced by foundation movements. It would have been interesting, had Mr. Lovis given the amounts of frost upheaval observed in his tests. The writer has measured frost upheavals on High St. pavement amounting to ¾ in.

S. T. Morse.

Carlinville, Ill., April 30, 1915.

Although tubing and pipes of American manufacture are well and favorably known in Italy and are extensively used, American pipe fittings have proved unsatisfactory and are undersold by German and Swiss goods of better quality. According to a consular report there is a promising market in the Florence district for American-made fittings of a high quality.

CURRENT NEWS

The Doings of the Week.

Had it not been for the Lusitania disaster the past week would have been one of marked betterment in the fields of business and finance. Aside from this unfortunate occurrence many favorable developments took place. The May report of the U. S. Department of Agriculture indicated that, unless adverse weather conditions intervene, a billion bushel wheat crop, the largest in history, will be harvested in this country. Export figures showed an unprecedented total for the month of April. The report of the Federal Reserve Board on the financial and banking condition of the country was most encouraging. Bank clearings for the week ended May 6 amounted to $4,196,715,000, an increase of over 29 per cent over last week and nearly 22 per cent over the corresponding week of last year. The figures for the first week of May were greater than the previous high totals reported in October, 1912, and January, 1910. In the construction field the past week has been one of considerable activity. More work came up for advertising for bids than in any previous seven days so far this year. Numerous large contracts were let and many important undertakings were advanced a step nearer the beginning of active construction. In the Metropolitan District of New York an actual gain in building construction of 20 per cent is indicated for the first four months of 1915 over the same period for 1914. In the Iron and Steel markets the trade began May with more grounds for confidence in the outlook than existed one month ago. Steel plant operations continue near the 75 per cent mark. Rail purchases the past week were not much in excess of 30,000 tons but orders aggregating over 150,000 tons are pending. The Pennsylvania R. R. alone, it is stated, will soon place an order for 138,000 tons. Orders for several thousand cars were placed during the past week, and several additional special contracts from Europe were received. The Iron Age prices for finished iron and steel and for sheets, nails and wire for the week ending May 5 were as follows:

Finished Iron and Steel.	May 5.	Apr. 28.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia. .	1.17½	1.15
Iron bars, Pittsburgh.........	1.20	1.20
Iron bars, Chicago............	1.15	1.15
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York..	1.369	1.369
Tank plates, Pittsburgh. .	1.15	1.15
Tank plates, New York... .	1.319	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York.... .	1.369	1.369
Skelp, grooved steel, P'gh....	1.12½	1.12½
Skelp, sheared steel, P'gh.	1.17½	1.17½
Steel hoops, Pittsburgh...	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers		
Sheets, black, No. 28, P'gh.	1.80	1.80
Galv. sheets, No. 28, P'gh....	3.40	3.25
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh ..	1.35	1.35
Barb wire, galv., P'gh........	2.10	2.10

For structural material f. o. b. Pittsburgh the Iron Age prices were as follows: I-Beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—No development of importance looking to the taking up of any great amount of railway construction took place last week. In fact the carriers displayed no especial activity in either purchasing equipment or making announcements of new work. The Chicago, St. Paul, Minneapolis & Omaha Ry. has awarded contracts for about 35,000 cu. yds. of concrete for substructure of new bridge over Mississippi River. The Union Station Co. of Chicago awarded a contract to Blome Sinek Co., Chicago, for the foundations for the freight house at the new union terminal in Chicago. The contract for trunk sewers, concrete retaining walls and other work in connection with the terminal was let to W. J. Newman Co., Chicago. The St. Paul Union Depot Co. closes bids on May 15 on the dredging and concrete work in connection with the river change for the new $15,000,000 union terminal at St. Paul, Minn.

Roads and Streets.—A great deal of state highway construction reached the call for bids stage last week. California opens proposals May 24 on four contracts, 32.2 miles in all; New York is calling for bids on 22 contracts; Ohio is advertising 6 contracts and several good sized jobs are ready for bids in Washington. Illinois likewise has asked proposals on several contracts. Maine is advertising its first letting of the year, the contracts covering some 27 miles of highway. Bids are being asked on a considerable amount of county work. In Milwaukee County, Wis., alone, proposals will be opened May 14 on 111,960 sq. yds. of concrete roads. The 174 mile highway letting of Vermillion County, Illinois, advertised for May 17, has been postponed. Baton Rouge, La., also, has extended the date for receiving bids on its 192,000 sq. yds. letting. New York opened bids on 20 state road contracts, several of which ran well over $100,000 each.

Bridges.—No especially large contracts in the bridge construction field appear to have been advertised during the past week. Calcasieu Parish, La., is calling for bids on a reinforced concrete arch bridge with double leaf Strauss trunnion bascule span; California Highway Commission opens bids May 24 on plate girder bascule of 80 ft. clear span. Bids also are being asked on numerous smaller structures in New York, Ohio, Virginia, and Illinois. The contracts let include a concrete steel and arch bridge at Canton, N. Y., to cost about $25,500; a Strauss bascule lift bridge for Cape May County, N. J., to cost about $27,480, and seven reinforced concrete bridges near Elkins, W. Va.

Drainage and Irrigation.—Few big jobs in either the drainage or irrigation fields appear to have reached the call for bids stage during the past week. Perhaps the largest undertaking is the dredge ditch in Monroe, Blue Creek and St. Marys Townships, Indiana. The estimated cost of this is $74,000.

Water Works.—A considerable amount of water works construction for smaller municipalities is being advertised. Albion, N. Y., is calling for bids on water works improvements requiring 23,900 ft. of water mains, filtration plant, etc.; Plant City, Fla., opens proposals June 5 on pumping station equipment; Salem, Mass., is asking bids on 10,000,000 gal. covered concrete reservoir; Binghamton, N. Y., opens bids May 24 for standpipes; Petersburg, Va., is taking bids on two water tnaks and towers; Cleveland, O., is advertising several contracts for work at its Division Ave. pumping station; Bloomington, Wis., is asking bids for water works and Cresco, Neb., is calling for proposals for similar work. Durham, N. C., awarded contracts for water works.

Sewerage—Limon, Colo., is calling for bids for sewer system to cost $25,000; Greenwich, Conn., is asking proposals for sewage disposal works; Baltimore, Md., is advertising two fair sized contracts, one of which calls for 7,300 ft. of 30 in. to 60 in. masonry drain; Cleveland, O., opens bids May 20 for constructing the Dugway Brook branch sewer; Mt. Ayr, Ia., opens bids May 17 on a $30,000 sewer system; Ebensburg, Pa., is asking bids for sewage disposal plant.

Calls for Bids Notices.

Many public officials consider the call for bids notices they insert in the local papers merely a further step in the legal proceedings necessary for the carrying out of the improvement. The law requires that the work be advertised and therefore they comply with the statutes. As the usual thing the only information in these advertisements of value to a contractor is the statement that the city is asking proposals for a piece of work and that bids will be opened at a certain time. Commonly no details are given as to the size of the job and so the outside contractor must investigate for himself to find out whether the undertaking is big enough or small enough for him to figure on. In a season when little work is being offered almost any bidding opportunity will be followed up; but when there are plenty of contracts in sight a contractor does not have much time to look into the uncertain jobs. A village in Ohio is now asking for bids on street improvements. No one would guess from the official advertisement that the estimated cost of the work is over $165,000. Had this fact been stated it would have made the notice half a line longer but it would have increased its effectiveness in securing competition from contractors a hundred fold.

Decrease in Immigration.

The effect of the European war on the labor supply of the United States is shown by the immigration figures for February of the Federal Department of Labor. During this month the total number of immigrants admitted to this country was less than one-third of the number in February, 1914, the figures being 18,704 and 57,119 respectively. During March of last year 108,907 immigrants came into this country. As is to be expected, the greatest falling off is from the countries directly engaged in the war. In February, 1914, 6,676 immigrants from Hungary were admitted, as compared with 11 for this year. Only 159 immigrants from the Russian empire and Finland were admitted during last February. The number for the corresponding month of last year was 9,687. Italy, which has been hesitating on the verge of war for some months, contributed 2,732 of its citizens, a falling off of 4,808 over the previous February. At present in most localities the supply of foreign labor is greater than the demand. Should there be, however, even a normal season in the railroad construction field there is liable to be some difficulty in securing unskilled labor.

Railroad Contractors and Other Work.

The hard heartedness of railway companies in curtailing construction is serving one purpose: It is teaching contractors who have depended almost entirely on the carriers for work that there are other construction opportunities. A few weeks ago one contractor, who heretofore has confined himself exclusively to steam shovel work for railroads, took a $120,000 highway job. He purchased some rollers and light grading outfits and is now piling up as good estimates as he ever did in the old days. Another big railroad contractor joined hands with a firm specializing in concrete construction and secured a $400,000 contract for flood protection work. All of which goes to show that if there is no particnlar work in your own line it is possible to get in on other jobs nearly as good.

Dr. F. S. Pearson.

Many of the big construction undertakings of the past 10 years were directly due to Dr. F. S. Pearson, one of the victims of the Lusitania disaster. He was interested in numerous projects in this country, in Mexico, and in Spain. One of the largest private irrigation developments in this country was financed by him, and at the time of his death he was engaged in an extensive hydro-electric and irrigation project in Spain. He was president of the Mexico Northwestern R. R. and much of this line was built while he was connected with the company. He was also president of the Barcelona Traction, Light & Power Co., Ltd., of Spain, the Mexico Tramways Co., Mexican Light & Power Co., and the Riode Janeiro Trmways Co.

PORT IMPROVEMENTS FOR CANADIAN CITIES.

Work Under Construction or Contemplated.

Breakwaters—Wharves—Dredging—Dry Docks.

Extensive developments for Canadian ports are being carried on or are in contemplation by the Dominion Department of Public Works, Ottawa, Ont. The following outline of the improvements in hand and proposed at several cities is taken from the Third Annual Proceedings of the American Association of Port Authorities. The information was collected early this year by the secretary of the association:

St. John, N. B.—Courtenay Bay Improvements.—These include (1) the construction of a rubble mound breakwater, 4,570 ft. in length; (2) the dredging of a channel 7,800 ft. long by 500 ft. wide to a depth of 32 ft. below low water; (3) the dredging of a basin to a depth of 32 ft. below low water for an area of 100 acres; (4) the construction of 4,780 lin. ft. of quay wall composed of timber and concrete; (5) the filling of an area of about 28 acres. The total amount of this contract was $7,500,000. The date for completion is March 30, 1917. As a condition to the acceptance of the tender the contractors agreed to construct a dry dock of the first class in Courtenay Bay on a site approved by the Minister of Public Works. The breakwater is completed. The site for the dry dock partly excavated and dredging operations are under way.

Beacon Bar Deep Water Wharves, St. John West.—Wharfage amounting to 3,730 lin. ft. at Beacon Bar, St. John West, is under contract. The first section of the work is 1,960 ft. long. It is a cribwork structure on a stone foundation 5 ft. thick, and is 43 ft. high and 48 ft. wide at the base. The outer faces are double sheathed and sloped at the rate of 6 in. 70 ft.

On this cribwork there is a concrete superstructure 27 ft. high, 18 ft. wide at the base and 7 ft. at the top. The total height of the structure is 75 ft., the depth of water along the face of the wharf being 35 ft. at low water level. This section (early in the year) was practically complete. The second section will be 1,770 ft. long, of the same width and height as the first section, except that the stone foundation will be 2 ft. high. The total cost will be $1,335,000.

Considerable filling was required behind the new wharfs. A contract was let to provide about 1,500,000 cu. yds. of this material. About half the work was to be completed this spring and the balance next season. A temporary freight shed 505 ft. long by 80 ft. wide was erected on Berth No. 15. Plans are in hand for a permanent shed of structural steel and concrete construction, equipped with overhead passageways for handling passengers. There will be two covered loading tracks at back of shed. The shed and quay space is designed to enable future installation of seven 1½ to 2-ton electric traveling, luffing jib, semi-portal wharf cranes, gantry spanning one track. The dredging for the sites and berths of the Beacon Bar wharves to a depth of 35 ft. has been completed. The remainder of the dredging on the bar was to be completed March 31, except the removal of some ledge rock.

Quebec Harbor: Lauzon Dry Dock.—The 1914-15 appropriation for this is $1,000,000. The dry dock under construction will be 1,150 ft. long, 120 ft. wide at the entrance, with 40 ft. of water on the sill at high water, ordinary spring tides. The dock will be divided into two compartments, 650 ft. and 500 ft. long. The outer entrance will be closed by a rolling caisson and a floating caisson will close the middle entrance. The walls will be of concrete with granite copings and granite altars. Pumping machinery will consist of three centrifugal pumps, each capable of delivering 60,000 gals. per minute and emptying the dock in 3 hours; two auxiliary drainage pumps each of 6,000 gals. capacity also will be installed. The pumps will be run by electric motors, supplied by three generators connected to steam turbines. Eight boilers of a combined capacity of 3,600 hp. will furnish steam.

Quebec Harbor: River St. Charles Improvement.—The appropriation for 1914-15 is $750,000. The improvements consist of the construction of a concrete dam 1,600 ft. long, 20 ft. in average height, and two locks, respectively 450 ft. and 350 ft. long by 65 ft. at the entrance walls. Each lock will have 15 ft. of water on the sill at low water.

Harbor Improvements, Toronto, Ont.—Harbor improvements amounting to $5,370,000 were under contract early this year. These include the following: 17,295 lin. ft. of seawall, pile substructure, concrete superstructure; breakwater, 18,600 ft. long, crib substructure, concrete superstructure; ship channel and turning basin; retaining wall, 6,894 ft. long, crib substructure, concrete superstructure.

Harbor Improvements, Port Arthur.—The following improvements are under construction: Breakwater to protect the dock of the existing and proposed industries and to increase the size of security of the harbor. The ultimate length is 20,800 ft. About 5,700 ft. of this work is now in hand, to cost $562,000. The dredging will cost $130,000 and will provide for widening of main harbor and excavating of channel to sundry elevators and slips.

Improvements at Fort William.—These include extension of revetment wall around G. T. P. basin into slip No. 2 and outward into entrance channel 2,600 ft., at a cost of $365,000. The dredging improvement of McKellar, Mission and Kaministiquia Rivers and widening and deepening G. T. P. basin will involve expenditure of $750,000. The Department of Public Works contemplates, in the future, the extension southwesterly of Bare Point breakwater to the present breakwater and the extension of the new breakwater southwardly towards the entrance of the Kaministiquia River. The plan of development also calls for further dredging in the above rivers and the construction of about 4,500 ft. of revetment wall in the Mission River.

Harbor Improvements, Vancouver.—The 1914-15 appropriation is $1,000,000. This amount was to carry on the following improvements: (1) Construction of combined concrete and timber cribwork 800 ft. long by 300 ft. wide between Commercial and Salisbury Drives; (2) completion of dredging in False Creek, and the dredging of the proposed turning basin, involving the removal of 542,000 cu. yds. at 21 cts.

Harbor Improvements, Victoria. — The 1914-15 appropriation was $1,100,000. This was to be used in carrying on the following improvements: (1) Construction of a rubble mound breakwater at Ogden Point, about 2,500 ft. long, consisting of rubble rock fill with granite blocks and concrete superstructure; (2) construction at Ogden Point of concrete piers Nos. 2 and 3. These will be each about 800 ft. long and 250 ft. wide, with a clearance of 300 ft. between the inside faces. They will consist of reinforced concrete substructure and mass concrete superstructure.

Merger of Freight Terminals at Boston, Mass.

A comprehensive plan for state and municipal control of the freight terminals of Boston, Mass., is under consideration. The scheme provides for the formation of a company to be known as the Boston Railroad Terminal Co., under a statute enacted by the Massachusetts legislature. The directors of the company are to include the Governor of Massachusetts, and the Mayor of Boston. The capital stock of the company is fixed at $250,000, the entire amount being subscribed for, and the title standing in the name of the commonwealth.

The freight terminals at Boston are now controlled by three private corporations. According to the plan the new terminal company is to lease all the standard gage railroad property within a radius of 15 miles from the State House and pay the companies owning these properties a rental of 4½ per cent of their value. The terminal company is authorized to equip the roads within these limits for electric operation, and it also has power to build lines and tunnels to connect the various leased properties.

PUBLIC WHARF FOR DUNKIRK, N. Y.

Bids Asked on $100,000 Structure.

Crib Substructure—Concrete Superstructure.

The city of Dunkirk, N. Y., is calling for bids for the construction of a public wharf that will call for an expenditure of about $100,000. The structure will be located at the foot of Central Ave. and its construction will involve the following units: (1) excavation for crib foundation; (2) timber cribs built, sunk, filled, settled and leveled; (3) sheet pile bulkheads at circulation openings, and between side cribs, including walings, tie rods and screw bolts; (4) riprap in circulation openings; (5) concrete superstructure over cribs and at circulation openings; (6) fender streak; (7) mooring posts; (8) back fill to subgrade of pavement. The approximate bill of quantities is as follows:

Excavation	19,400	cu. yds.
Back fill	17,500	cu. yds.
Concrete	1,320	cu. yds.
Crib filling	10,700	cu. yds.
Hemlock timber	696,800	ft. B. M.
Oak timber	9,330	ft. B. M.
Steel channels	22,500	lbs.
Drift bolts	65,800	lbs.
Screw bolts	12,300	lbs.
Reinforcing bars	9,350	lbs.
Mooring posts	23	

The buildings occupying the deck of the present structure will be removed by the city. It is not contemplated that any further clearing will be necessary, as preparation for the excavation in the foundation. The foundation excavation will include all material above bed rock in the areas to be occupied by the cribs. The material is believed to be a stiff blue clay for about 4 ft. above the rock; above the clay the material is sedimentary.

The timber cribs will consist of tight front and end walls and cob house back walls with tiers of cross ties and plank grillage. They will be built of 12 in. by 12 in. hemlock timber and 3 in. by 3 in. grillage plank, fastened together with screw bolts, drift bolts and 10 in. boat spikes. The bulkheads at the circulation openings will consist of built-up wooden sheet piling, timber waling, tie rods, screw bolts, concrete superstructure and riprap. For the tongue and groove sheet piling 2 in. by 12 in. yellow pine plank, 18 ft. or 16 ft. in length will be used.

The concrete superstructure will be moulded in monoliths not more than 30 ft. in length, the joints between sections being made by one layer of heavy tar paper. The concrete will be proportioned: 1 cement, 2 sand, 2 gravel and 4 broken stone. Alternate bids will be received on a natural mixture of gravel and sand so constituted that the latter will bear the relation of not to exceed 35 per cent, nor less than 30 per cent of the volume of the total aggregate, and 1.17 bbls. cement to the cubic yard of concrete in place. The reinforcing steel will be of a deformed pattern and of units not less than ½ in. square.

The fenders will consist of 12-in. channels secured in the concrete of the superstructure by countersunk anchor bolts 24 in. long and ¾ in. diameter, bent at the end. The snubbing post, which will be secured in the superstructure concrete, will consist of 6 lin. ft. of heavy weight wrought iron pipe and a cast iron pipe.

Bids for constructing the wharf will be received until 8 p. m., May 18, by A. D. Toomey, City Clerk of Dunkirk, N. Y. Bids for the purchase of $100,000 of bonds for building the dock were opened on May 4. W. H. Shelton is City Engineer of Dunkirk.

INTERCEPTING SEWERS AT MILWAUKEE, WIS.

First Contract for New $10,000,000 Development.

Brick and Concrete Sewers in Open Cut and Tunnel.

Sewer construction to cost about $500,000 is now being advertised by the Sewerage Commission of Milwaukee, Wis. Bids are asked on the first two contracts for work in connection with the new system of interceptors and disposal plant of the city. The whole scheme of improvement involves the building of about 35 miles of sewer and disposal works and will require an expenditure of about $10,000,000. The contracts on which bids are being taken call for the construction of intercepting sewers and connections or both sides of the Milwaukee River. Bids on these particular contracts were opened on Feb. 24 last, but all bids were rejected and the improvement is now being readvertised.

The work to be done may be divided into two separate contracts, numbered 9 and 10, or it may be further subdivided into five contracts numbered 11, 12, 13, 14 and 15. Number 9 embraces the construction of an intercepting sewer and branches on the east side of the Milwaukee River from a point below the dam to the intersection of Broadway and Detroit Sts., and requires the construction of approximately:

7,927 ft. brick and concrete sewer, 30 in. to 51 in. in diameter, in open cut.

3,992 ft. brick and concrete sewer, 30 in. to 5 in. in diameter, in tunnel.

3,844 ft. terra cotta pipe sewer, 10 in. to 24 in. in diameter.

1,762 ft. of manholes and pile and timber foundations.

Contract No. 9 may be subdivided into three contracts—Nos. 11, 12 and 13.

Contract No. 10 embraces the construction of an intercepting sewer and branches on the west side of the Milwaukee River from the Holton St. viaduct to the intersection of West Water and Fowler Sts. It requires approximately

8,480 ft. brick and concrete sewer, 30 in. to 48 in. in diameter, in open cut.

2,340 ft. terra cotta pipe sewer, 10 in. to 18 in. diameter.

1,105 ft. of manholes and pile and timber foundations.

Contract No. 10 may be subdivided into two contracts—Nos. 14 and 15.

At the first letting on Feb. 24 bids were taken on contracts 9 and 10 as units. The following contractors submitted proposals, the totals being for the bids for standard section without foundation: Jones & Erbeck, Pittsburgh, Pa., No. 9, $239,008, No. 10, $162,804; Jos. Hanreddy, Chicago, Ill., No. 9, $324,046; No. 10, $208,292; Oscar Daniels Co., Chicago, Ill., No. 9, $366,490, No. 10, $242,823; F. H. Nakielski, Milwaukee, Wis., No. 9, $366,490, No. 10, $262,237. The unit prices of these contractors on the principal items are given in Table I:

Bids are invited upon two separate types of sewers: one type having concrete base and brick arches; the other type will be constructed of concrete throughout. The latter design may beused for all circular sewers over 30 ins. in diameter, except in tunnel. Proposals also are invited upon two separate types of sewer in tunnel, egg shaped and circular.

Bids for the construction of the intercepting sewers will be received until 2 p. m., May 14, by the Sewerage Commission of Milwaukee. J. H. Fowles is Secretary of the Commission and T. Chalkley Hatton is Chief Engineer.

TABLE I.
CONTRACT NO. 9.

	Jones & Erbeck.	Hanreddy.	Daniels Co	Nakielski.
Standard section:				
Combined section, 36 in. and 51 in., all concrete sewer, in open cut, 804 lin ft.	$32.92	$34.00	$49.65	$50.00
Combined section, 36 in. and 51 in., all concrete sewer, in tunnel, 982 lin. ft.	38.12	36.20	49.80	40.00
Brick arch and concrete invert sewer, 36 in., in open cut, 4,427 lin. ft.	13.70	21.10	27.30	40.00
Brick arch and concrete invert sewer, 30 in., in open cut, 1.892 lin. ft.	11.92	14.00	12.00	24.00
Brick arch and concrete invert sewer, 36 in., in tunnel, 1,147 lin. ft.	18.32	31.10	27.50	30.00
Brick arch and concrete invert sewer, 30 in., in tunnel, 1,863 lin. ft.	16.82	26.90	27.00	24.00
Alternative bid:				
All concrete sewer, in open cut, 36 in., 4,427 lin. ft.	13.70	20.60	27.30	50.00
44 in. and 66 in. sewer, in tunnel, 3,010 lin. ft.	19.22	23.10	32.00	40.00
CONTRACT NO. 10.				
Standard section:				
Brick arch, concrete invert, 48 in., 2,023 lin. ft.	19.22	24.70	27.75	35.80
Brick arch, concrete invert, 42 in., 2,667 lin. ft.	19.00	22.20	27.00	28.00
Brick arch, concrete invert, 36 in., 2,719 lin. ft.	14.70	17.40	22.90	26.50
Brick arch, concrete invert, 30 in., 1,071 lin. ft.	12.92	16.10	17.75	20.00
Alternative bid:				
All concrete sewer, 48 in., 2,023 lin. ft.	19.22	24.40	27.75	35.80
All concrete sewer, 42 in., 2,667 lin. ft.	19.00	21.80	27.00	...
All concrete sewer, 36 in., 2,719 lin. ft.	14.70	17.00	22.90	26.50

500 Miles of Road Construction in Arkansas.

A large amount of highway construction is proposed for the present season by counties in Arkansas. The new Alexander Road Law, which went into effect recently, is responsible in great measure for the large increase in prospective highway work in this state. Under this law a majority in the number of landowners, of land value or acreage can file petitions with the County Court for the formation of a district. It also is provided that the County Judge or 10 land owners in the district may request the State Highway Department to prepare preliminary plans, specifications, estimates and reports on any road project, without cost to the petitioners.

The State Highway Department now has five engineering corps in the field engaged on work for various counties. One corps is engaged in surveys for 30 miles of road in Perry County. Another corps is at De Witt, Arkansas County, surveying a route for a 20-mile road. A third corps is in Ouachita County working on a 40-mile road; another is engaged in Boone and Newton Counties on surveys for a 30-mile road and the fifth corps is in Woodruff County, where 40 miles of road improvement are contemplated.

It is estimated that the probable road construction that will be undertaken this season will amount to over 500 miles, involving an expenditure of nearly $2,700,000. This estimate does not take into consideration small sections of road work contemplated in several counties. The following tabulation shows the counties in which it is anticipated road improvements will be undertaken:

County.	County seat.	Miles.	Cost.
Arkansas	DeWitt	15	$ 70,000
Boone	Harrison	12	60,000
Columbia	Magnolia	20	110,000
Grant	Sheridan	27	145,000
Jefferson	Pine Bluff	28	160,000
Lafayette	Lewisville	10	55,000
Lonoke	Lonoke	20	98,000
Miller	Texarkana	60	400,000
Mississippi	Osceola	100	500,000
Newton	Jasper	12	60,000
Ouachita	Camden	12	45,000
Perry	Perryville	30	150,000
Poinsett	Harrisburg	20	200,000
Pope	Russellville	25	100,000
Pulaski	Little Rock	25	125,000
Randolph	Pocahontas	8	20,000
Stone	Mountain View	7	50,000
Washington	Fayetteville	35	180,000
Woodruff	Augusta	40	175,000

Hugh R. Carter, Little Rock, Ark., is State Highway Engineer.

NEW SUBWAYS FOR PHILADELPHIA, PA.

First Contracts to Be Let in a Few Weeks.

$6,000,000 Provided at Election in April.

The first contracts for the new rapid transit system at Philadelphia probably will be let this spring. At an election on April 29 a $6,000,000 loan was authorized for commencing construction on a development that will call for an ultimate expenditure of perhaps $60,000,000. Preliminary work, such as the enlarging and lowering of sewers in the downtown district that would be affected by the new subways is being carried out under a $500,000 loan. The contemplated improvements to the transportation facilities of the city, as outlined in the Jan. 14, 1914, issue of ENGINEERING & CONTRACTING, provided for the construction of a north and south subway under Broad St., and a delivery loop subway in Arch, 8th, Walnut and 15th Sts. In addition several elevated lines were to be built. The $6,000,000 provided at the recent election will be expended on the Broad St. line; the work on the delivery loop will be taken care of under future bond issues.

With the exception of a few deep locations, it is probable that all of the subway can be excavated by the open cut method. In the business section it is likely that the construction will be carried out by the methods followed by the contractors in the downtown section of the subway in New York. In this work the streets were planked over and kept open for traffic. Along Broad St. it is proposed to keep one-half the street open to traffic at one time. Electric power for hoisting, pumping, etc., will be employed. The work probably will be divided into sections of such length that each can be completed within 2½ to 3 years from the awarding of the contract.

In the central business section of the city (Broad and Market Sts.), after passing through top soil, sand and clay, good gravel is usually encountered 15 ft. to 20 ft. below street level. This continues to about 40 ft., where it becomes cemented gravel of great supporting power and removable only with the pick. Pockets of quicksand are occasionally encountered in this formation. Rock is met a few feet lower. The upper stratum of this, especially if near the surface, is unually rotten and can be easily loosened with the pick. Below the few feet of rotten rock there is bed rock of gneiss or schist formations to great depth.

Disposal of the surplus excavation will prove one of the important items in the construction of the Broad St. subway. It has been proposed that all material excavated south of Lehigh Ave. be taken to the low ground south of Oregon Ave. and used in bringing streets and parks in that district to grade. All material excavated above Lehigh Ave. could be used filling streets in the northern end of the city. It is stated that a fair average value of this spoil to the city in place in park and street fills is about 20 cts. It is assumed that the material would be hauled for these fills by teams and dump wagons and by motor trucks with or without trailers. According to a report of A. Merrit Taylor, Transit Commissioner of Philadelphia, the estimated gross cost of construction of the North Broad St. subway to Pike St. (4-track) was $15,256,000. The estimated cost of the South Broad St. subway to Bigler St. and depressed tracks Bigler St. to Government Ave. (2-track) was $5,080,000. For the 2-track delivery subway the cost was estimated at $10,592,000.

The total subway mileage was as follows: North Broad St., 4.2 miles; delivery loop, 2.1 miles; South Broad St., 2.3 miles. The general design of the developments according to the report included the following features: Minimum radius of track curves, 165 ft.; maximum ascending grades, 5 per cent; 12 ft. headroom and 12 ft. track centers for subways; steel frame construction for sidewalks and roofs of subways; subway floor finished with concrete and track laid on short fixed ties without ballast.

State Highway Construction in New York.

The third road construction letting of the present season by the New York State Highway Commission was held on May 5. Bids were received on 20 contracts covering a total of about 99.34 miles of highway. There was considerable competition on most of the roads, and the bids were more closely bunched than they have been at previous lettings. The work included several good sized jobs, four of them each running in the vicinity of $100,000 or over. The largest contract called for the construction of 7.27 miles of the Philadelphia-Antwerp Road in Jefferson County. On this there were 18 bidders, the Pathfinder Construction Co., of Troy, N. Y., winning out by an even $1,000. Some close figuring was done on the Belvidere-Transit Bridge-Angelia Road in Allegany County (Road No. 1260). There was a difference of only $74 between the two low bids on this work. On the Richmondville-Summit Road in Schoharie County (Road No. 1234), C. S. Mathusa, of Albany, bid $46,267, while John A. Jova of Newburgh put in an estimate of $46,315. Several out of the state contractors figured on the work and on two of the roads were low bidders. M. Bennett & Sons, Indiana, Pa., at $49,829, were low on Road No. 831; and the Curren Corp., of Middletown, Conn., at $44,222, was low on Road No. 5545. The following tabulation shows the high and low bids and the number of bidders on each of the contracts:

Road No.	Length, miles.	High bid.	Low bid.	Number bidders.
1259	4.00	$ 39,705	$ 34,946	10
1260	8.64	101,084	95,710	10
1254	4.43	57,428	52,694	6
1026	3.99	106,751	96,461	6
1062	1.59	52,882	47,671	9
5549	.88	59,490	51,594	8
5552	8.81	96,538	86,661	14
1258	5.01	78,508	59,991	7
1257	1.81	23,890	20,087	4
471	3.60	38,890	31,530	18
831	5.63	61,616	49,829	10
5548	7.27	163,683	139,993	18
1247	3.51	56,487	47,561	9
1248	3.20	45,468	43,608	3
1249	2.18	19,509	17,539	8
1261	5.66	81,806	68,690	11
1263	10.85	133,969	116,760	12
1264	9.09	99,785	85,400	8
5545	5.62	58,360	44,222	12
1234	4.99	49,089	46,267	5

The bids of the three low contractors on each of the above contracts will be found under Roads and Streets in this issue.

The next highway construction letting of the Commission will be held on May 21. This covers 22 contracts involving the improvement of 99.82 miles of road. The roads, their location and length are as follows:

County.	Road No.	Name.	Length, miles.
Broome	1238	Union Village	1.03
Broome	5412	Union Village	.28
Broome	5440	Binghamton City	.41
Cattaraugus	1269	Little Valley - Cattaraugus, Part 1	5.62
Cattaraugus	1275	Little Valley - Cattaraugus, Part 2	3.95
Cattaraugus	5544	Hinsdale-Franklinville, Part 2	6.88
Delaware	1270	Meridale-Delhi	7.69
Delaware	1271	Rockrift-Colchester	11.40
Delaware	1272	Colchester-Delancy	5.84
Genesee	1268	Pavilion-Batavia, Part 2	4.49
Greene	1242	Hunters-Tannersville.	4.43
Oneida	5553	Camden-Oswego County Line	5.73
Ontario	1139	Clifton Springs Village	1.38
Ontario	1276	Victor Village	1.23
Ontario	1277	Phelps Village	1.53
Ontario	1278	Canandaigua-Orleans.	8.63
St. Lawrence.	1262	Madrid - Waddington, Part 1	5.07
St. Lawrence	1266	De Kalb Junction-Hermon	3.09
Schenectady	5551	Duanesburg-Quaker St.	3.34
Suffolk	1274	Qurque-South Hampton	10.50
Washington	1081	South Argyle-Argyle	3.34
Washington	1223	Battersville-Salem	5.96

Concrete Facing for Levees in Yazoo-Mississippi Delta District.

The Yazoo-Mississippi Delta Levee District will face a considerable mileage of its levees with concrete. About 6 miles of levee of the district are exposed in high water to the action of violent storm waves. These places heretofore have been protected by plank revetment. This is now being replaced by a 3-in. concrete slab on the river side slope of the levee, reaching up over the edge of the embankment crown and extending to a line below the zone of wave attack. About 2 miles of this construction has been placed already with very satisfactory results.

The concrete slab will be 3 ins. thick, will have no expansion joints and will not be reinforced. The capping will lap 2 ft. over the levee crown. There will be a footing at the lower margin of the slab 1 ft. deep vertical in the levee, 4 ins. thick and made continuous with the slab. The sand and gravel for the concrete may be "river run" from the bed of the Mississippi River. The proportion of sand will be not less than 35 per cent nor more than 50 per cent of the mix. The proportion of cement to the whole aggregate will be 1 to 6.

The work is located in De Soto County, Miss., and is divided into five sections, as follows:

Location.	Sq. Yds.
Near Lake View	43,000
Near Lake Cormorant	42,000
Sta. 663 to Sta. 678	10,000
Sta. 690 to Sta. 737	30,000
Sta. 751 to Sta. 774	13,000

Bids on the work were to be opened at 4 p. m., May, 12, at the office of the Levee Board, Clarksdale, Miss. T. G. Dabney is Chief Engineer.

First State Road Letting in Maine.

The first road letting of the present year by the State Highway Commission of Maine is now being advertised. Bids are asked on 27.07 miles of state highway, the location of the work being as follows:

Towns.	Miles.
Scarboro	5.47
Thomaston	1.28
Manchester	2.68
Fairfield	2.29
Searsport	2.53
Prospect	0.32
Edmunds	1.95
Poland	3.65
Oxford	3.77
Cities.	
South Portland	2.22
Bath	0.89

The work will consist of building gravel surface roads, with the following exceptions:

Scarboro, bituminous macadam; South Portland, concrete or bituminous macadam; Manchester, waterbound macadam; Oxford, sand clay. Bids on the above work will be received until 11 a. m., May 19, by the State Highway Commission, Augusta, Me. Paul D. Sargent is Chief Engineer of the Commission.

First Contract on $15,000,000 Union Station, St. Paul, Minn.

Actual construction will be under way in a few days on the first work in connection with the new $15,000,000 union terminal at St. Paul, Minn., described in our issue of March 10, 1915. The St. Paul Union Depot Co., representing the railways that will use the terminal, has asked for bids on the first contract. This provides for the dredging connected with the change in harbor lines, the extension of sewers, building of concrete levee wall and other concrete work directly connected with the river diversion. This work will occupy practically 2 years and is preparatory to the starting of work on the station structures proper.

It is understood that 18 contractors were invited to bid on the first contract. The estimates are to be in May 15. About 3,000,000 cu. yds. of excavation are involved in the first contract. W. C. Armstrong, St. Paul, Minn., is chief engineer of the St. Paul Union Depot Co.

LEVEE WORK FOR MISSISSIPPI RIVER COMMISSION.

Details of Letting to Be Held May 26 at Memphis, Tenn.

One of the largest government levee lettings so far this year is now being advertised by the U. S. Engineer's Office at Memphis, Tenn. This work calls for about 4,500,000 cu. yds. of levee construction. Of this 3,886,300 cu. yds. is in the Upper St. Francis, Lower St. Francis and White River Levee Districts.

The construction in the Upper St. Francis District is all new work and banquette. It comprises about 8 miles of new levee, with a standard 40-ft. banquette, known as the Dorena extension, beginning at Station 67/45, about 3 miles below the Dorena Ferry Landing, Mo., which is across the Mississippi River by ferry from Hickman, Ky. This work can best be seen by going to Hickman, Ky., thence with saddle horse across ferry to the locality of the work.

The following tabulation gives some details of the work in this district:

Section.	Station.	Cubic yards.	Average height, ft.
1	67/45—68/21	170,000	18.0
2	68/21—69/0	115,000	17.5
3	69/0 —69/24	120,000	15.9
4	69/24—70/0	120,000	15.9
5	70/0 —70/26	102,000	14.6
6	70/26—71/0	102,000	14.5
7	71/0 —71/28	100,000	14.0
8	71/28—72/0	100,000	14.0
9	72/0 —72/26	158,000	17.0
10	72/26—73/0	120,000	17.0
11	73/0 —73/27	110,000	14.8
12	73/27—74/0	106,000	14.8
13	74/0 —74/26	112,000	14.7
14	74/26—75/0	112,000	14.5
15	75/0 —75/27	142,000	17.0
16	75/27—76/0	141,000	17.0

All the above is riverside borrow.

The work in the Lower St. Francis Levee District is divided into 9 sections. Sections 1 to 4 form a continuous stretch of enlargement laying opposite Wilson, Ark., on the Frisco Railroad. It begins 3 miles above Golden Lake Ark., and extends 1½ miles below. Sections 5 to 7 lay 7 miles above Old Mound City Store, Ark. Sections 8 and 9 begin at Old Mound City Store and extend upstream 2 miles.

It is presumed that mile 145/11-146/15 will have to be done with steam shovel and cars. The United States will remove the water from the land side of the levee, down to 146/15, and a shovel pit will be provided on the land side opposite 146/15. The first six sections call for enlargement and the last three provide for enlargement and banquette. Details of the construction in this district are as follows:

Section.	Station.	Cubic yards.	Average height, ft.
1	101/0 —102/0	73,000*	19.6
2	102/0 —103/0	50,000*	17.5
3	103/0 —104/0	90,500*	16.8
4	104/0 —105/35	126,500*	20.8
5	139/20—140/0	110,600*	26.3
6	140/0 —140/29	100,000*	27.1
7	140/29—141/0	124,000†	26.1
8	145/6 —146/15	440,000**	29.8
9	146/15—147/8	218,700†	26.5

*Riverside work. †Landside work with banquette. **Station 145/6—145/11 riverside work without banquette; Station 145/11—146/15 landside work with banquette.

The work in the White River Levee District begins 2 miles below Fair, Ark., and runs continuously for 4 miles to a point 1½ miles above Dawson Landing, Ark. The improvement is divided into four sections, all calling for enlargement. The following table gives details of the work:

Section.	Station.	Cubic yards.	Average height, ft
1	32/0 —33/0	158,000*	5.0
2	33/0 —34/0	146,000†	5.1
3	34/0 —35/0	144,000†	5.3
4	35/0 —36/0	175,000**	5.7

*32/0—32/45 riverside work. 32/45—33/0 landside work. †All landside work. **35/0—35/6 landside work. 35/6—36/0 riverside work.

Bids will be received on individual sections of the work above outlined or any combinations of sections, and will be canvassed as to the best interest of the United States. Work in the Upper St. Francis District, however, will be awarded so that the result will be a continuous levee south from its present terminus. In other words, if necessary, sections will be dropped from the lower end to the extent required, to bring the total work awarded within available funds.

The levee will be put up to grade with 8-ft. crown and 3 to 1 slopes. One foot topping will be added on the 8-ft. crown. The banquette will have 40-ft. crown, 20 to 1 crown slopes and a 4 to 1 back slope.

Bids for the above work will be received until May 26 by Maj. E. M. Markham, U. S. Engineer, Memphis, Tenn.

PERSONALS

Mr. H. McL. Harding, consulting engineer, announces the removal of his office from 17 Battery Place to 52 Vanderbilt Avenue, at East 45th street, New York City. Mr. Harding specializes in location, design and plans for marine and railway terminals, terminal equipment and freight handling equipment.

Mr. O. L. Remington, general manager, and Mr. H. P. McColl, engineer for Wm. McLean & Co., merchants, engineers, manufacturers and importers of Melbourne, Australia, are in the United States making a study of methods, machinery and new developments. They will visit all of the important industrial centers before leaving for England.

Professor Ira O. Baker has resigned as the head of the civil engineering department of the University of Illinois after a service of more than 40 years. A brief biography and appreciation of Professor Baker's work appeared with a photograph in our issue of March 25, 1914, in connection with the banquet given by the Alumni in Chicago celebrating the completion of his fortieth year of service on the faculty.

Mr. Daniel S. Hooker has been appointed by the governor of Colorado as civil engineer of the Public Utilities Commission of the state. Mr. Hooker has been a practicing engineer for 30 years, having graduated from the University of Colorado in 1884. For ten years he was locating and construction engineer for the Colorado & Southern railway. For the past year he has been in New Mexico as highway engineer under the state engineer.

Mr. L. E. Stevens has opened an office in Sioux Falls, S. D., for a general engineering practice, specializing in waterworks, sewerage and reinforced concrete construction. Mr. Stevens acquired his early experience in railroad work, and later with the American Bridge Co. For five and one-half years he has been in the employ of the city of Grand Rapids, Mich., for the last three as city engineer. Mr. Stevens is an associate member of the American Society of Civil Engineers.

Mr. George I. Oakley is the new city engineer of Little Falls, N. Y., succeeding Mr. O. J. Dempster. Mr. Oakley was employed on public work in New York city from 1904 to 1905. For a brief period following he was engaged in engineering work in the Borough of Queens. From August, 1905, to September, 1912, he was assistant engineer and from that date until January, 1915, he was resident engineer of the New York State barge canal, having charge of preliminary surveys and construction of over $3,000,000 of construction. Since January last Mr. Oakley has been engaged in special work for the Acme Engineering and Contracting Co.

Mr. Adelbert A. Weiland, consulting engineer, 717 Thatcher building, Pueblo, Colo., has been appointed state engineer of Colorado. Mr. Weiland was for several years with the U. S. Geological Survey in the water resources branch. From 1907 to 1910 he was hydraulic engineer for the Colorado Fuel & Iron Co., and for the past five years he has been chief engineer of the Arkansas Valley Ditch Association, an organization of 20 large canals in the Arkansas Valley. Since 1910 he has maintained a private consulting practice, and will retain his consulting offices at above address. Mr. Weiland is a member of the American Society of Civil Engineers.

The New Professor of Civil Engineering at Illinois.

Frederick Haynes Newell, consulting engineer for the U. S. Reclamation Service, has been appointed Professor of Civil Engineering and head of the Department of Civil Engineering of the University of Illinois, succeeding Prof. Ira O. Baker, and entered upon his duties on May 1 in order to be fully prepared for active work at the beginning of the next college year. Prof. Newell has been for twenty-six years in government service, principally as chief engineer and later as director of the U. S. Reclamation Service.

Professor Newell was born at Bradford, Pa., where his father, a New England engineer, was then engaged in the construction of a branch of the Erie Railroad. He graduated at the Massachusetts Institute of Technology in 1885 in mining engineering, and then took post graduate work in geology and hydraulics. Later he found employment in the oil regions of Ohio and in the coal areas of Virginia. He was designated as assistant hydraulic engineer of the United States Geological Survey on October 2, 1888, this being the date of the first appropriation by Congress of funds to investigate the extent to which the arid regions of the United States might be reclaimed. Starting as the first person appointed under this act, Professor Newell continued for over twenty-six years to devote his energies not merely to the ascertaining of the physical conditions of the country, but also to the building up of a larger and better appreciation on the part of the public of the importance and magnitude of the problems of water supplies and of their conservation and use, thus aiding in the realization of the ideals which were embodied in the reclamation act.

F H Newell

This act, signed by President Roosevelt on June 17, 1902, set aside the proceeds from the disposal of public lands for survery, examination, construction and operation of irrigation works. The bureau having charge of the expenditure of these funds, now amounting to over $80,000,000, was organized by or under Professor Newell, as it was in effect an outgrowth of the investigations started under the U. S. Geological Survey, and was largely initiated and guided by him from the period of preliminary study to that of final completion. He was chief engineer from 1902 to 1909, when he was made director, which office he held until the first of this year. He has been retained as consulting engineer to the Service since that time.

The Reclamation Service under Professor Newell's direction has constructed some of the largest dams and storage reservoirs in the world with systems of canals for distributing the stored water to about three million acres of agricultural lands. As part of the construction of the canals and reservoirs there have been built many miles of tunnels, also extensive controlling works, hydro-electric or steam power plants and hundreds of smaller structures such as head-gates, bridges, flumes and culverts; also scores of miles of wagon roads and of telephone and electric power lines, several short railroads, and almost innumerable buildings used for mills, offices, store-houses, or shelters for men and equipment. The work has been exceedingly varied in character and in location, being at widely scattered points in seventeen western states. The engineering operations have thus embraced not only civil and hydraulic, but also hydro-electric, railway, mechanical, mining, structural, sanitary, and other problems.

Growing steadily but rapidly from a single individual, the organization expanded until several hundred engineers, technical and clerical assistants have been employed, and a force of upwards of eight thousand laborers. The wide distribution of the work necessitated a quite elaborate and yet flexible organization, and the problems encountered have required the exercise of engineering and business judgment to a high degree. Frequently investigated by Congressional Committees and by special boards of engineers or experts the results have been commended both for economy and efficiency and no shadow of distrust has been cast upon them. The devotion of the members of the Service to the public welfare has been conspicuous and has attracted much favorable comment from foreign engineers and well informed citizens. Much of this has been due to Professor Newell's personal influence and to his careful selection of men. His attitude has been to encourage and push forward the men of high character and initiative, laying out the work to be done, leaving to them the details and then standing behind each man, protecting him as far as possible from "red tape" or petty annoyance, but demanding large results.

In addition to his regular work for the government and his service on various boards and commissions, Professor Newell has given much time to various scientific and related organizations, having been secretary of the National Geographic Society and of the American Forestry Association, president of the Washington Society of Engineers, vice president of the Cosmos Club of Washington and a member of the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Society of Civil Engineers, etc. He is the author of many official reports and of various pamphlets and books, some of which are used as text-books. Some of the better known of these publications were entitled "Agriculture by Irrigation"; "Hydrography of the Arid Regions"; "The Public Lands of the United States"; and "Hawaii: Its Natural Resources."

Mr. H. S. Collette, secretary of J. G. White & Co., Inc., and the J. G. White Engineering Corp., has resigned from those companies and expects to reside permanently in California.

Mr. E. W. Sheets, recently appointed as deputy commissioner of the Missouri State Highway Department, has also been appointed by Acting Governor Painter as delegate from Missouri to the Ozark Trails Convention to be held at Independence, Kans., June 7-8. Mr. Sheets has been county engineer of Marion County, Missouri, for the past three years. He is also secretary of the Missouri Association of County Engineers. Mr. Sheets was formerly connected with the U. S. Office of Public Roads and with the State Highway Commission of Illinois.

Mr. L. H. Brady has been appointed city engineer of San Bernardino, Cal., succeeding Mr. Frank A. Smith, resigned. Mr. Brady is a graduate of the Columbia School of Mines, class of 1904. For the following four years he was mining engineer and mine superintendent for the Guggenheim and other companies in Mexico. In 1909-1910 he was chief draftsman for the board of education of Kansas City, Mo., on mechanical equipment. The following year he was assistant engineer in charge of tunnel construction for the Utah Copper Co., and during 1912-13 was employed in subdivision and general engineering work at Los Angeles. Mr. Brady became assistant city engineer of San Bernardino in 1913, and has held that position until receiving his present appointment.

Mr. John Wilson, civil and sanitary engineer, announces the opening of an office at 300 First National Bank building, Duluth, Minn., where he will engage in the general practice of civil and sanitary engineering, water supply, sewerage, sewage disposal, paving, concrete and reinforced concrete construction, making a specialty of municipal problems. Mr. Wilson received the degree of bachelor of science in civil engineering from the University of Wisconsin in 1903, having completed both the civil and sanitary engineering courses. Previous to graduating he spent three summers with the topographical division of the United States Geological Survey; after completing his course he spent four years in railway location, construction and maintenance. In 1908 he received the degree of master of science from the University of Minnesota, having taken special work in sewage disposal. From 1908 to 1911 he was city engineer of Mankato; from 1911 to 1912 special assistant engineer on sewerage designs for Duluth; and from 1912 to present date has been city engineer of Duluth. During the past eight years he has also been engaged in considerable private practice, and has designed a number of sewage disposal plants and water works systems.

CONTRACTORS.

The Oregon Engineering & Construction Co. of Oregon City, Ore., recently awarded the contract for the construction of the pipe line to bring water from the Clackamas river to Oregon City, has been in business on the Pacific coast since April, 1911, when the firm was incorporated under its present name. Mr. J. W. Moffatt, president of the company, was for 25 years superintendent of construction for the Willamette Pulp & Paper Co. Mr. Charles T. Parker, secretary and manager, is a graduate engineer, who for seven years past has followed construction work. These two formerly operated under the firm name of Moffatt & Parker. Since its organization in 1911 the present firm has handled a considerable amount of street, sewer, railroad and concrete construction work. Among the contracts noted in our "News Section," were street paving in Vancouver, Wash., $60,000, and street paving in Oregon City, Ore., $85,000. The firm has also completed about $85,000 worth of sewer work in various places, and railroad and reinforced concrete work amounting to about $200,000. The present contract calls for 26 miles of National tube, Matheson joint, steel pipe line, including 1,000 ft. of tunnels and about eight miles of rock work in the Clackamas gorge. The contract price is $300,000.

FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409 U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should be made to the file numbers.

Machinery, Railway Supplies.—Business man in West Indies wishes names and addresses of American manufacturers of machinery for sugar mills, railway materials, electrical machinery. No. 16642. [For address see first paragraph.]

Road-Making Machinery, Etc.—Firm in Australia desires to represent American manufacturers and exporters of mining machinery, road-making machinery, and kindred lines; also blasting powder. No. 16680. [For address see first paragraph.]

Water Works.—An American consular officer in Russia has transmitted plans, specifications, etc., for the construction of a water works in his district. Further information relative to this work may be had on application to the Bureau of Foreign and Domestic Commerce or its branch offices, where the plans and specifications may also be examined. No. 16737. [For address see first paragraph.]

Cement.—Business man in South America purchasing about 1,000 bbls. of cement per month would like to arrange to buy direct from dealers in the United States. No. 16571. [For address see first paragraph.]

Street Cleaners.—Officials of Canadian city contemplate purchasing a street vacuum cleaner. No. 16624. [For address see first paragraph.]

Railroad Cranes.—Engineer in Russia desires to place orders for from three to seven locomotive railroad cranes, suitable for a 5-ft. gage, having a lifting capacity of 5 tons. It is stated that these cranes are urgently needed. No. 16716. [For address see first paragraph.]

CIVIL SERVICE NEWS

The United States Civil Service Commission announces an examination for the following positions: Examiner of accounts, Interstate Commerce Commission; Division of Valuation. Salary, $2,220 to $3,000 per annum. June 8.

INDUSTRIAL NOTES

The Peerless Form Clamp Co., St. Louis, Mo., has transferred its general office from the Victoria Bldg. to the factory, which is located at 5072 Delmar Ave., St. Louis.

The James McKay Co., Pittsburgh, Pa., announces that its new forging plant at McKees Rocks, Pa., is now in operation on crank and cam shafts, connecting rods and other miscellaneous forgings.

The Browning Co., Cleveland, O., has received recently a contract from the Alaska Railroad Commission for a $6,000 locomotive crane. The machine will be made up at Cleveland and shipped to Seattle overland, and will go from there to Alaska by boat to be used on the government railroad to be constructed there.

The Edgar Allen American Manganese Co., Chicago, Ill., has changed its name to the American Manganese Steel Co. No change other than the change in name is involved, and the same personnel and management under which the business has been developed will continue to conduct it under the policies which have heretofore prevailed.

The Wright Machine Co., of Owensboro, Ky., has been incorporated with a capital of $150,000 and will commence business May 1. This company succeeds the Gunther-Wright Machine Co., and will manufacture gas engines, also excavating machines and wet dredge machines, equipped with both steam and oil engines. John S. Wright is president of the company.

The Zahner Metal Sash & Door Co., Canton, O., on May 1 celebrated the first anniversary of the removal of its plant from Kansas City to Canton. About 80 men, including members of the sales force, contractors, engineers and architects attended the banquet and celebration. Announcement was made that the company will have completed within a year a new office building and an additional shop building, the size of the present structure, to the north end of the 5-acre tract of land owned by the company near Buck Hill.

The Heltzel Steel Form & Iron Works, of Warren, O., has proceeded with the construction of a new and modern addition to its present plant which will more than double the capacity. The general office will remain at Warren and the Cleveland office will be discontinued after 1915. Offices will be opened in New York, Pittsburgh, and Chicago. Stock of standard form equipment will be carried in New York.

NEW CATALOGUES

Slide Rule.—Paper, 6x9 ins.; 4 pp. Keuffel & Esser Co., New York City.

Describes the K. & E. Surveyor's Duplex Slide Rule, recently placed on the market. Illustrated.

Sidewalks and Curb Forms.—Paper, folder. Blaw Steel Construction Co., Pittsburgh, Pa.

Describes Blaw steel forms for sidewalk, curb and gutter construction. Shows views of actual application in work now underway.

Corporations.—Paper, 3½x6 ins.; 12 pp. The Union Water Meter Co., Worcester, Mass.

Catalogue and price list of the curb and waste stops, hydrant stops, couplings, etc., manufactured by the Union Water Meter Co.

Floor Hardener.—Paper, folder. Trus-Con Laboratories, 1223 Trus-Con Building, Detroit, Mich.

Folder describing and showing view of the crowds at the opening of the "Yale Bowl." Trus-Con floor hardener was used in the finishing of this concrete structure.

Road Building Machinery.—Paper, 9x12 ins. J. I. Case Threshing Machinery Co., Racine, Wis.

Describes and illustrates Case road machinery, and shows numerous views of actual operations on road work. Also briefly describes Case Threshing Machines and Case automobiles, and gives price list.

Steam Appliances.—Paper, 7x5 ins.; 22 pp. Union Water Meter Co., 39 Herman Street, Worcester, Mass.

Catalogue of steam goods, No. 47, describing the chronometer governor and regulator valves, steam fire gongs, steam pressure regulators, etc., of the company. Gives dimensions, capacities and weights and price lists. Illustrated.

Wall Forms.—Paper, 6x9 ins.; 32 pp. Blaw Steel Construction Co., Pittsburgh, Pa.

Bulletin 66, a detailed description of Blaw Light Wall Forms, and summary of the advantages of steel forms, with instructions for using. Illustrations show the wide range of adaptability by picturing some of the structures on which these Blaw forms have been used. Lists other types of Blawforms with catalogue numbers.

Rock, Ore and Gravel Handling Machinery.—Paper, 6x9 ins.; 48 pp. Smith Engineering Works, 32nd and Locust Streets, Milwaukee, Wis.

Catalogue 254 showing "Telsmith" ore and gravel handling machinery. Describes operation and special features and gives tables of capacities, sizes, etc. Line includes various types of "Telsmith" breakers, belt conveyors, gravel washing screens, settling tanks, quarry hoists, reciprocating feeders, belt and chain elevators, etc.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS
H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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Public Regulation of Farmers?

A New York State legislator has introduced "an act to amend the agricultural law" which is a clever parody on the public service commission law of the state. We quote a few of the paragraphs:

> All wagons, and all poles and whiffletrees shall be provided with couplers, coupling by impact, so that the hired man need not go between the wheels of the wagon and the heels of the horses.
>
> Every hired man shall work eight hours only a day, not including the Sabbath, and shall not recommence work unless he has completed a period of not less than eighteen hours absolute rest and quiet.
>
> Every farmer shall hire one more hired man than his work requires.
>
> All bulls, when moving on the highway or in unfenced areas, shall be equipped with a bell of not less than 50 pounds weight, a steam whistle and an electric headlight of at least 1,000 candle power.
>
> If a calf is delayed in arriving or is born dead, the farmer shall instantly provide another cow whose calf shall be born that day.
>
> Only one price for a given commodity shall be lawful. A farmer desiring to change a price shall file a schedule thereof with the State Agricultural Department, which shall go into effect thirty days thereafter, unless suspended by the commission at the instance of any consumer.
>
> To enforce this act a commission of five persons shall be selected by the Governor with a view to placating as many shades of political opinion as possible. No commissioner shall, however, be deemed disqualified by lack of previous political or other experience.

The full text of the proposed act has been circularized by the Brooklyn Rapid Transit Co. The Transit Company disclaims wishing any ill luck to farmers—"that sturdy tribe so often hailed by the orator as the bulwark of the nation"—but it seems anxious to have those of the "bulwark" join those of the "cowcatcher" under the banner of public regulation. The company plaintively remarks:

> We can't help wondering what those engaged in some other callings would do and say if some of the conditions that we are obliged to meet came their way.

Is the "Favored Son Idea" in the Employment of Engineers by State Highway Commissions Desirable?

Many state highway commissions have shown a tendency in the past few years to favor engineers that are residents of the state in the selection of assistant engineers and other employes. In some states requirements of this nature are quite stringent. There are both advantages and disadvantages in the following out of this idea, some of which have not received proper consideration.

It is believed that in no other class of engineering work is a knowledge of local soil and climatic conditions and labor conditions of greater value in the successful prosecution of construction work than in road building. Yet it is also believed that no class of public work lends itself so readily to the building up of a mighty political organization as a state highway department. This fact was demonstrated in New York State several years ago. Could it be possible that in many cases "favored sons" are also "political sons"? If so, the nucleus of a widespreading political machine is formed, most effective since it reaches into all sections of the state. Political sons frequently follow in the way of the father and not all sons are as much devoted to the work of road building as to upholding the hands of the father.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

It is a reasonable proposition that efficient and well-informed engineers that are natives of a state can be found. Also it is desirable that employes of a state as far as possible be natives of the state. But what are the requirements of legal nativity? Are they that an engineer shall have been engaged in work for a specified length of time within the confines of the state? Yes. But legally he must have lived within the state the year, or other required period, just *prior to appointment*. The political value of an employe that has been out of the state several years is nil. If he is living in the state at the time of appointment his friendships have a definite political value. But is not a man of broader experience such as is possessed of necessity by one who has worked abroad, frequently of greater value than one whose work has been confined to one state?

Moreover, in many cases it is desirable that an engineer be unhampered by a too broad acquaintanceship in the neighborhood of his work. In this way any suspicion of favoritism is avoided and the work is carried out with regard alone to the engineering problems involved.

The most efficient highway engineers are those of broadest experience. Under present civil service requirements in many states they become ineligible for appointment on public works regardless of their length of residence in the state unless they reside there just prior to appointment. We believe that the states are losing the services of many good engineers by this ruling and that the danger of political domination is increased many fold by its observance. It is a subject that state societies of engineers would do well to consider.

A Country-Wide Employment Bureau Under Federal Direction.

In one mail there come to us two announcements of different agency means for providing positions for laborers. One is the report of the Department of Public Welfare of the city of Chicago. It outlines the work and methods of "labor agencies" in Chicago and is on the whole a sordid tale of trickery and petty graft. The other is the statement by the Federal Department of Labor that its organization has been completed of a country-wide employment bureau embracing all kinds of common and skilled labor. Because, perhaps, of the refreshment felt in its clean humanitarianism following a half hour in the fetid air of the Chicago report on private agency methods, this announcement of the Federal department seems exceptionally welcome. It has, however, more than this to recommend it to the attention of the engineering construction field. The new Federal bureau is country wide; it has an agency wherever there is a post office; it makes no charge for service; it makes no distinctions of sex, and aliens and citizens may benefit from it alike.

To explain briefly, the United States has been divided into 18 sections or Distribution Zones and in each of these zones an employment office has been opened. These zones in nearly every case have been subdivided and branch offices opened under the jurisdiction of the controlling zone office. At any of these offices the employer who needs help of any kind, skilled or unskilled, can secure service without expense or any other requirement than a statement of his desires in person or by letter. Neither is any fee required from those who seek employment. The service goes even farther. At every post office in the United States will be found on application to the postmaster blanks for the use of employers in need of help and of unemployed persons seeking employment. These blanks, upon being handed to the postmaster, are transmitted by him, free of charge, to the proper zone office, where both blanks are properly registered, and proper help selected for the employer in need of help, either from applicants residing in the city in which the office is located, or from the applications on file. On the day the employer's application is received by the Distribution Office, a copy is sent to the Division of Information, at Washington, D. C. At frequent intervals these applicatons are assembled and published in the form of bulletins and distributed to all distribution offices, thereby making it possible for each office to know where help of any description is in demand.

The assertion is emphasized that selections for positions are made entirely on the basis of fitness of the applicants. Only upon such a basis can the services of the bureau stand high. Unfortunately, the job just now is not seeking the man, but we urge those of our readers who may have call for labor to seek the service of the Federal Labor Bureau and learn its efficiency.

Taking Inventory.

It is an established custom—brought about by necessity—for merchants to take inventories of their stocks at definite periods. The taking of these inventories is not a mere formality, but the work is done with thoroughness and care, and the actual values of stocks on hand are sought. It is necessary for the merchant to determine whether or not his business is being conducted profitably, both from a personal standpoint and in order that he may establish credit for future purchases. Some contractors—not all—realize the importance of knowing what their equipment is worth at certain times, in order to determine the depreciation factor and thus ascertain whether their profits are real or imaginary. As a rule, the tangible equipment possessed by the engineer is small. If he is in consulting practice, possibly he owns a desk or two, a few drafting tables, and other miscellaneous equipment. If he is an engineer in the employ of another, his equipment probably consists of a slide rule, some drafting instruments, and a few books; and many such engineers value and use these possessions in about the order named.

In the case of the average engineer, taking inventory appears to be an easy task. But is it? What really constitutes the chief asset of the engineer? Obviously it is not equipment—ordinarily it is not wealth. His main asset is, and must always be, his ability to do useful, constructive engineering work—either design or construction, or both. His success will depend: first, upon whether or not he possesses brains and knowledge; and second, upon his ability to *create* a market for them. Brains, he possesses, or lacks, at the outset; but knowledge—and the ability to market this knowledge—must be acquired.

Many engineers either fail completely or achieve only mediocre success because they are unable or unwilling to take careful inventory of themselves. Every engineer should, occasionally, seriously debate with himself the question as to whether or not he is advancing, in knowledge, in influence, and in compensation. He should attempt to discover in what activities he is merely wasting his energy, and to what extent he has neglected to take advantage of opportunities and of natural ability. He should seriously question his fitness for the work he is doing, and, if he finds himself "out of place," he should face the fact honestly and courageously, bearing in mind that the most successful men have always been compelled to make such decisions. He should compare himself with those about him, and should seek to discover the things he can do better than they. On the other hand, he must be honest and not try to make himself believe he is succeeding if "convincing himself" appears to be a difficult task. Many men apparently convince themselves that they are unselfish and praiseworthy merely because they withdraw from competition and permit the other fellow to advance—they are unwilling to acknowledge that laziness is their chief motive for so doing. If the engineer will carefully inventory his abilities and deficiencies he will by so doing "know" himself, and when this knowledge is gained he will find that his employer also knows him, favorably.

The accompanying list of questions—taken from an article by Edward Earle Purington, in *The Independent*—may well be given careful consideration by engineers and contractors.

> Do you like your work?
>
> Have you learned the best, quickest and easiest way of doing it?
>
> Do you know where your greatest power lies?
>
> Have you a fixed goal, in line with your supreme talent?
>
> Do you believe absolutely in your own future?
>
> Have you learned how to get well and keep well?
>
> Have you made an inventory of your mental and moral traits?
>
> Are you correcting your own weaknesses: mental, financial, social or spiritual?
>
> 'Have you discovered which foods, baths and exercises increase your energy and heighten your mentality?
>
> Are you independent, fearless, positive?
>
> Are you tactful, cautious, courteous?
>
> Have you secured the best possible advisers and associates?
>
> Do you wish your rivals well, and never speak ill of them?
>
> Do you work harder than anybody else in the business?
>
> Have you learned the science of planning your day ahead?
>
> Can you relax entirely in your leisure hours?
>
> Are you saving money systematically?
>
> Do you enjoy art, music, literature and the presence of little children?
>
> Does your highest, ambition include some real service to humanity?"

In giving your best answers to these questions you will, no doubt, be surprised to learn how much there is concerning yourself about which you are not certain, or at least are not satisfied. You are constantly being called upon to answer some of these questions, although they may not be put in this form, and you may not realize that answers are being required. You are to be congratulated that, at this time, you are not compelled to show your answers to your competitors, or even to your associates—although you are fortunate if you have some trusted friend who will give you his frank and constructive criticism. It may be well to set down your answers in writing, and compare them with answers submitted six months and a year from date. You may "flunk" on your first examination, although it is up to you to show increasingly better results at subsequent tests.

Inaccurate Municipal Accounting and Cost Keeping.

The Wisconsin Railroad Commission has frequently criticised the accounting of city water departments and other city departments having charge of public utilities. More pronounced and far more sweeping are the criticisms of the same sort made by the U. S. Census Bureau in the volume entitled "Financial Statistics of Cities." To quote:

> With few exceptions cities do not include depreciation among their expenses, nor do they make adequate provision for it in their accounts. As a result, the reports of all cities exaggerate their outlays or expenditures for additions to their permanent properties and public improvements and understate their current expenses.

This misstatement of capital costs is not confined to cities. It is also found among public utility companies, to some extent, particularly where the companies are not profitable. The object in the case of such companies is to make the net earnings seem higher than they really are, and thus to make easy the sale of their bonds. In the case of cities the object is to show a lower operating cost than really exists, and thus to give an appearance of profitable operation. New plant purchased to replace obsolete or inadequate plant is charged to plant account instead of to maintenance, and thus the deception, with intent or from ignorance, goes on. But it could not go on if there were a periodic appraisal of the property, which appraisal, unfortunately for the public, rarely is made.

Quoting again from the Census report:

> Inaccurate statements of governmental costs are found in the reports of all cities with public service enterprises, such as water-supply and gas-supply systems, in which no account is taken of the value of the public utilities furnished other departments by such systems.

This relates to the income from operation. The argument is quite properly made that each department of a city should conduct its accounting as if it were a separate company, and should charge every other department at least the cost of services rendered.

In a certain municipality whose electric lighting department is generally believed to be profitable there is, in fact, not even a bond interest rate earned on the entire investment. A careful analysis of investment costs and operating expenses made by the writer disclosed the fact that $500,000 had been borrowed from the "general fund" of the city and invested in the plant, but the "general fund" was credited with no interest on this sum. Another large sum had been raised by direct tax upon the abutting property, and this, too, showed no interest debit. The "depreciation reserve" annuity of 5 per cent looked sufficient, until it was seen to be only 5 per cent on the "depreciated value" of the plant, and besides was made to carry not only true depreciation charges but current repairs.

There are countless ways in which an appearance of profitable operation can be secured without there being a real profit. Hence the crying need not only of uniformity in municipal accounting but of a periodic audit of every department by an outside department. In addition, it seems to us, there should be a periodic inventory and appraisal of the property of every department of every city. Once every five years, say, such appraisals should be reviewed by engineers not connected permanently with the city.

The Census report above quoted urges unit cost keeping, for all cities, the sort of cost keeping that engineers are accustomed to make. Here is a field for engineering employment that has as yet been occupied only in slight measure.

Every engineer particularly interested in municipal accounting will profit by reading the report, and particularly by studying the 34 large pages relating to Municipal Accounting Terminology. Nearly all the important terms are defined and accounting methods are discussed.

In this connection let us add that to know the principles of double entry book-keeping is alone not sufficient for the engineer who aims to understand the business and management of public or private enterprises. In addition, some such book as Hatfield's "Modern Accounting" should be thoroughly mastered. Then the accounting rules prescribed by public service commissions should be studied. Finally the detailed processes of book-keeping and accounting of some well organized public utility company should be gone into, preferably by actual employment in the accounting department of such a company, if only for a few months in a minor position.

Engineers in general have been rather deficient in knowledge of corporation accounting. Certainly all who aim to secure managerial positions should hasten to qualify themselves not merely to understand but to supervise the installation of accounting systems as well as cost keeping systems.

The Legality of the Chicago Wheel Tax.

Since 1908 the city of Chicago has imposed tax on all pleasure and commercial vehicles using the city streets. The proceeds from this tax have been upward of $500,000 per annum since the beginning and for the last year, 1914, approximated $700,000. All income from wheel taxes has been by law expended in repair and maintenance of pavements. Early in its life the wheel tax law was attacked and its repeal sought. By vigorous resistence on the part of the city the repeal was defeated. The law was general and applied to any Illinois city, and several other cities besides Chicago enforced wheel taxes. One of these other cities was Lincoln and some time ago suit was brought by a citizen of Lincoln resisting the imposition of a wheel tax against pleasure vehicles as unlawful. Chicago, whose interest was great in the decision, joined with Lincoln and we believe with one or more other communities, in the defense of this suit. Recently the Supreme Court has handed down its decision on this case, holding that imposition of a wheel tax on pleasure vehicles is unlawful. No decision has been rendered on the legality of taxing commercial vehicles and, we believe, action is being taken to reopen the case to determine this question and others.

The preceding explanation has been made without any attempt at legal preciseness in statement because Chicago's wheel tax has aroused interest in many cities and has been rather widely cited by city street officials as a possible means of direct taxation for street maintenance. It has another phase, of course, to the street officials of Chicago. Should the taxing of all vehicles be held illegal it will deprive, at one stroke, the street department of Chicago of from one-half to three-quarters of a million dollars heretofore since 1909 devoted to street repair and maintenance. This would be a matter of financial moment to any city, but for Chicago with its increasing shortage of funds for works of public service it amounts to real deprivation. It is perhaps worth while in these circumstances to review broadly the work that has been done during four years and particularly in the last calendar year of record with the funds of Chicago's wheel tax.

The wheel tax law was passed in 1908, and the first collections amounting to $500,186, were available in 1909. Expenditures have approximately equaled collections, averaging the six years including 1914. Comparisons for 1914 are not available, but those for 1913 are, and indicate as well as would later figures the character and cost of the street maintenance work done with wheel tax funds. We quote from a statement by J. L. French, efficiency engineer, Chicago Civil Service Commission:

> Since the city began to repair its roads and pavements under the wheel tax in 1909, the cost

of doing this work has been decreased and the areas covered proportionately increased each year. The annual reports of the bureau of streets indicate the quantities and cost of repair and maintenance work. The comparison of the figures of 1910 and 1913 are interesting. In 1910 approximately 100,000 sq. yds. of asphalt pavement were kept in good condition at an average cost for repair of $1.15 per yard and at an average cost for maintenance of 6.9 cts. per square yard. In 1913 the average cost of repairing approximately 150,000 sq. yds. of asphalt pavement is shown to be 81 cts. per sq. yd. for repair and 3.4 cts. for maintenance.

The average cost for caring for approximately 54,000 sq. yds. of brick pavements in 1910 was $1.01 per sq. yd. for repair and 6.9 cts. per sq. yd. for maintenance. In 1913 a similar area of brick pavement was repaired at an average cost of $1.17 per yd. for repair and 5.2 cts. per yd. for maintenance.

Approximately 65,000 sq. yds. of granite block pavement were maintained in 1910 at a cost of 60 cts. per sq. yd. for repair and 11.5 cts. per yd. for maintenance. In 1913, 60,000 sq. yds. of granite block pavement were repaired at the cost of 53 cts. per yd. for repair and 4.3 cts. per yd. for maintenance.

During the years 1909 to 1914 an average of approximately 1,500,000 sq. yds. (85 miles) of macadam pavements have been maintained each year at a cost varying from 12 to 16 cts. per square yard for maintenance. In addition to this macadam repair work, 5,000,000 to 6,000,000 sq. yds. (280 to 350 miles) of macadam pavements have been oiled each year at a cost varying from 6.4 cts. to 2.15 cts. per square yard.

Up to July 1, 1914, $450,000 of the $650,000 collected in 1914 vehicle license fees had been expended in the repairing of roads and pavements. The greater portion of this work was completed early in the season so that the traffic is benefiting by the repair work at the present time. This amount has been distributed as follows:

	Miles.
Asphalt, approximately	100
Brick, approximately	35
Granite, approximately	10
Macadam, approximately	300
Asphaltic concrete, approximately	5

The number of square yards of each of the above, with the total and average costs, as prepared by the bureau of streets, is shown to be as follows:

Pavement.	Repaired. Sq. yds.	Total cost.	Per sq. yd.
Asphalt	89,123	$81,525.00	$ .95
Brick	30,440	32,368.00	1.06
Granite	30,900	17,000.00	.55
Macadam	376,960	75,392.00	.20

These statements and quantities are far from a final enumeration of the benefits derived by Chicago from its wheel tax fund but they indicate plainly the character of these benefits. They will be hard to do without and difficult to attain by any other means no more burdensome.

DRAINAGE AND IRRIGATION

Notes on the Design of Drainage Ditches, With Diagrams.

Contributed by W. H. Poe, Warner & Poe, Engineers, Benton, Mo.

The writer points out in this article what he considers the proper method of design of open ditches, and presents some ideas, which, so far as he knows, have never before appeared in print. It may be well first to consider the status of an engineer retained by a drainage district to design and superintend the construction of its system of drainage. He is a quasi-public official, owing his best efforts to the successful discharge of the duties imposed upon him by his selection, but he should look upon those duties in an impassionate manner, neither allowing himself to be swayed by a desire to make low estimates in order to ensconce himself in the good graces of a few taxpayers at the expense of some unfortunate and unsuspecting contractor, or, on the other hand, not allowing any act or suggestion upon the part of the contractor to influence him to commit any act or arrive at any decision detrimental to his district. His position usually gives him a wide discretion in the adjustment of the affairs between his district and the contractor, and within the limits of that discretion they must both place their trust in him, and he should not allow his employment by the district nor his friendship or ill-will toward the contractor to influence him in the least in the administration of their respective rights and liabilities. In the design of the system proposed he should use his best efforts to see that the entire layout is so coordinated and adjusted that the contract price should be a minimum, but in his zeal, he must not place pitfalls and snares for inexperienced contractors. At nearly every ditch letting there are one or more bidders who have had no experience in this line, and have not been up against ambiguous phrases in specifications or cross-sections reduced considerably below that necessary to float the dredge boat which the engineer probably knows will be used, and in their anxiety lest some other man may get the job, they may name prices that will call for the services of a referee in bankruptcy. While a bond is always required to cover such cases, and the doctrine of *caveat emptor* applies, forcing a surety to complete the contract is not an economical proposition, and it is usually cheaper for a district to pay what the work is worth than to resort to such methods, to say nothing of the moral question involved.

GENERAL CONDITIONS TO BE MET.

The thing of most importance to an intelligent design of a drainage system, and strange to say, the one most neglected by drainage engineers, is the cost, operation and capacity of the equipment and machinery that must be used in constructing the work under consideration. It should be remembered that the district must pay for the errors and bad judgment of the engineer in laying out the work, and if the contractors find a system that is laid out so as to call for expensive methods of construction when by a different arrangement much less expense would attach, they do not consider it their business to indicate their disapproval, but merely add the extra cost to their bids. The contractor is in business to make money and not to act as consulting engineer, and no doubt his good advice would be resented. The subject of excavating machinery is a large one, and the reader is referred to some of the excellent treatises already published. Information as to the maximum and minimum working capacities of the various machines used in the construction of drainage ditches may be found in the manufacturers' catalogues which are valuable additions to the library of a drainage engineer. The manufacturers will usually advise an engineer as to special conditions which he may meet, but this is usually unnecessary. Space forbids anything further than a few general remarks and suggestions regarding contractors equipment, and these will be confined to the most usual type used, that is, the dipper dredge mounted on a floating hull. As a general rule the cheaper the plant, the cheaper will be the cost of construction. This is not always the case, however, so the engineer must carefully consider his design from the standpoint of the contractor so that there will be no necessity of an unduly expensive plant, and at the same time the work will be prosecuted in a rapid and efficient manner.

In this same connection, study should be given the dimensions of the cross-section. Each plant has its limitations of minimum and maximum working conditions, and if the variation between the largest and smallest section of ditch to be constructed by the same machine is greater than the limitations of the plant, the cost of the work is enhanced by either requiring a larger plant or expensive work. Very often slight changes of the grade line may be made that will meet these objections and not impair the efficiency of the ditch. The size of the ditch that may be constructed with a given machine depends upon the size and buoyancy of the hull and the length of boom and dipper handle. Since a boom of any length may not be indiscriminately placed upon any size of hull, the limitations mentioned above are explained.

It is useless to design a ditch smaller than the machine to be used can properly dig. The yardage will be smaller, it is true, but the unit cost will be proportionately greater, and the contractor, in his effort to get his boat through with the least amount of work, may not take sufficient pains with the side slopes, and defend himself on the ground that he is already doing more work than the specifications call for. Since there is no reduction in cost, there is no reason for risking disputes and probable injury to the ditch. The engineer should therefore differentiate between the cost of making some ditches larger than necessary, and adding additional small machines. There are two reasons for this: one, that since the district must pay the bill either way, it might as well be decided by the engineer, and second, the addition of another machine may make a change of grade necessary on account of a different method of construction, as will be presently explained.

Another subject that should be given consideration is the manner of construction and the effect that it will have upon the grades and cost of the component structure of the system. As a rule the most economical method of construction is to begin at the head of a ditch and work downstream. But very often transportation facilities are inadequate and it becomes more economical to begin operations at the intersection of the ditch with a railroad or good wagon road, and construct part of the system upstream and part downstream. Upstream work is almost as cheaply done as downstream if water conditions are right. Water comes to rest on a level plane at the height of the natural ground at the terminus of a ditch unless there is a considerable inflow, and does not take the inclination of the grade line. If on this account the water finally becomes too low to float the dredge, the contractor must either dig deeper than the specification calls for or erect dams behind him, and if there is no source of supply ahead, he must also pump sufficient water to float the dredge. Either of these methods are costly, and the former is open to the further objection that the flattening of the grade line due to the excess excavation may materially disarrange the calculations of velocity and discharge, and the capacity of the ditch may be materially reduced. It is therefore well for the engineer to carefully consider the design of all of the work that it may be expedient to construct upstream.

DESIGN METHODS.

The subjects of runoff coefficients and field location are covered by many excellent and widely disseminated papers and books, and nothing that the writer could say would add anything to the information already at the disposal of the profession. The solution of these problems depends upon the judgment of the engineer based upon the conditions to be met.

The capacity of a waterway is determined, according to the lore of famous hydraulicians, according to the area of cross-section; slope of the water plane; the hydraulic mean radius, and the degree of roughness of part of the waterway over and through which the water must find its way. Many excellent formulæ have been devised to martial these many conditions in such form as to produce values for the velocity of flow agreeing with experimental results. Among the best of these is the Chezy formula using the Kütter or Bazin coefficient, but on account of the many constants and variables employed, they are difficult of application. The writer has slightly modified the Kütter-Chezy formula by considering the slope to have no effect upon the value of the coefficient of velocity, and using a value of 0.025 for the coefficient of roughness, which has been recommended by high authority for the design of drainage ditches:

$$v = \frac{130\,r}{\sqrt{r} + 1.44}\sqrt{s} \quad \ldots\ldots(1)$$

where v = mean velocity, r = hydraulic mean radius and s = the sine of slope, or the fall for a given distance divided by the distance.

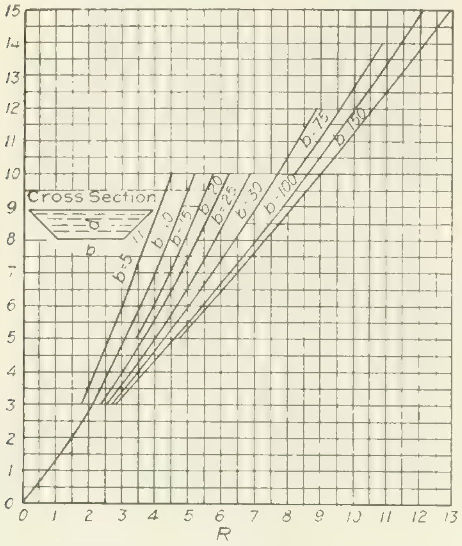


Fig. 1. Diagram of Hydraulic Mean Radii.

(Ordinates indicate depth of flow; abscissas indicate mean radii. Curves are loci of the equation $R = \frac{(b + d)\,d}{b + 2.828\,d}$ for several values of b and d.)

It will be found that this formula agrees within about 2 per cent, with values computed with the Chezy formula for the values of r and s usually encountered in drainage practice. For values of r between 6 and 16, and s between 0.00005 and 0.0005 the following simple formula gives fairly close results:

$$v = 133\,(\sqrt{r} - 1)\,\sqrt{s} \quad \ldots\ldots(2)$$

This formula is wholly empirical, however, for when $r < 1$, it gives negative results which is of course absurd.

The writer has constructed diagrams shown in Figs. 1 and 2 to facilitate the proper design of drainage systems. Figure 1 gives the hydraulic radius for the cross-sections usually met with in practice. Figure 2 gives the velocity of flow in channels having the usual values of hydraulic radii and slope. Both diagrams are self explanatory, and values not given directly may be easily interpolated. Values given by Fig. 2 were obtained by solving formula (1) for v, after substituting the proper values of r and s. It might be well to note that v varies directly with $\sqrt{s}$, so that when v is taken from the diagram for $s = .0001$, its value for any other value for s is

$$v' = v\,\frac{\sqrt{s'}}{.01}$$

where v = velocity as taken from the diagram; v' = velocity sought, and s' = the sine of the slope for which the velocity is sought.

For the purpose of further facilitating the comparison of the hydraulic properties of different cross-sections the writer has prepared a series of diagrams which indicate the capacity of ditches of different bottom widths and slope, but lack of space prevents them accompanying this article, because a separate diagram is necessary for each value of s.

After determining the velocity by means of the formula or diagram, the capacity is easily determined by multiplying the velocity by the area of cross-section.

The method of design used by the writer, after determining the capacity necessary for each ditch, is to determine tentatively the layout likely to be used in construction. This is at first nothing more than a guess, which will be confirmed or rejected as the later calculations show them to merit. This fixes a limit upon the width of the ditch, as previously explained. A profile is drawn and a grade line tentatively fixed. The height of the grade line is determined by the machinery employed and the topographical conditions of the watershed of the particular ditch under consideration. The ditch should be deep enough for sub-drains to be efficiently located. Another rule to observe is that the bottom width should not be less than the depth, or there is danger of the bank caving in and forming a shoal in the bottom of the ditch. These data then, fix the maximum and minimum dimensions of the ditch. The effective depth is then fixed by drawing a maximum flow line indicating the highest point that it is desirable for the water to flow during flood stage. By assuming values for the bottom width and using the formulæ or diagrams above mentioned it can be determined whether the assumptions first made were correct. It would probably be better to make these preliminary calculations for all of the ditches in the system before undertaking to change the position of any of the grade lines or dimensions. In this manner it will no doubt be possible to co-ordinate the entire system without making any startling changes in the original assumptions, if they were very nearly correct. Between the maximum and minimum cross-section that may be economically excavated with a given size and type of machine, the cost of operating will be about proportional to the work done, but since the original cost of the plant is the same, the work may be done cheaper per cubic yard when working under maximum, than under minimum, conditions. Very often a slight change in the grade line will meet all of the requirements of economical construction.

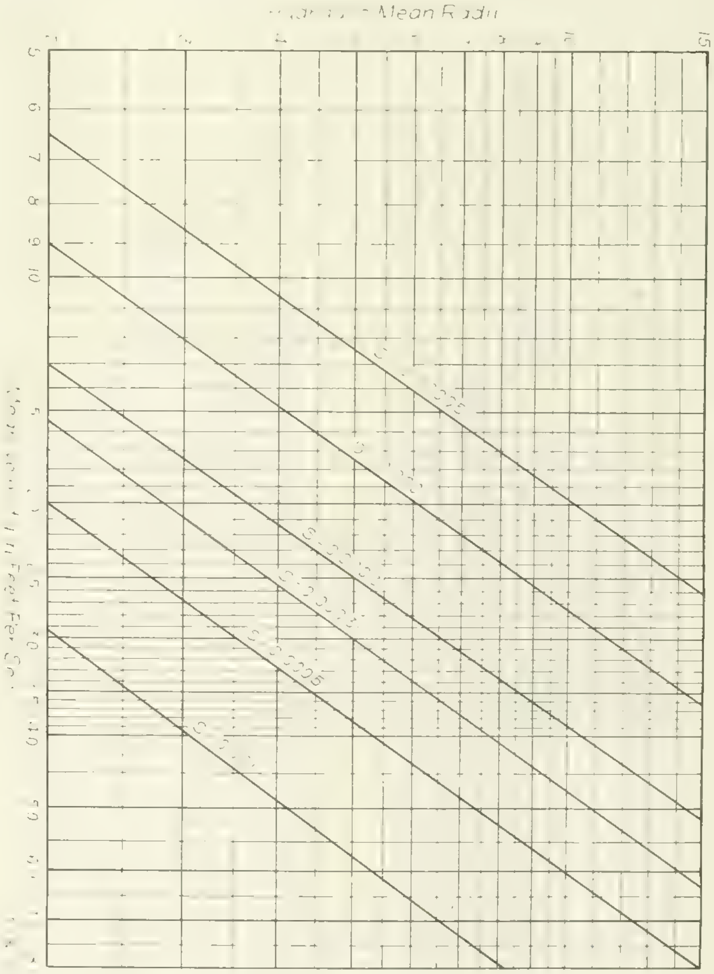


Fig. 2. Diagram of Mean Velocity.

(In earth channels in fair order, no weeds or stones. Formula $V = \frac{130\,r}{\sqrt{r} + 1.44}\sqrt{s}$; V = mean velocity, r = hydraulic radius, s = sine of slope.

The velocity of flow is another subject that should receive the attention of the designer. It should be great enough to prevent the deposit of any but the heaviest silt carried and must not be great enough to cause scouring. The numerical limits to be set depends upon the character of the soil and the dimensions of the ditch. A large ditch may safely stand a greater velocity than a small ditch. The engineer must depend upon his judgment in fixing these limits. The velocity in the component parts of the system should be so regulated that, working downstream, it should not decrease, and the increment between successive sections should be small. The reason for this is that a decrease in the velocity during flood stages, when the water carries more or less silt, will cause the suspended matter to drop, thus causing the ditch to shoal. A large increase in velocity will cause eddies, producing the same result. Another frequent cause of eddies, and the consequent deposits of silt, is allowing laterals and sub-drains to intersect with the ditch at a large angle; this should never be done, but the lateral or sub-drain should be curved so that the directions of flow in the two waterways are almost the same.

In conclusion, the writer wishes to state that, while a consideration of all of these points will take time and much study, they are all based upon sound engineering principles, and if the engineer wishes to design a system that will at once be economical and efficient, he must give them his most intelligent consideration.

Methods of Plaster Lining Irrigation Canals and Laterals, Okanogan Project, U. S. Reclamation Service.

(Staff Abstract.)

This paper will only take into consideration the methods, cost and efficiency of plaster lining, such as has been done on the Okanogan Project. This lining has for the most part been put in the canals and laterals already constructed, and is one and a half inches thick. Practically all concrete has been mixed with a gasoline power concrete mixer.

DESIGN OF CROSS SECTIONS.

1. The cross section of the concrete lining should be as near an ideal economic section as it is possible to make for new ditches, taking into account the cost of laying as well as the cost of the material. For ditches already constructed, with less than a 3-ft. base and 3 ft. in depth, an economic section can be designed by lowering the grade and backfilling on the sides without making the cost excessive, but if the water surface is fixed, as is generally the case upon ditches that have been constructed and in operation, it may be necessary to raise the sub-grade which will make the backfill excessive, and the cost per lineal foot more than for a section of wider base.

2. In practice it is not economical to build an economic section in small ditches, as the cost of preparing the base and laying the concrete will increase the cost considerably more than the saving that is made in the amount of material used, as the bottom width is made too narrow to work in to advantage. This particularly applies to ditches having a depth of between 1 and 2 ft.

3. For all ditches over 1 ft. in depth it is not economical to plaster them without working in the bottom, and with the bottom width made so narrow that the plasterer can neither stand nor kneel, without danger of tearing down the side slopes when he moves, and thereby causing extra work to fix them up as the plastering is done, which will increase the cost to a great extent either by additional help necessary or by delaying the concrete mixer and the balance of the crew.

4. The side slopes for plaster lining should not be steeper than 1½ to 1. A steeper slope requires the concrete to be mixed too dry to spread easily and to obtain an impervious finish without extra labor, and whenever the concrete is mixed a little too wet it will naturally run if laid on a steeper slope.

5. A berm not less than 4 ins. wide should be used on small laterals up to a depth of 1 to 2 ft.; for greater depths this berm should be increased to 5 or 6 ins., and for side hills should not be less than 6 ins. for any size lateral, and may often need to be wider.

6. This berm not only serves to strengthen the top of the lining, but also prevents surface water from getting under the lining, when it is properly covered with earth after being laid. Ordinarily no harm would come from allowing any surface water to get behind or under the lining, but in the latter part of the winter, such as we have at Okanogan, when the snow is going off, it may thaw very rapidly for one or more days and then freeze very hard, in which case if the water is allowed to get under the lining, heaving will take place and considerable harm may be done.

7. When a ditch is all in a fill a minimum berm of 4 ins. may be used with safety, but along side-hills where there is considerable drainage into the canal, a wider berm should be used, then after it is laid it should be well covered with earth. Where the water has been flowing into the canal in well-defined drainage channels, these should be taken care of by allowing the water to get into the lining by lowering the side of the lining from 4 to 6 ins., and widening the berm to sometimes as much as 2 or 3 ft., which will prevent the water from getting under and damage following.

GRADE AND ALIGNMENT.

8. For small canals carrying 100 c. f. s. or less, the stakes should be set so that they can be used for both grade and center line. One stake set every 10 ft. is sufficient; this should be set on the sub-grade of the back-fill or the bottom of the lining, so that a template can be set on the grade hub, and the back-fill material placed so that it comes flush with the top of the hub. By setting the grades in this way it is not necessary to remove them when the concrete is put in place.

9. The grade and lines should be checked after the back-fill has been placed and flooded, and before the final finish to neat lines, which is done before the placing of the concrete.

EXCAVATION FOR BACK-FILL.

10. Where a new ditch is constructed with the idea of lining immediately, it is constructed to fit the cross section of the lining which has been designed and which should be an economic section, but where the ditch to be lined has been constructed for some time and has been in use, there is generally some sod to be removed at the water line. Even if it is economical to reduce the section it is necessary to slope these sod berms so that the back-fill will not settle away from any part that might be overhanging.

11. The economical crew necessary on this work has been found to consist of a sub-foreman, with anywhere from 10 to 20 men, depending upon the size of the ditch, and the amount of excavation to be done. The efficiency of the crew is cut down considerably if they are strung out over a long section of the ditch.

12. Two men go ahead with a template to which a carpenter's level is attached so that it can be kept level, and excavate trenches at each grade hub on the sides, and bottom, if necessary, these trenches being excavated to the neat lines of the section as it is to be before the back-fill is placed. The excess material between the trenches is then removed by the remainder of the crew. No straight edge is used on this work, as it does not need to be any more accurate than can be done with the aid of the eye. It is perhaps needless to add that the template must be kept centered on the grade hub, and level when digging these trenches.

HAULING AND PLACING BACK-FILL.

13. The material used for back-fill may be any material that is very pervious to water, so that in case of ground water getting under the lining during cold weather, it has a chance to seep away before freezing can take place.

14. In places where holes of considerable size are to be filled, boulders and large rocks are used to fill in, if handy, and if not, sand or gravel is hauled for this purpose, a minimum thickness of three inches is used.

15. The back-fill should be hauled, and where possible dumped on both sides of the canal; where the back-fill is heavy it will pay to bridge the canal. All bridges built for hauling back-fill should be built high enough to be out of the way of the lining and left in place until the lining is completed, as they will come in handy to cross when stringing out the running boards, and also may be located so as to form part of the platform for the set up of the concrete mixer.

16. The amount of back-fill should be checked at each grade and the line hub with template, to see that the required amount is being placed.

17. Two five-men crews, each with a template, under one sub-foreman, have been found to be the most efficient sized crew to employ in placing this back-fill in the canal. Any number of crews, of course, can be used, with additional sub-foremen. All sub-foremen used in the preparation and lining must work.

18. Back-fill should not be hauled any faster than it is being placed, so as to avoid having an excess, or an insufficient amount in any one place.

FLOODING AND FINISHING BACK-FILL.

19. In order to settle the back-fill properly and give it a good wetting so that it will not draw all of the moisture from the concrete, it has been found necessary that it should be thoroughly soaked by flooding, before giving it the final finish. Only a small amount of water should be used in the flooding, and this should be let in slowly to prevent washing the back-fill off from the slopes.

20. If there are not enough permanent checks in the canal so that the water may be checked up to within at least a few inches of the top of the back-fill, temporary checks should be constructed at necessary intervals. For small canals and laterals a sack dam has been found the safest and cheapest to construct and to remove, and serves the purpose better than any other temporary structure.

21. The dams should, of course, be constructed before the water is turned in and then allowed to fill up and run over the top, so that the upper section can be well soaked, while the section next below is slowly filling. After all sections have been thoroughly soaked the water should be let out slowly in order not to carry away any back-fill, or cause any to sluff down from the slope; there is a tendency for this to happen if the water is lowered suddenly. After the water has drained out, the finishing of the back-fill should be started as soon as possible, as the wet back-fill works better than after it has been allowed to dry out to any great extent.

22. In finishing, the greatest care should be used to see that the finished section is as near the theoretical section as it is possible to make it, without too great an expense, as the capacity of the lined section may be considerably reduced if it is not carefully straight-edged, this being particularly true on ditches with a steep slope. Particular care should also be taken with the corners, where the bottom and the side slopes meet, as a rounding corner will hold the plasterer's straight-edge away from the slope, and will not only make a kink in the alignment of the side slope and decrease the capacity of the ditch, but will increase the amount of concrete for the lining.

23. The crew for this work should consist of a sub-foreman with from 16 to 20 men; there should be three men with a template, who go ahead and set the template on the grade hub, and after it has been centered and leveled, thin strips are inserted under the template on the side slopes for the straight edge to slide upon.

24. The upper ends of these strips are set just even with the top of the template and should be at least two inches longer than the side slope so that they can be pressed into the back-fill in the bottom to hold them in place after the template has been removed.

25. For small ditches, whose side slopes do not exceed 4 ft. in length, ordinary plaster lath has been used with very satisfactory results; for larger ditches, 1x2-in. material serves the purpose. Four men are employed on the straight edges; these straight edges are made of 2x4-in., 12 ft. long, planed smooth on all four sides. One man works on each end of the straight edge. The first time it is stroked with the straight edge the flat way, and for finishing it is run on edge to remove any excess material that may be left, on account of the straight edge springing when flat, a straight edge is worked on each slope. Behind the straight edge crew, from five to ten men are employed in shoveling out the excess material and leveling up the bottom. Back of these, four more men are employed, one on each berm and two in the bottom. The two men on the bank are employed in cutting the berm level with the top of the strips which have been set with the template. The men running the straight edge should mark the top of the berm with the straight edge by pressing it back from the top of the strips, and thus making a mark that these shovelers can follow. These shovelers should use long-handled, square-pointed shovels, and the berm should be cut level for a distance of not less than 10 ins.

The two shovelers in the bottom are employed in finishing the bottom ready for concrete. They also use square pointed shovels, to make the square corners at the junction of the bottom with the side slopes.

AGGREGATE.

26. The Okanogan Project is very fortunate in having an abundance of aggregate. A long haul is hardly ever required, as aggregate of a good quality can generally be found near the work. Seldom is a haul of a mile required.

27. Pit run has in general been used, and everything has been screened out that will not pass a one-inch screen. This leaves generally a preponderance of sand, and is just what is wanted for plaster lining. Tests as to the volume of voids in the aggregate are often made, and the amount of cement necessary has varied from 1:4½ to 1:5½, generally running about 1 to 5.

MIXING AND PLACING.

28. *Equipment.*—The mixing on the Okanogan Project has been done with a Northwestern ¼-yd. power mixer, equipped with a self-loading bucket and a rotary pump for supplying water.

29. It has been found economy, however, to have the pump run by a small engine of 1½ HP., separate from the mixer. The pump and engine are both mounted on a small platform, which could be moved from one set up to another by hand, unless a long move was made, in which case it was hauled in a wagon.

30. The pump was placed at the upper end of the section to be lined, where the water supply is, and a 1¼-in. supply pipe run from the pump to the mixer. The length of this pipe varied from 300 to 400 ft., depending on the length of the set up and location of the mixer, the mixer being set up as near the center of the section as the local conditions would permit.

31. This method of furnishing the supply of water for mixing has been found far better than the old plan of working the pump with the engine on the mixer, as in this case it was necessary to run the supply pipe in the bottom of the ditch, to the mixer, because it was impossible to get the joints tight enough so that the pump would lift the water from the ditch, at a distance of 300 to 400 ft. When the pipe was laid in the bottom of the ditch it was considerable of a handicap for the plastering crew working on that end of the section.

32. The platform for the mixer is set on solid ground whenever possible, and in a good many cases where the lower bank was narrow, a temporary bridge was built across the canal and the mixer set on this. The minimum size for a mixer platform is 16x16 ft., and in most cases this was increased to 16 ft. by 20 ft., with the mixer set cross-wise on one end. The platform is nailed down in all cases to make it solid, so as to facilitate the movement of the wheelers to and from the discharge door of the mixer.

33. The time of discharging the batch of mixed concrete from the mixer with the wheelbarrow is one of the limiting conditions to the maximum output, and special effort has been made to eliminate all delays at this point. There should be an incoming and an outgoing runway in each direction, to avoid confusion at the mixer. The mixing and placing is handled by one sub-foreman, who must be a very energetic fellow, and who can see to the details which aid or hinder the total day's work of the crew. He must also be ready at all times to lend a hand on anything that may come up and need immediate attention.

34. The runways used for the wheelers were 1½x12-in. and 1½x10-in. planks, 16 ft. long; the latter were just as convenient as the former and seemed to last longer without splitting at the ends, besides being easier to handle and cheaper first cost. Two complete sets of mixer platforms and running boards were used, the set not in use being moved ahead for the next set-up, and were all in place when the mixer was ready to be moved. Where there is a low bank and the concrete lining comes near the top, the running boards should be set out at least three feet from the edge of the lining, where it is possible. They can be set closer when necessary, but when they are set closer the wheelbarrows bother the plasterers when working near the top of the lining, and this should be avoided if possible. Wherever it can be done, the bank should be leveled off for the full length of the set-up on the outside of the running boards, so as to provide a return runway for the empty wheelbarrows. If it is not economical to do this, then frequent turnouts should be made so that the empty wheelbarrows can avoid the loaded ones without losing any time.

35. The platforms for dumping the concrete on, at the point where it is used, are 6x6 ft., set on trestles 2 ft. high. One-inch boards and 2-x4-in. are used in making these platforms and trestles. In the case of small ditches, the platforms are laid across the ditch, from bank to bank, while in medium sized ditches, of the right height, one trestle is used in line with the ditch, and the other end of the platform is put on the bank. These platforms are moved ten feet at a time.

36. *Mixing.*—The cement and gravel are placed in the loading bucket together, and the water is started running with the mixing drum, as the bucket starts up to discharge. In this way all the batch is mixed to the same consistency. The mixing should be continued for one minute and enough water applied to make it wet enough to spread easily. The man who runs the engine operates the loading bucket and the water supply. The operator signals the man at the discharge door when the batch is ready. Two or three men are required to load the bucket with gravel, and one to handle the cement. It takes two and a half minutes to mix and unload a batch.

37. *Wheeling.*—A good concrete wheelbarrow is needed for this work, having a guaranteed capacity of 3 cubic feet of wet concrete. The number of wheelers required depends upon the length of the set-up, and height of runways above tables. Under average conditions, with a 700-ft. set-up, ten wheelers can keep the mixer running to full capacity.

PLASTERING.

38. The tables or platforms, for a 600-ft. set-up, which is the best length to use under average conditions, are located as follows: Table No. 1 is located at upper end of the section; Table No. 2, 140 ft. below No. 1; Table No. 3, 300 ft. below No. 2; Table No. 4, 460 ft. below No. 3. All four crews work in the same direction, which keeps the total average length of haul the same until the section is finished. The difference in the length of sections for the two middle and the two end crews is made on account of the concrete being harder to plaster and finish after it has been hauled the greater distance. When concrete is hauled from 400 to 500 ft., it is necessary to remix it after it is dumped on the tables, on account of its settling while being hauled. On this account the length of set-up should not exceed 700 ft., which makes the average haul 350 ft.

39. A placing crew consists of one shoveler and two plasterers, which in small ditches is reduced to a shoveler and one plasterer. The shoveler uses a No. 2 scoop, and the plasterers have a wooden float, a plasterer's trowel, a template or straight edge and a jointer. The shoveler places the concrete on the bottom and slopes, where the plasterers can spread it out evenly with their float and then finish it up with their trowels. Every 10 ft. an expansion joint is made; several kinds of joints and jointers have been tried. The easiest and most satisfactory joint was made with a common plaster lath sharpened on one edge. To make the joint, this lath is pressed into the concrete to a depth of 1 in. and then removed, and the crease made is stroked lightly with a trowel to smooth down any rough edges that might be made when the lath is removed. The plasterers use a straight edge on the berm and on the side slopes to gage the thickness of the lining, and in case the ditch bank is so high that the plasterers can not work from the bottom, a ladder is used which is laid flat on the slope, and has a straight edge on one side the right thickness, to which he lays the concrete. In all cases, when the plasterer moves his ladder or template, to which he is laying the concrete, he strokes the edge of the finished concrete with his trowel and gives it a bevel. If this is not done, a small crack will appear where the union is made.

40. The plasterers work opposite each other and take turns in finishing the bottom. In some cases where it is convenient, the wheelers dump the concrete on the slope to the plasterer on the side next to the runways; this saves shoveling and enables the shoveler to give more time to placing the concrete for the other plasterer. Both corners where the side slopes join the bottom and the berm, are rounded slightly which gives a much better appearance. A good plasterer on this work should plaster 5 to 6 cu. yds. of concrete in an eight-hour day, providing he is furnished material all the time, making 1,080 to 1,296 sq. ft. Two men have done 16 cu. yds. in one day, making for one man 1,628 sq. ft.

WATER SUPPLY.

41. The water supply is kept up with the mixer, by building sack dams at the lower end of the section just completed, and letting the water down for each move, as it is made. A sack dam was found most convenient, as the water could be easily controlled when letting it out. On account of the concrete being green, it is necessary to let it in slowly at first, until it has reached the next dam and started to back up, when the flow can be increased. As the dam cannot be built until the upper section is finished, it is necessary to take precaution to have everything in readiness beforehand, as for average moves the water supply is the last thing ready, and with a pay-roll of $10 to $12 per hour, any delay of the whole crew on this account, may increase the cost of a move from 50 to 100 per cent.

42. When the pump was attached to the mixer, from 300 to 400 ft. from the water supply, it was necessary to lay the pipe in the bottom of the canal, so as to have a gravity flow up to within 30 ft. of the pump, as a rotary pump would not deliver a sufficient supply, on account of air leaks at joints, and it also required some time to get it started, which increased the cost of moving considerably. With a separate pump and engine, the pipe can be laid on the bank out of the way of the plasterers, and can be moved in about half of the time, without damaging any lining in taking it apart at the union, and getting it up on the bank.

The supply pipe has a union every 100 ft., so that it can be uncoupled for moving from one set-up to the next. Where the canal is comparatively straight, the 400 ft. can be moved in one piece by placing a man at each 20-ft. joint. This is much quicker and cheaper when it can be done, and does not require any more men, as there are always plenty of men available for this work.

43. A track man is employed whose duty it is to see that the runways are kept in order, who also assists the placing crew when making a move with their table. The runway board, from the runway to the table, always comes down from the slide away from the placing crew, so that the wheelbarrow load is always dumped on the side nearest to the shoveler. Two or three boys are employed to keep the sides and bottom of the ditches well sprinkled, with a sprinkling can, just ahead of the plastering crews, as the surface is apt to get dry before the concrete is laid.

44. A roustabout team is employed, to haul away boards and platforms ahead to the next set-up, and also as one of the teams in moving the mixer. One of the teams employed in hauling aggregate is used when needed in moving the mixer from one set-up to the next. One man is employed in keeping the concrete wet that has already been laid; this is wet from four to six times a day for a week after it has been laid. The cost of this work is lessened, and better results obtained, by keeping the water backed up in these sections as high as possible with sack dams. This should not be done, however, for at least 24 hours after the lining is placed, as there is danger of the thin lining being broken up if a

high head of water is backed upon it before the final set takes place. In case the weather should be cold, and there is any likelihood of frost, it is well to cover the concrete before the day is finished with 2 or 3 ins. of earth, which will, under ordinary circumstances, protect it until it can withstand the frost.

EFFICIENCY OF THE LINING.

45. From observation of what lining has been done on the Okanogan Project, we have found the loss in these lined sections to be very small. In one ditch on which we have weir measurements at the head and for all deliveries, and which carries about 10 c. f. s., we have not been able to detect any loss in the 8,700 ft. that are lined.

COST OF LINING.

46. One of the essential factors that has determined the cost of the lining on the Okanogan Project is the cost of the cement on the work, which until last spring was $6 per barrel, but we are now getting it for $3 per barrel. With this comparatively cheap cement, the lining has been done for about $12.50 per cubic yard, as against $18 to $22 when the work first started. The cheapest lining cost $11 per cubic yard, and the costliest $13.90, being respectively 5.1 cts. and 6.4 cts. per square foot. The cheaper lining has not all been due to price of cement. A constant improvement in the methods of doing the work has aided greatly in reducing this cost.

The above data are reprinted from a paper by Calvin Casteel, Okanogan, Wash., in Proceedings, Washington Irrigation Institute.

A Simple Method of Cross-Sectioning Employed on Ditch Work.

Contributed by Benj. L. Parker, City Engineer, Sikeston, Mo.

None of the methods of cross-sectioning that the writer has examined, eliminates the mental processes of addition or subtraction that must be performed by the man at the instrument. Some time ago the writer had occasion to cross-section a ditch on somewhat irregular ground, made more so because of a smaller excavation of very irregular section and alignment that had been made within the limits of the proposed excavation. To avoid the mental arithmetic involved and as giving him more time for the proper direction of the men who were new at the work, the writer made use of two paper scales made from Webb's co-ordinate paper pasted to the *A* and *B* scales of an ordinary 10-in. slide rule. Figure 1 shows the arrangement of the scales and the numbering. This method is easy of application, a guarantee against errors and does not in any way conflict with the use of tables, specially graduated tapes or other devices designed to facilitate the work.

In the work in question, the tape man was provided with an ordinary cross-section table showing the distances out from the center for the various cuts, the same being pasted to a wooden paddle for convenience in handling. The cuts were called or signalled to the tapeman and the positions tried until in agreement. As the work progressed the rod-man and tape-man grew more proficient in the work and were able to save a considerable number of trials for the position of the slope stake and were better able to locate breaks in the transverse profile.

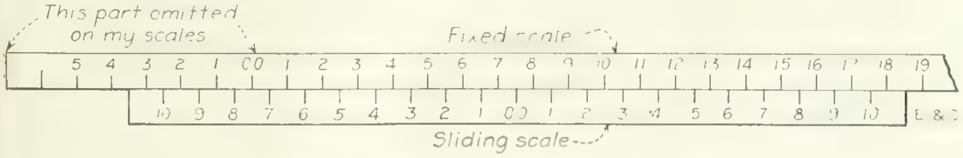
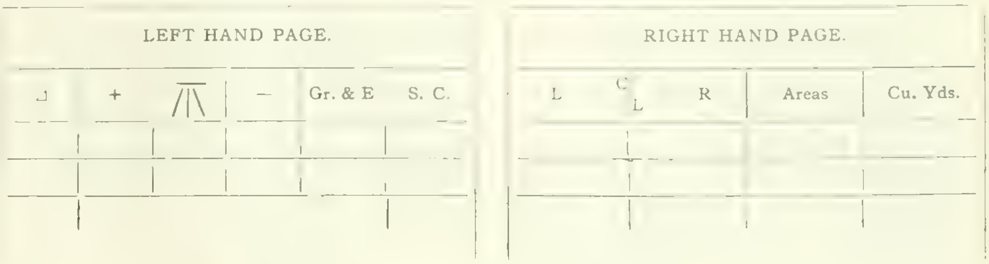


Fig. 1. Scale for Cross Sectioning.

The note book used by the writer is one of the standard field books made by the Eugene Dietzgen Co. and listed in their catalogue as No. 403 T. This book is well adapated for use as a transit book or level book and is well suited for the purpose of keeping cross-section notes. It has the further advantage that all the notes relating to any particular work, if not too large, may be kept in the same book, thus avoiding the necessity of carrying two or three books into the field. The columns are headed as shown in Fig. 2.



LEFT HAND PAGE.

⌟	+	/|\	−	Gr. & E	S. C.

RIGHT HAND PAGE.

L	℄	R	Areas	Cu. Yds.

Fig. 2.

In using the standard cross-section books with printed headings, the levels must be jotted down in the back of the book or elsewhere, while in the method above indicated, all of the information needed is shown on the page then in use and offers a further check against errors. It allows the accuracy of the station constant or the "grade rod" to be checked as well as that of the bench-marks that have been previously established.

The method of procedure is as follows: Fill in column of grades from the profile before going into the field. If not already recorded in the book note the bench marks established in the back of the book or other point of convenient reference. Take a reading on the most convenient bench mark and determine the height of instrument and the grade rod or station constant which record in the proper column. Set the 0.0 of the lower scale at the value of the grade rod or station constant on the upper scale. Set the indicator on the lower scale at the value of the rod actually read, and immediately above on the upper scale, read the cut at that point.

In all cases in the writer's work the station constant was positive and the indicator was always run to the left from the 0.0 on the lower scale to obtain the cut. Where the station constant is negative; that is, the elevation of the instrument being less than that of the grade, slide the indicator to the right of the 0.0 on the lower scale for the value of the fill at that point. By numbering the upper scale similarly to the lower scale, both ways from 0.0; the depth of fill may be read off when the station constant is positive and the surface rod greater numerically.

In the scales used by the writer, each minor division represented 0.1 ft., this being as close as desirable or necessary. Other levels were carried to 0.01. ft.

Inasmuch as the slide rule is to be found in every well equipped engineering office and as pointing out the road to correct habits to the younger members of the profession, the writer has been led to give a more extended description of the device and method than would seem necessary, and it is with this aim and with the hope that others may lessen the mental drudgery attending that this article is presented.

Street railway passenger traffic in Winnipeg has decreased to such an extent since the advent of the jitneys that the Winnipeg Electric Railway Co. has been forced to adopt economic measures, involving the reduction in the number of cars, a reorganization of routes, and a probable reduction in staff.

Development of Sedimentation Areas in Connection With Bottom Land Reclamation.

(Staff Abstract.)

The Big Black River and its valley in Mississippi are typical of those of many southern streams. The river is tortuous and is bordered on both sides with bottom lands; these lowlands lie between ridges on the two sides of the river. Small tributary streams enter the valley through the ridges. In a recent drainage investigation by the engineers of the Department of Agriculture a plan of bottom land reclamation is proposed for the Big Black River, which is applicable in many other places and which is unusual in its suggestions that an essential part of the reclamation plan should be provision of sedimentation areas for apart to provide way for the heaviest floods. branch streams entering the valley through the ridges. Briefly, the main plan is to provide it by levees on the two banks and far enough a floodway for the main stream by enclosing into this flood way the branch streams are carried by channels properly designed to meet the conditions. Turning now to the sedimentation area plan: The smaller streams and ravines which enter the valley from the surrounding hills usually carry a large amount of sediment and drift, which being deposited is continually filling up the lands where the streams enter the bottoms. For this reason many of these smaller streams have not established channels for themselves, but have filled up and spread over the bottom. If ditches are constructed to connect these small streams with the main drainage channels, the same process of sedimentation will continue and the ditches will soon become filled.

To overcome this difficulty in the ditches that are to be constructed, it will be necessary to provide sedimentation areas, each bounded by a levee on the lower or downstream side that will serve to impound the water and decrease its velocity, thus causing the suspended matter to be deposited. In this manner the excess sediment and drift can be confined to a limited area and damage to ditches prevented. When an area has become filled to such a height that storage is no longer possible, a new levee can be constructed a little farther upstream or downstream; thus a new sedimentation area is formed, leaving the old one, filled with fertile soil, available for cultivation.

These areas are of the utmost importance in the reclamation of a river valley of the character of that of the Big Black, and as they make it possible for the farmer to retain the most fertile soil on his farm, they should be constructed by him regardless of whether the larger drainage work is carried out or not. The sediment carried by these tributaries originates for the most part in the erosion of the surrounding hills. Too much stress can not be laid on the importance of controlling this action by proper terracing of slopes. It should be realized that it is the most fertile particles of soil that are thus carried away, not only to the detriment of the land, but to the great damage of the drainage channels in which the sediment is deposited.

In Vancouver, B. C., there are 350 jitney buses operating on the city streets and suburban lines. In Winnipeg there are 572.

ROADS AND STREETS

Some Methods and Costs of Concrete Pavement Construction at Des Plaines, Illinois.

Contributed by M. P. Taylor, Engineer on Construction, Chicago, Ill.

A concrete pavement was built last year which covers practically the whole south side of the town of Des Plaines, Illinois, and comprises 40,000 sq. yds. with curb, underdrainage system, etc. All the pavement laid was on a 20 ft. roadway except one street approximately one-half mile long where it was 22 ft. wide and another street in the business district where it was 30 ft. wide for a distance of a few hundred feet.

General Description.—The pavement was given a 3 in. crown on the 20 and 22 ft. roadways, and a 4 in. crown on the 30 ft. The concrete was laid 5 ins. thick at the sides of the roadway, and 7 ins. thick at the crown. Longitudinal expansion joints ½ in. wide were placed along the curb, and transverse expansion joints ¼ in. wide were placed every 25 ft. The transverse joints were of the armored type, Baker steel plates ¼ in. thick being used for protection. All the expansion joints were filled with tarred felt. Steel wire fabric weighing 4 lbs. to the square yard was placed in the concrete as reinforcement. This is much heavier reinforcement than that generally used in this type of pavement. The wire fabric came in 50-in. widths, which were lapped 2 ins. in laying.

The pavement laid is of the one course type which, while inferior to the two course in some particulars, has fewer difficulties of construction than the latter. The concrete throughout was mixed in a 1:1½:3 proportion. Washed gravel and torpedo sand were used for the coarse and fine aggregates respectively. Both materials were excellent, being clean and well graded; the gravel was hard and durable, and the sand coarse and sharp. The gravel used ranged in size from ¼ in. to 1½ ins. Both fine and coarse aggregates were supplied from two separate sources, the pits being located at Algonquin, Ill., and at Waukesha, Wis.

Under Drainage.—The underdrainage was taken care of by 4 in. vitrified drain tile, laid 1½ ft. beneath the base of the curb. This pipe was of the hub and spigot variety and was laid with open joints around which were placed coarse cinders. The ditch was then back filled with cinders up to the elevation of the bottom of the curb, forming a foundation for the latter. The drains were connected to the sewer system through catch basins where convenient or direct. It is thought that this system will effectually protect the pavement against frost, which has proven itself to be one of the worst enemies of a concrete pavement.

Subgrade.—The subgrade was black loam and heavy clay, and as a whole seemed to make a quite desirable base for the pavement. The main trouble with the subgrade was its tendency to retain water, so that after a rain it was usually some time before the laying of the concrete could be resumed. After the excavating was finished, the subgrade was brought to its final place by rolling with a three-wheel steam road roller weighing 10 tons. The subgrade was given a crown of 1 in. Most of the excavation, which totaled 16,000 cu. yds., was done with wheeled scrapers.

Laying Pavement.—The work of laying the pavement proper was started Sept. 1, and finished Nov. 30. Various delays were incurred in the course of construction due to bad weather, plant break downs, and delays in receiving material. It was attempted to eliminate the latter difficulty by procuring the aggregates from two separate sources over two different railroads, but, while this proved advantageous for other reasons, it failed to some extent in accomplishing the desired end. One paving gang started work Sept. 1, and on Sept. 17 a second gang was started; both these gangs were retained until the end of the work, and when one was unable to pave for some reason or other, it was employed on some other branch of the work. Two entirely different styles of concrete mixers were employed by the two gangs, and this gives a chance for some very interesting comparisons in both method of construction and results. Both machines were traction mixers of a type specially designed for paving work. One was a gasoline mixer which deposited the concrete in place by means of a chute, while the other was a steam mixer with boom and bucket. The steam mixer seemed the more reliable of the two, as more or less trouble was experienced with the mechanism of the gasoline mixer, though this may have been due to the unfamiliarity of it to the operator. The boom and bucket method proved to be the more satisfactory method of handling the concrete from the mixer, for the following reasons: (1) Less moving of the machine was required; (2) the concrete could be deposited more readily in the exact spot in which it was required; (3) a mixture of dryer consistency, which would have to be shoveled from a chute, could be handled readily. This last is an important point, as it is almost always a difficult matter to get the contractor to use as dry a mixture as desired, the wet mixture being more easily handled. On wide roadbeds especially the advantage of the boom and bucket is apparent. As a rule the gang with the steam mixer laid at least 25 per cent more pavement in a day than the other gang. This was due probably to the reasons given above which allowed the concrete to be handled more rapidly. The steam mixer was 2 cu. ft. larger than the other in drum capacity, but this had no effect, as both machines used a two sack batch, which they both handled readily. The actual working time on the paving was 55 days. Of this time two gangs worked 26 days, and the remainder of the time only one worked. The average work accomplished in a day was 714 sq. yds., and the average day's work per machine was 491 sq. yds. The greatest amount of pavement laid in one day was 1,538 sq. yds. by both gangs, 818 sq. yds. by one gang, and 720 sq. yds. by the other. This is a very good day's work, but not remarkable. The average day's work of the gang using the steam mixer was 557 sq. yds., and that of the other gang was 417 sq. yds.

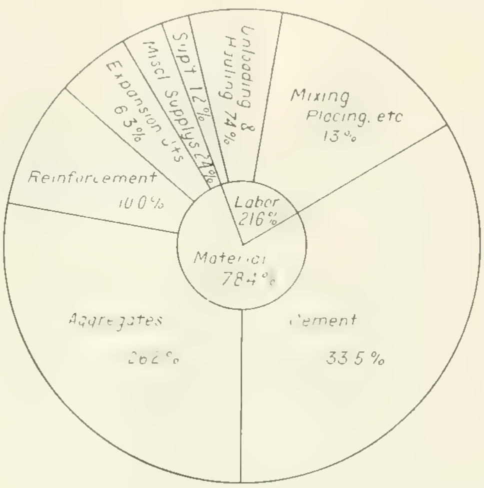


Fig 1

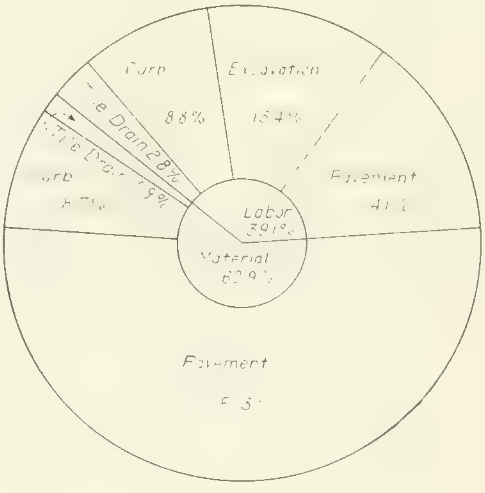


Fig 2

Figs. 1 and 2—Diagrams Showing Apportionment of Costs of Reinforced Concrete Pavement at Des Plaines, Ill.

The materials were measured by the conventional methods employed in such work; that is, the cement was measured in sacks and the aggregates in wheelbarrows, the capacities of which were first determined. Quite accurate results were obtained by these methods, the average variation from standard in the amount of cement used in the 25 ft. sections being about 5 per cent. This variation was probably due in some extent to slight unevenness in the subgrade.

On a large part of the work the grades were very flat and, in order to allow the surface water to run off more freely, additional pitch was given in the gutters, which varied in depths from 3 ins. at the summits to 7 ins. at the inlets. This means that between the summit and the inlet the amount of crown of the pavement was constantly changing. This change was effected in the 3 ft. of pavement nearest the curb on both sides of the street, the middle part remaining unchanged. Where it was necessary to do this the steel plates for the expansion joints were secured in three pieces, a 14 ft. piece (if on a 20 ft. roadway) for the middle and a 3 ft. piece for each side. The 14 ft. piece had the same crown as the middle 14 ft. of an ordinary plate, and the 3 ft. pieces were straight.

In most concrete paving work the surface is given its final form by means of a strike board, or template reaching from curb to curb. On this work it was impracticable in many places to use a strike board of the ordinary type on account of the construction described above that is where the cross section of the pavement was constantly changing in shape. Therefore a strike board was not used at all, and the concrete was struck off with a lute or float about 8 ft. long. This implement was made of 1 in. lumber and was about 4 ins. wide at one end, and 2½ ins. at the other. At the wide end it was provided with hand grips about 2 ft. apart. Two men each using one of these lutes worked behind each machine and brought the concrete to surface. Although very good results were obtained by this method, it is not to be recommended for the work as a general thing. It involves too much of the personal equation of the workmen; that is, the results depend entirely upon the ability and care shown by the men who do the striking off. It requires men skilled in the work, and capable of detecting any slight unevenness in the surface by the eye alone; whereas a strike board shows up the imperfections mechanically and can be operated by laboring men of the lowest class. After the concrete was brought to its final surface it was finished by means of a small wooden float. This produced the ordinary "floated" finish. The finishing was done from a bridge in order not to disturb the surface.

Curing.—To prevent the concrete from drying out and hardening too rapidly, it was subjected to a curing process as follows: After the pavement was laid and had become so hard that the surface would not be damaged, it was covered with a layer of dirt about 2 ins. in thickness which was kept thoroughly wet for a period of eight days. This covering remained on the pavement for a period of 15 days, during which time all traffic was kept off the pavement. During the latter part of October and the first of November the weather was quite cool (although not frosty) and the covering was dispensed with, although the pavement was sprinkled daily for the period of eight days. A proper curing process is regarded as second to nothing in importance in the effect it has of developing the full strength of the concrete.

Costs.—No minutely exact record of the cost of the work was kept, but the data given in the following table is available and is very nearly correct. The itemized average cost of the labor per square yard of pavement is given. This is for the pavement proper, the subgrade being already prepared.

Unloading material	$0.02
Hauling material	0.058
Charging mixer	0.034
Mixing concrete	0.025
Placing concrete, reinforcement and joints	0.028
Bringing surface to final grade	0.015
Finishing surface	0.013
Curing pavement	0.015
Superintendence	0.013
Total	$0.221

In the item Mixing Concrete is included the cost of fuel, oil, etc., for the mixer. All the other items given are labor only. The cost given for superintendence is for superintendence of construction alone. Of course there are overhead expenses which should be charged to superintendence, but it is only attempted here to show the field costs.

The accompanying diagrams have been worked out and show the costs of the work on a percentage basis. Figure 1 shows the cost of the pavement proper, and Fig. 2 shows the cost complete, including excavation, underdrainage and curb. These take into consideration all costs except overhead office expense and depreciation.

The work was contracted for and constructed by the Jensen-Jensen Company, of Chicago. Ewing & Allen, of Chicago, were the engineers.

Experience in Paving by Day Labor at Duluth, Minn.

Contributed by John Wilson, City Engineer, Duluth, Minn.

In 1914 the city commission of Duluth decided to do considerable paving by day labor instead of by contract as was the former practice. The city does not own a plant or any equipment, and has no special organization for handling such work, but in spite of these handicaps the results so far have been satisfactory; however, to get good results under such conditions requires the expenditure of much energy, overtime and constant vigilence on the part of the engineers in charge.

The most important undertaking was the paving of West Superior St., which amounted to 54,367 sq. yds., a stretch of 18 blocks. This pavement was laid at a total cost of $128,139.47, which cost included the necessary excavations, sewer connections, relining of curbs, etc.

The first 13 blocks had been paved a few years ago with a 2-in. tar macadam surface on a 6-in. broken stone base. Because of the high annual cost of maintenance on this pavement, which from the first amounted to about 20 per cent of the first cost, it was decided to repave, using brick on a concrete base.

The surface of the street was raised as much as the height of the curbs would permit, and in this way some of the old macadam base was utilized. A double track car line occupied the center of the street and the street railway company's franchise requires them to pay only the extra cost of pavement due to the presence of their tracks. It was agreed between the company and the city that in lieu of this extra cost they would remove with their cars the greater portion of the excavation, provided the material was broken up and piled near the tracks to permit it being hauled during the night. The cost of this hauling is not included in the total cost of the work.

The old tar macadam surface was broken up with a scarifier and what could not be utilized in filling depressions on adjoining earth streets was removed by the street railway company.

The remaining five blocks had previously been paved with cedar blocks, all visible evidence of its presence having disappeared several years ago; however, upon excavation much of the old plank foundation was found to be in a fair state of preservation.

The new pavement consisted of a 5-in. concrete base, 1½-in. sand cushion and vitrified paving block with grout filler, except 6,039 sq. yds. where sandstone was used. The base consisted of 1-3-6 mixture using gravel for the coarse aggregate; the grout was one part cement to one of sand.

The cost of the brick pavement, exclusive of grading, was a trifle over $2.06 per square yard. The sandstone blocks were of Kettle River Sandstone, 6-in. deep and laid with a ½ grout filler. The cost of the sandstone section exclusive of grading was $2.86 per square yard.

Unit prices of material delivered f. o. b. Duluth were as follows: Brick per square yard street measurements, $1.10; sandstone, $1.65; cement, $1.93 per barrel, less 40 cts. for return of sacks; gravel, $1.10 per cubic yard; concrete sand, 80 cts per cubic yard and cushion sand 60 cts. per cubic yard. Common labor was paid 22.5 cts. per hour for a ten-hour day and teams 55 cts. per hour for a ten-hour day. The dock and warehouse from which most of the material was hauled were centrally located and but one block from the work.

A decided weakness of our organization was the accounting system which rendered the determination of unit costs impossible. As near as it is possible to ascertain the cost was about 20 cts. less, per square yard, than similar work, only of less magnitude, let by contract during the same season.

The principal reason that prompted the commission to depart from the contract system was the general dissatisfaction with the work of local contractors for some years. It cannot be denied, however, that this condition was largely an outgrowth of a policy of discriminating against outside contractors, which resulted in a generally demoralized state of affairs among local contractors. They neither qualified nor equipped themselves to properly construct modern types of pavement, inasmuch as each one felt certain of landing a number of jobs each season, since competition was purely local.

To my mind it is doubtful if the day labor system of making public improvements will prove a great success in cities the size of Duluth or smaller. The financial investment necessary for the proper equipment necessary to economically build the widely varying types of pavement now demanded by property owners is very great; skilled foremen and laborers almost impossible to obtain for the short period of street construction; and as long as the workmen are selected by city councils or commissioners control of the work by the engineer is very difficult.

It has been argued that by the day labor system the contractor's profits are retained by the property owners, also that the cost of inspection is eliminated. That thorough inspection is as necessary on city work as on contract work I am wholly convinced.

If it is possible to arrange to award contracts of sufficient magnitude to interest competent contractors with complete equipments and trained workmen, and give them a square deal regardless of their place of residence, then I am inclined to think the contractor's profits is money well spent.

I would not have it understood that I have arrived at the above conclusions as a result of last year's experiences only, but from observations during the past seven years in municipal work.

Methods of Applying Tars for Dust Prevention.

(Staff Abstract.)

The use of tars for surface treatment has been confined chiefly to macadam roads. Tars may be applied either cold or hot depending upon their fluidity or consistency. When available, crude water gas tar has been used to advantage for a temporary dust preventive. This is applied from an ordinary sprinkling cart at the rate of about 1/3 gal. per square yard. For more lasting results, mixtures of crude water gas tar and crude coal tar may be used. A refined water gas tar from which all of the water and part of the light oils have been removed, or a partially refined coal tar to which light oils have been added until sufficiently fluid, is to be preferred to the crude tars.

In the application of heavier tars the most costly method is the application by hand, although with small jobs this may yet be the most economical method to use. A large number of tar spraying machines are now on the market, some of which give excellent results. A very common type of pressure tank consists of a steel tank mounted on wheels equipped with an air pressure tank and a fire box. The heated tar is forced by the pressure within the tank through a hose and nozzle by means of which it is sprayed upon the surface of the road.

If dust and other fine materials are present, the tar will not properly grip to the road surface, and owing to lack of bond, will soon peel and be removed by traffic. The surface of the road should have comparatively little dampness in it when the tar is applied. The warmer the road surface, the better are the results secured. Hence the tar is best applied during hot, sunny weather. Therefore, June, July and August are the most desirable months for the application of tars.

Before applying the tar, the surface should be swept clean so as to expose the larger stones. Best results will be secured when the voids are swept clean of the filler (stone dust, sand or dirt) to a depth of ¼ to ¾ in. Also better results will likely be secured where a fairly good sized stone has been used in the surface of the road.

The amount of tar required to treat a road will depend upon the fluidity of the material when applied, the condition of the road surface, and the degree of permanency expected. If the surface of a macadam road made of comparatively large stone, say 2 to 4 ins. in size, is swept clean of its natural binder, as described above, the surface may be such that as much as 1 gal. per square yard can be used at a single application as a surface treatment when a fairly heavy tar is used. If the surface is smooth, 1/3 gal. per square yard may be as much as should be used at a single application. Also the lighter the grade of tar, the less there should be applied at any one time. Care should be taken not to apply an excess of the tar.

It is absolutely imperative (except possibly with the lighter water gas tars) that screenings be applied, for otherwise the adhesion of the tar to the wheels of vehicles, would destroy the surface, as well as be a nuisance to traffic. The amount of screenings that should be applied will depend upon the amount and grade of tar used. Where tar is used at the rate of about ½ gal. per square yard of surface, a cubic yard of the screenings will cover from 75 to 120 sq. yds.

With the lighter grade of tars that do not thicken quickly upon exposure to the air, it will be well to let the road stand several hours after putting on the tar before adding the screenings; but with the heavier tars this will be of no value. In fact with the latter grade of material it may be necessary to add the screenings immediately, for they should be applied to the surface before the tar stiffens enough to prevent them from being absorbed by it. Quite often it will be necessary to apply additional screenings, from three to ten weeks after traffic is allowed on the road, depending upon the amount of traffic and the air temperature during that time. Tar applied to the road surface in the fall (which is not the best practice) and after being used all winter, will frequently have to be coated with screenings the following spring during hot weather to prevent it from sticking to the wheels of vehicles. It is very essential, for the preservation of the road, that these screenings be applied when the surface will absorb them. When an excess of tar has been used, the tar will continue to absorb screenings for a couple of years, and when such is the case the screenings should be applied.

The grade and quality of the tar will very largely determine its cost. This will vary from 4 cts. per gallon for the lighter water gas tars to 9 cts. per gallon for the heavier refined coal tars, f. o. b. cars at the plant. To this must be added the cost of freight and the cost of application. The cost of application will depend upon the amount to be applied and the method used. It will vary from ½ to 3 cts. per gallon.

The above data are condensed from a report on Dust Prevention by the Ohio Highway Department, Columbus, O.

Costs of Three Types of Board Fences.

(Staff Article.)

The illustrations, Figs. 1 to 3, show three types of board fences built under the supervision of John H. Gardinier of Lake Charles, La. Fairly close cost records were kept excepting for gates, the labor cost for which was included in the placing of boards. In the corral fence there were two 8-ft. gates and in the town fence two 12-ft. and two 8-ft. and one 4-ft. gates.

The holes for the posts were dug with a 6-in. post hole digger, the ground was moist and would have been fairly easy digging if it had not been for the numerous small roots encountered for the first foot under the surface, as these fences were built in the pine woods. The posts for the corral fence were set by contract at 15 cts. apiece, costing the same as for the town fence by day labor. But the three men by contract made $3 a day. The only difference in price of having the posts set by contract and day labor was that the posts set by the day men were a little more carefully set. The cost of each fence is itemized under the drawing of that fence.

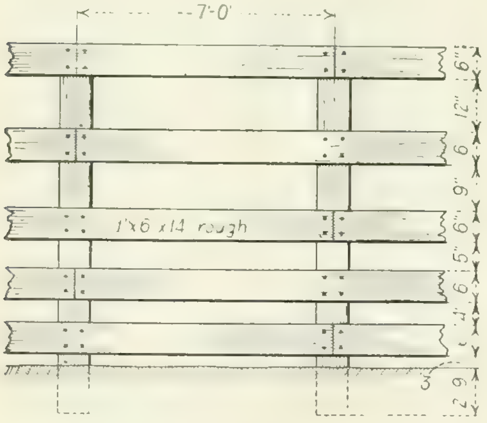


Fig. 1. Corral Fence.

360 posts, 4-in. x 6-in. x 8-ft., 5,760 ft. B. M. at $14.75	$ 84.96
Lumber, 1-in. x 6-in. x 14-ft. plank, 6,300 ft. B. M. at $15.50	97.65
160 lbs. nails at $2.20	3.52
Labor setting posts	54.00
Labor placing boards	50.54
Two per cent use of tools on labor	2.09
Distributing material	8.50
Total cost	$301.26
Cost per lineal foot, labor	$0.04148
Cost per lineal foot, material	.07806
Total cost per lineal foot	$0.11954

Posts set by contract at 15c each.

Boards placed by day labor: One man, at $2.50; 2 men at $2.00 each.

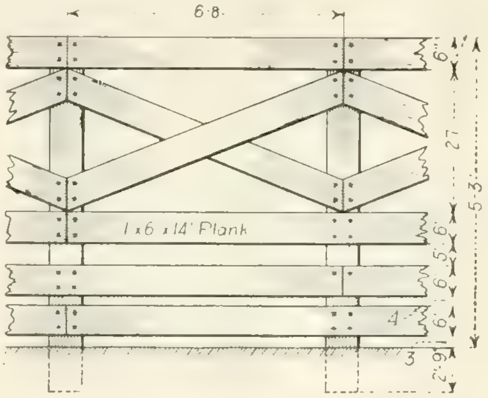


Fig. 2. Town Fence.

570 posts, 4-in. x 6-in. x 8-ft., 9,120 ft. B. M. at $14.75	$134.52
Lumber, 1-in. x 6-in. x 14-ft., 11,466 ft. B. M. at $15.50	177.72
248 lbs. nails at $2.20	5.46
Labor setting posts	85.50
Labor placing boards	119.81
Distributing material	31.50
Use of tools	4.11
Total cost	$558.62

Posts set by day labor: One man, at $2.50; 2 men, at $1.75 each.

Boards placed by day labor: One man, at $2.50; 2 men, at $2.00 each.

Cost per lin. ft. for labor	$0.05371
Cost per lin. ft. for material	.09244
Total cost per lin. ft.	$0.14615

Cost setting posts, 15c each.

Method of Estimating the Cost of a Concrete Road.

(Staff Abstract.)

The question, "What is the cost per square yard or per mile of concrete road?" is as easily answered as "What is the cost of a house?" One is as definite as the other, for there are almost as many kinds of concrete roads as there are houses, and for each kind there is a different answer. Even after the quality and thickness of concrete to be built has been determined, there are naturally many local conditions that will have a marked bearing on the results; such as lengths and kind of roads available to haul material over, facilities for unloading and hauling aggregates and cement; amount of labor available; the necessity of camps; the distance and elevation that water must be carried and also its source; the availability of suitable aggregates, whether they must be washed, or crushed or shipped by rail; the weather conditions that are liable to exist. Any or several of these conditions may have a marked effect on the cost of construction. Given answers to these questions or conditions, the problem of figuring the cost becomes much simplified.

Assuming the standard Wisconsin State Specifications, which call for a 1:2:3½ mix, and assuming a pavement with an average thickness of 7 ins., we will attempt to show how we arrive at our estimates of costs. Some of the statements may seem like the A. B. C. of engineering, but will, perhaps, be of assistance to laymen.

With an average thickness of 7 ins. we allow only 5 sq. yds. per cubic yard of concrete, allowing the extra inch as a factor of safety.

With a 1:2:3½ mix we know we need approximately ½ cu. yd. of sand and about 0.84 cu. yd. of aggregate, or a total in all of about 1⅓ cu. yds. of material for a cubic yard of concrete. No suitable material is available without shipping in by rail and we find that washed sand and gravel can be laid down at almost any siding in the county for $1 per cubic yard of sand or gravel, the sand to weigh 3,000 lbs. per cubic yard and the aggregate a little less, depending upon the idea of the dealer.

This brings our sand and gravel for a cubic yard of concrete to about $1.33 or about 27 cts. per square yard of road.

The next problem encountered is unloading this material on to the hauling vehicle. In our case, nearly all has been done by hand. Allowing for lost time due to rain, switching of cars and waiting for teams, and figuring labor at from $2.25 to $2.50 per day of ten hours, we have a cost of 5 cts. per square yard for unloading. This may be reduced a little, but we have found it safer to not expect too much from shovelers, especially in hot weather.

The next item is the most variable of any, perhaps, in the entire cost, that of hauling. The length of haul, the method of hauling, and the kind of roads to haul over, all have a marked bearing on the result; here also possible weather conditions must be taken into account, for after a rain the size of load and number of trips must be materially reduced. Where steep grades are encountered, extra teams must be figured upon. Assuming an average haul of 2½ miles, a team would average about 3½ trips per day under our conditions or about 17 miles per ten-hour day during the various kinds of weather. At $6 per day, which we often are forced to pay, and assuming an average of 1¾ cu. yds. per load, we arrive at a cost of $1.35 per cubic yard of concrete or 27 cts. per square yard of pavement.

The mixing and placing, under which we include all labor connected with the job, such as watchmen, pumpmen, smoothing grade, etc., will with our labor conditions and allowing for lost time and overhead expenses come to about $1 per cubic yard or 20 cts. per square yard.

In case steel joints are placed, these will come to about 2½ cts. for the steel and 1½ cts. for the felt, when placed 50 ft. apart and ¼ in. in thickness of felt.

The cost of furnishing water is rather uncertain, for the amount of pipe necessary may vary from one to three or even more miles per job. Assuming two miles of pipe at a rental of 2 cts. per foot for use in placing a road one mile long, we have a water cost of about 2 cts. per square yard.

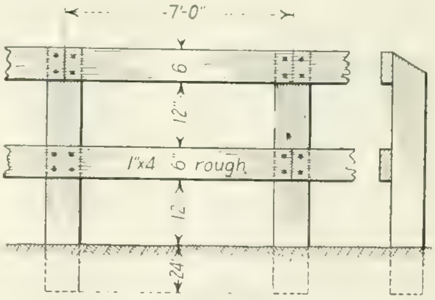


Fig. 3. Park Fence.

173 posts, 4-in. x 4-in. x 5-ft., 1,153 ft. B. M. at $15.25	$17.58
Lumber, 1-in. x 4-in., 809 ft. B. M. at $15.00	12.13
Nails, 30 lbs.	.66
Labor setting posts and placing boards	40.00
Distributing material	2.50
Use of tools on labor	.80
Total cost	$73.67

Labor: One man, at $2.50; 2 men, at $1.75 each.

Labor cost per lin. ft.	$0.03252
Material cost per lin. ft.	.02737
Total cost	$0.05989

For carrying liability insurance, a contractor must add about 1½ cts. in our state.

The depreciation on machinery we have found to be about 1¼ cts. per square yard.

Trimming up the shoulders will require an additional expenditure of about 1 ct.

The items as enumerated bring us to a total of 87¾ cts., to which we add a reasonable profit when figuring what a contractor should bid.

Since we furnish cement in all cases, we add our cement cost only after the profit percentage has been included. With cement at $1.14 per barrel on cars and 20 cts. per barrel for cartage, we arrive at a cost of about $2.25 per cubic yard of concrete for cement or 45 cts. per square yard.

This gives us a total of $1.32 without a contractor's profit, under the conditions we met in 1913. Work done in 1913 by force account varied from $1.30 to $1.61, and that done by contract varied from $1.24 to $1.72, the variations depending entirely upon the local conditions.

In 1914, with cement slightly higher but with labor and teams considerably cheaper, but other conditions about as 1913, the costs in Milwaukee County varied from $1.10 to $1.45.

An engineer should thus be able to compute the cost of the various items in his community and separate the labor and material into fairly definite per cents for each job. He will find that cement will vary the least, while hauling labor will vary the most.

These facts are extracted from the report of the County Highway Commisisoner, Milwaukee County, Wisconsin, H. J. Kuelling, Milwaukee, Wis. Articles by Mr. Kuelling on concrete road construction methods and costs were published in our issues of May 13 and June 10, 1914.

Table for Making Assessments for Paving.

Contributed by D. B. Davis, Civil Engineer, Richmond, Ind.

The legislature has given the Board of Works in Indiana the privilege of assessing back 150 ft. from the line of the improvement on street work. This opportunity some boards have taken advantage of, but the practice oftentimes involves some complicated problems in order to arrive at a fair and proper assessment for lots which are of different size and are varying distances from the improvement, since it is essential that about the same per cents be attained for similar cases in order to keep peace with the property owners. To arrive at these same per cents in all cases is almost an impossibility without some formula by which to treat each case alike.

Table I was worked out by the writer when he was assistant city engineer of Richmond, Ind., and has proven of great value in ascertaining the assessments on properties lying at different distances from the improvement. When the per cents in the table are platted a curve is obtained which resembles a parabalo, but is arranged in such a manner that there is no direct ratio between any 2 ft. of distance.

This table can easily be applied when the lots are tapering, the average length of the two unequal sides being used for the distance back from the improvement. Take, for example, three lots, the one next the street 40 ft. wide, the next one 60 ft. wide and the other 50 ft. wide, to find the per cent of assessment for each lot. In the table to get the assessment for a lot you subtract the per cents of the near and far side of the lot; so from the table opposite 40 in column marked "depth in feet" we get 61.25 per cent, which is for the first lot, and opposite 100 we get 93.00, which with 61.25 subtracted, makes 31.75 per cent for the second lot; while for the last we subtract 93.00 from 100 and get 7 per cent for the last lot.

This table has proven to be a quick and satisfactory way of arriving at the proper amount to assess when the distance of 150 ft. extends over more than one lot.

TABLE I.—STREET IMPROVEMENT TABLE.

For Determining Per Cent of Assessments for Properties Lying Within 150 Feet of the Improvement.

Depth in feet.	Per cent.	Depth in feet.	Per cent.	Depth in feet.	Per cent.	Depth in feet.	Per cent.	Depth in feet.	Per cent.	Depth in feet.	Per cent.	Depth in feet.	Per cent.
0	0.06	22	38.73	44	65.07	66	79.37	88	89.69	110	94.80	132	98.06
1	2.01	23	40.20	45	65.96	67	79.91	89	90.04	111	94.97	133	98.18
2	4.00	24	41.65	46	66.82	68	80.45	90	90.38	112	95.14	134	98.30
3	5.97	25	43.07	47	67.66	69	80.99	91	90.68	113	95.30	135	98.43
4	7.91	26	44.47	48	68.47	70	81.52	92	90.97	114	95.46	136	98.54
5	9.83	27	45.84	49	69.25	71	82.04	93	91.25	115	95.63	137	98.66
6	11.72	28	47.18	50	70.00	72	82.56	94	91.53	116	95.78	138	98.78
7	13.58	29	48.50	51	70.63	73	83.07	95	91.79	117	95.94	139	98.89
8	15.42	30	49.80	52	71.25	74	83.57	96	92.05	118	96.10	140	99.00
9	17.24	31	51.07	53	71.86	75	84.07	97	92.30	119	96.25	141	99.11
10	19.05	32	52.31	54	72.47	76	84.56	98	92.54	120	96.40	142	99.22
11	20.82	33	53.52	55	73.07	77	85.04	99	92.78	121	96.55	143	99.32
12	22.58	34	54.70	56	73.66	78	85.52	100	93.00	122	96.70	144	99.42
13	24.30	35	55.86	57	74.25	79	85.98	101	93.19	123	96.84	145	99.53
14	26.00	36	56.99	58	74.84	80	86.44	102	93.38	124	96.98	146	99.62
15	27.68	37	58.10	59	75.43	81	86.89	103	93.56	125	97.13	147	99.72
16	29.33	38	59.18	60	76.00	82	87.33	104	93.74	126	97.26	148	99.82
17	30.96	39	60.23	61	76.57	83	87.75	105	93.93	127	97.40	149	99.91
18	32.56	40	61.25	62	77.14	84	88.17	106	94.10	128	97.54	150	100.00
19	34.15	41	62.25	63	77.71	85	88.57	107	94.28	129	97.67		
20	35.70	42	63.22	64	78.26	86	88.95	108	94.47	130	97.80		
21	37.23	43	64.16	65	78.82	87	89.33	109	94.63	131	97.93		

The difference between the per cents of the near and far side of the lot is the per cent of assessment for that lot. Compiled by the City Civil Engineering Department, Jan. 20, 1912.

WATER WORKS

Method of Assessing Cost of Water Main Extensions by the Municipally Owned Water Works of Duluth, Minn.

(Staff Abstract.)

Few subjects are of more general interest to the officials of water departments than the methods employed by various municipalities in the assessing of costs of water main extension. The procedure at Duluth, Minn., is here described. The method is simple and rational and is easily applied.

An improvement of any kind which is largely local in nature, that is, which from the nature of its construction is largely an accommodation to the abutting property only, is found in lateral sewers and water mains of minimum capacities supplying or serving local properties only, and which do not provide capacities in excess of local requirements, and which are not indispensable for serving more distant territory.

A city owned utility usually has the power to assess certain benefits, whether the party interested chooses to be a consumer or not. Applying this fact to sewers and water mains the proper method would be to assess the costs of construction, or in other words the capital investment, against the property that it is possible to serve. The costs of operation, however, should be levied against the parties purchasing the output or using the service.

In the case of a municipal water supply, these matters seem to be much easier of solution and it seems quite practicable to assess costs of construction directly upon the property susceptible of being served, and to assess the operating costs directly upon the customers or patrons of the utility, in proportion to the quantity of water consumed. This condition, it must be observed, is not met entirely by a rate charged upon a demand and output basis such as is in effect in New Orleans, for the reason that the demand charge does not extend to vacant property.

To those who believe that vacant property should not escape taxation for any improvement that directly enhances its value, this fact will appeal. It would also seem to be a fair check or restraint upon interests that invest in idle property with a view of gain which results largely from the activities of others and in which its existence directly increases the cost of every utility that passes the premises.

It is assumed that a municipal water plant should be self-sustaining in every sense of the word. It should neither give or receive any benefit or consideration of any kind from the taxpayer, the city or the individual.

A water main in which the size is in excess of the minimum may be classified as serving two purposes, the service to the property directly abutting and the service to properties located more distantly from the source of supply. In the first instance, for the purpose of this discussion, a 6-in. service may be considered as sufficient, and for all sizes in excess of 6 ins., for the additional service to those more distant. Assessments against abutting property for the 6-in. main are easily applied. For costs of main in excess of this size the only practicable way appears to consider the additional cost as a part of the general distribution system, the expense of which has to be absorbed by the utility and included in the consumer's rates chargeable as operating costs. The direct assessment to the abutting property for the 6-in main (this size being used as a matter of convenience), may be assessed against the abutting property by means of either of two methods. First, in the total, on the completion of the work, which is paid by one assessment. Second, the principal being furnished from the funds of the utility a percentage may be assessed annually against the property to cover interest and sinking fund upon the investment. After a term of years the percentage assessment will have returned enough money to the utility to cover the principal as well as interest upon the investment. Ordinarily the vacant property thus assessed should continue to pay the assessment for the full term of years necessary to wipe out the original costs. Improved property, using water and paying for it upon meter rates would be entitled to some credit or rebate on account of these rates, especially if the rates are based upon capital investment expense as well as operating costs upon the entire plant. Assuming for the purpose of illustration that one-half of the water rates are to cover interest and sinking fund expense, and that the balance is to cover operating costs, including depreciation, it will be found necessary to credit one-half of the customer's water rates against his assessment. This credit will ordinarily retire the annual percentage assessment upon improved property, unless the cost of constructing the extension was large and the consumers consumption was low. If his consumption is considerably more than necessary to wipe out his individual assessment, the surplus, of course, should be applied pro rata to lessen the tax upon the vacant property. It is quite possible for the consumption on an extension to increase to such an extent that the overplus of credits will be sufficient to retire all the assessment against the vacant property upon that particular extension, in which case, having reached that point, all assessments should be discontinued, as the customers are carrying the entire expense of the extension, including capital investment as well as operating costs. This even may be accomplished at the end of one year or two years or possibly ten or fifteen years, depending upon the rate of the percentage assessment against the property, the interest and sinking fund factor in the rates charged for the water, and the amount of the consumption upon the extension.

It is also quite possible an extension may be made where there is no consumption for the first year. In this case all the property pays the percentage assessment with no credits and the utility receives the exact amount necessary to pay interest and sinking fund charges.

The method employed at Duluth, Minn., in which a gas utility is also operated in connection with the water system, the pipes being laid in the same trench, has been to assess annually against the abutting property 8 per cent of the total cost of each extension as represented by a 4-in. gas and a 6-in. water main, it having been established that sizes in excess of these dimensions would be more or less of a general benefit to all customers and property and for the strengthening of the system to benefit other customers outside of those served by that particular extension. The proportion of charges against the abutting property has been based upon 5 per cent for interest and 3 per cent for sinking fund assessed annually for a period of fifteen years, 3 per cent contribution to a 4 per cent sinking fund, however, will not retire the principal short of 22 years, but for various reasons it has been considered advisable to limit the duration of annual assessments to a fifteen-year term. A special discount of 25 per cent is allowed to those paying the total amount in one payment. These assessments are made according to the frontage of the lot, without reference to its depth. However, the frontage of the lot is not considered necessarily as being the side abutting the street upon which the extension is made. It may lie parallel to the mains and front on another street. It is assessed the same as other lots of the same frontage dimension. Subsequently if mains are laid in front of the short side no assessment is made therefor on this particular lot, which can, of course, receive no benefit from a second extension. Against this assessment is credited one-half of the water and one-third of the gas rates paid by the occupant of the premises, it being estimated that these proportions are necessary factors in a rate that will yield the proper amount of revenues for maintaining and operating the plant.

The principles and results involved in the methods as outlined above seem to be as follows:

1. All charges whether of installation or of operation against property or a customer are based upon actual cost.

2. Costs of distributing systems are ordinarily borne by abutting property except when the consumption is sufficiently large to assume the whole or part of this expense when the charge is gradually transferred to the customer.

3. The customer bears operating costs and such installation charges as cover reservoirs, pumping machinery, stations, intakes and the larger distributing mains.

4. As the municipal plant increases in size and in the amount of its revenues, its percentage of indebtedness will gradually decrease, the proportion of interest and sinking fund in the rates charged for water, will decrease until eventually, when no indebtedness exists, this factor will become zero and there will be no credits against the assessments. They will have to be met in full cash payments or the consumer may discount the entire amount of his individual assessment by paying cash, taking advantage of the 25 per cent discount.

5. The percentage plan enables the small property owner who is a consumer to obtain extensions on very easy terms, with practically no additional expense over and above the regular water rates.

6. It seems to be a practicable way for real estate owners to secure extensions of gas and water service in newly platted additions without throwing any of the burden upon the utility or its customers.

7. It furnishes a profitable investment at 8 per cent net for the sinking fund of the department until the time arrives when it will be needed to retire bonds, at which time, if the money or any portion of it cannot be withdrawn, refunding bonds or new bonds in whole or in part may be issued. Eventually if the rates for service have been correctly established, the time will be reached when its entire indebtedness will be retired. This will be true if depreciation and maintenance has been provided for in the operating expenses as well as interest and sinking fund on the indebtedness.

ACKNOWLEDGMENT.

The foregoing data and discussion are from a paper before the annual convention of the American Water Works Association by Mr. D. A. Reed, manager of the Water and Light Department of Duluth, Minn.

The Manufacture of Alum at the Columbus Water Softening and Purification Works.

(Staff Abstract.)

The process now in general use for coagulating water consists of an application of a solution of aluminum sulphate, prepared by dissolving in water alum in crystal form. By a new process recently perfected at Columbus, Ohio, and here described, the syrup of alum is fed direct from the alum boiler, through the dilution tanks, to the water. This Columbus syrup-of-alum plant was placed in operation in January of this year, and has been an economic and scientific success. The requisite installation cost $12,000 and the annual saving to the city has been estimated, conservatively, at $6,000. Between 800 and 1,000 tons of alum will be made at Columbus this year at an approximate cost of $10.50 per ton. This development marks a distinct forward step in water filtration.

COMPARISON OF OLD AND NEW PROCESSES.

To show the advantage of the new process, as used in Columbus, and to point out the advantage of making alum at the point where it is to be used, a brief explanation of the old process of making alum for water purification purposes is appended.

Lump alum is combination of bauxite (a clay containing from 58 to 60 per cent alumina, the aluminum being present as $Al_2O_5H_4$) with sulphuric acid. By mixing the two in lead-lined tanks and boiling for a period of from six to eight hours, the first step in making the alum is taken. The following reaction takes place:

$$Al_2O_5H_4 + 3\,H_2SO_4 = Al_2(SO_4)_3 + 5\,H_2O.$$

The resultant solution is a mixture of aluminum sulphate and silica, and must be filtered to obtain the clear aluminum solution. The filtering process is perhaps the most costly, tedious, and annoying step in the whole procedure of alum making, because the finely divided particles of silica present in crude sulphate solution quickly clog the pores of the filtering medium to such an extent that it is often necessary to force the material through the presses under considerable pressure. After being filtered the alum solution is boiled to expel the excess water. The expense of concentrating the syrup must be taken into consideration, because the density is increased from between 25 and 30° Be. to a density of between 58 and 60° Be. The solution is then discharged into trays, and on cooling crystallizes to the alum cake. Then crushed or pulverized cake is shipped either in bulk, in barrels or in sacks.

In the new process bauxite and sulphuric acid are boiled in lead-lined tanks until a basic solution of aluminum sulphate is obtained. The solution is then diluted with water (usually enough water is added to make 500 gal. of the solution, equivalent to 1 ton of 17 per cent Al_2O_3 alum), and measured as needed into alum solution tanks, where it is diluted with sufficient water to make a standard solution, which is then applied to the water under treatment. By this process five distinct steps in alum making are eliminated—filtering, concentrating, crystallizing, grinding, and redissolving.

The plant comprises two lead-lined boiling tanks, two alum-measuring tanks, one acid-measuring tank, one sludge tank, one storage tank for sulphuric acid, one crusher and one pulverizer for the bauxite, conveying, elevating and transmission machinery, bauxite storage bins and weighing device, piping, valves and fittings. This plant, some features of which have been made the basis of patent application, has been in continuous operation since the middle of January. The plant was finished and the first alum made Dec. 25, 1914, but experiments had been carried on for two years.

The crude alum solution containing silica or other inert material from the bauxite, probably better defined as chemical mud, is applied to the water under treatment, the chemical mud mixes with the suspended particles present in the water and finally becomes entrained or coagulated by the precipitated aluminum hydrate and settles out in the settling basins. The crude solution, containing the chemical mud in suspension until the metallic sulphate has been converted into hydroxide, has a function not possessed by alum solution prepared by the old process, namely, forming a matrix or nucleus for starting the coagulation. This feature produces not only more efficient results with less coagulant, but also affords the process universal applicability irrespective of any lack of natural turbidity.

SOURCES OF BAUXITE.

At present the known workable deposits of bauxite are limited to a few localities. Its occurrence in the United States is in Georgia, Alabama, Arkansas and New Mexico. The mining of bauxite in the southern states has shown a great growth during the last few years, the annual production passing the 150,000 long ton mark in 1911.

As a rule bauxite is easily mined because of its comparative softness beneath the surface. In most cases it may be dug up with a pick, although black powder is sometimes used to loosen it from its position. The bauxite is usually removed in steps or benches, and loaded into small mine cars. The ore contains a large percentage of uncombined water, which, unless expelled or driven off before shipment, makes it an important factor in the freight cost. After being crushed the ore is passed through long rotary kiln dryers, similar to rotary cement kilns. Three grades of ore are mined, first, that used in the manufacture of metallic aluminum; second, that used in the manufacture of alundum, and third, that used in the manufacture of aluminum salts.

On account of the strict specifications drawn for sulphate of alumina by those in charge of water purification plants and paper mills, only the ore containing less than 2 per cent of ferric oxide (Fe_2O_3) is used in making aluminum sulphate. The more ferruginous ore is used in the manufacture of metallic aluminum, and the very purest grade of ore is used for the manufacture of alundum.

The possible yield of bauxite, according to Bulletin 2, Georgia Geological Survey, is greatly limited by the fact that nearly all but the first grade material is discarded, thereby necessitating the exclusion of a vast quantity of ore, which should, by proper skill and manipulation, find ready utilization at good prices. This condition was, perhaps, made necessary in the beginning, when markets had to be established, in order that home material might compete with the cheap and less pure foreign bauxites of long standing and reputation. The principle has been so rigidly adhered to by both operator and consumer, during the period of working in the American fields, that it has resulted in creating a demand for the first grade ore only, with practically no sales for the lower grade bauxite.

It is not thought necessary to demand bauxite of highest purity for making aluminum sulphate to be used for water purification purposes. It seems entirely possible that much of the cheaper grade bauxite could be used to advantage in making alum for water purification purposes.

BAUXITE SPECIFICATIONS AT COLUMBUS.

The specifications for bauxite now used at the Columbus plant are as follows: The bauxite is to be crushed and dried so as to contain not over 3 per cent moisture. By analysis there shall not be less than 52 per cent of Al_2O_3 and not more than 3 per cent of Fe_2O_3.

The contract for furnishing the supply needed for the period ending July 1, 1915, was awarded to the Aluminum Company of America, Pittsburgh, at $5.50 per long ton, f. o. b. Bauxite, Ark. The freight rate to Columbus is $4.40 per long ton, therefore a ton of 2,000 lbs. delivered at Columbus costs $8.84.

Bauxite contains from 58 to 60 per cent Al_2O_3, whereas ordinarily filter alum usually contains 17 per cent Al_2O_3; therefore 1 ton of bauxite will make a little more than 3 tons of alum ($Al_2(SO_4)_3\ 14\ H_2O$).

The Georgia Bulletin published in 1904 lists the following companies as either owning or working bauxite deposits in Georgia: The Republic Mining & Manufacturing Co., the Georgia Bauxite & Mining Co., the Dixie Bauxite Co., and the Southern Bauxite Mining & Manufacturing Co. Dealers known to be in position to quote prices on bauxite are: Aluminum Co. of America, Pittsburgh, Pa.; Winthrop C. Neilson Harrison Building, Philadelphia; National Bauxite Co., Philadelphia, and Globe Bauxite Co., Joliet, Ill.

HALLOYSITE—A SUBSTITUTE FOR BAUXITE.

Good filter alum may also be made from halloysite, the approximate chemical analysis of which is as follows: Soluble alumina, 38 per cent; insoluble material (silica, etc.), 40 per cent, and water, 22 per cent. Attempts to make crystallized alum from halloysite have failed because it has been found almost impossible to filter or separate the insoluble portions of the halloysite from the aluminum sulphate syrup. At the Columbus water purification plant, one tank, equivalent to about 6 tons of alum, has been made successfully and used. Several carloads of this material have been purchased, and further experiments with the use of halloysite as a base for making alum solution will be made.

The North American Chemical Co., Urbana, Ohio, has a very large deposit of this ore (estimated to be 15,000,000 tons) located near Rome, Ga. If a market can be created for halloysite, the material can be furnished f. o. b. cars Rome, at approximately $2 a ton.

Sulphuric acid used for making alum is contracted for at the Columbus water purification works under the following specifications: The sulphuric acid shall be that known as 66° Be. contact process acid, and shall contain not less than 92 per cent H_2SO_4. The material shall be delivered at a uniform rate of not less than 30 tons per month, or at such increased rate as shall be directed.

The sulphuric acid shall be shipped in acid tank cars, provided with all necessary connections for removing the acid from the car by air pressure.

ESTIMATED COST OF OPERATION.

Table I gives an estimate of the cost of producing 100 tons of 17 per cent Al_2O_3 alum solution.

TABLE I.—ESTIMATED COST OF PRODUCING 100 TONS OF 17 PER CENT AL_2O_3 ALUM SOLUTION.

468 tons 66 deg. Be. sulphuric acid @ $12.50	$ 5,850.00
265 gross tons bauxite @ $9.90	2,623.50
Lubricating oil	20.00
Steam	100.00
Electric current, 10,000 kw. hr. @ 2 cts.	200.00
Repairs to plant	500.00
Depreciation	600.00
Interest on investment	600.00
Total	$10,493.50

At the Columbus plant it is hardly fair to make any charge for labor because no additional labor is required to operate the new alum plant, consequently the labor item has been omitted in the above estimate. When lump alum was being used here it was necessary to unload it from the cars, sack and weigh it, store it in the storage house, elevate it to the third floor of the head house, stack it up there and finally dissolve it in solution tanks as needed. In addition to all this handling there was three times as much material to move and three times as much storage space required, because, as has already been explained, 1 ton of bauxite will make 3 tons of alum.

ACKNOWLEDGMENT.

This information is practically the full paper on the subject by Mr. C. P. Hoover, chemist in charge of the Columbus water softening and purification works, as prepared for the annual meeting of the American Water Works Association.

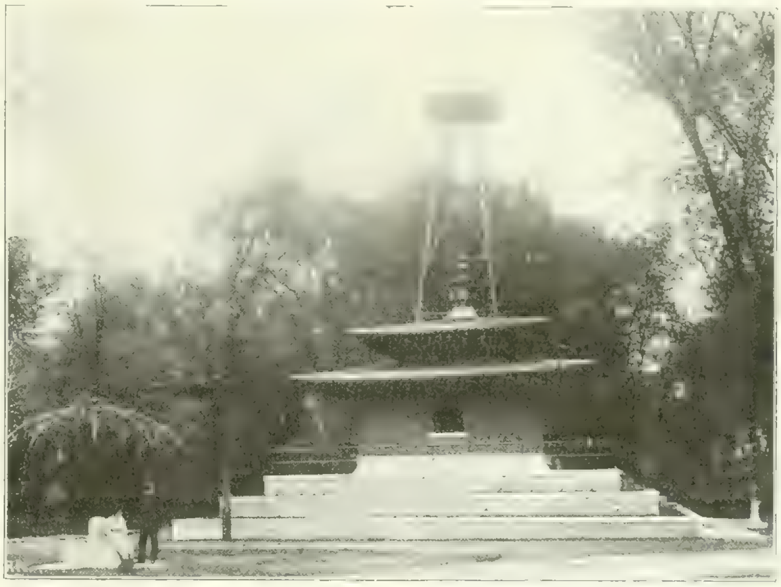
An Ornamental Well House at Waterloo, Iowa.

(Staff Article.)

The accompanying illustration shows the recently constructed ornamental well house over well No. 4, of the Waterloo, Iowa, water works in Cedar River park. The design of the structure, and its surroundings, add to the attractiveness of the park.

Well No. 4 is of the artesian type. It has a total depth of 1,378 ft. It is 15 ins. in diameter to a depth of 200 ft., and the balance of the well is 6 ins. in diameter. The well was drilled by the Miller Artesian Well Co. between Nov. 4, 1913, and April 1, 1914. The water bearing St. Peter sandstone was encountered at a depth of 800 ft. in a stratum 40 ft. thick. The water bearing Jordan sand was struck at a depth of 1,300 ft. in a thickness of 75 ft. As soon as this formation was reached the well started to flow and continued until the pump was installed. This well alone will provide 1,400,000 gals. daily, enough to supply the city.

The portion of the park in which the well house is located is subject to overflow from the flood waters of the Cedar River. For this reason it was necessary to place the floor line of the pumphouse about 9 ft. above the street grade. This was accomplished by building a foundation 8 ft. high and filling in, placing concrete retaining walls, or terraces, to hold the fill. The first terrace wall is 29 ins. high, 1 ft. thick, and is 50 ft. square. The second terrace is 28 ins. high and is set back 3 ft. from the first. It is carried on 20 concrete posts. The third terrace is also set back 3 ft. and is carried on posts. On top of the third terrace is a cement walk, 8 ft. wide, extending around the building.



New Well House of Waterloo Water Works in Cedar River Park.

The building is unique and was designed by the water department. Work on the plans was done by Howard Burr, and the building was erected by the H. A. Maine Co. The structure is 21 ft. square and is 12 ft. to the eaves. The outside is of pressed brick, two colors, with panel effect. The inside is of glazed tile, mottled with green to a height of 5 ft., and white from that point to the ceiling. The ceiling is of steel, painted white. The first roof has long, drooping eaves, covered with tile; the second is of the same construction and is 3 ft. above the first, making the building resemble a Japanese pagoda. It is surmounted by a 35-ft. iron tower for handling machinery.

A novel concrete rustic seat, shown at the left of the pump house, has been provided. This seat is covered by a grape vine, carried up through a 4 in. water pipe and spread over the top of the arches, in umbrella form. A public hydrant and drinking fountain are shown at the right. Numerous flower beds and a large amount of shrubbery have been added to increase the attractiveness of the water station. Shrubs are planted in the terraces.

The pump house was erected and the surroundings laid out under the direction of Mr. John P. Berry, superintendent of water works, to whom we are indebted for this information.

Experiences at Delaware, Ohio, in Deriving Water Supply from Wells in Gravel.

(Staff Abstract.)

The water supply of the Dalaware Water Co. of Delaware, Ohio, is obtained from rock and gravel wells. The gathering ground covers an area of about 25 acres, and lies in a bend of the Olentangy River. In 1909 an additional supply was obtained by running a suction line about 75 to 100 ft. from the river, following its contour for a distance of about 1,400 ft. On this line was constructed three deep rock wells, and 13 gravel wells; the latter being 4-in., with 3 to 4-ft. strainers, at an average depth of 28 ft. During the dry summer of 1914 an additional supply was thought necessary and plans were made for additional wells.

A new suction line was laid at right angles to the old one, and connected to it with a 10-in. cast iron pipe, and six new wells were drilled in the open field some 400 ft. from the old line of wells.

In this location was found 2 or 3 ft. of soil, 12 ft. of sand, mixed with some gravel and small boulders, and 12 ft. of coarse water-bearing gravel. It was evident that at some time this bend in the river had been its bed.

With a well drilling outfit the new 6-in. galvanized casings were sunk to the rock at an average depth of 28 ft. Then the casing was withdrawn about 3 ft. and a small charge of dynamite was exploded at the bottom, after which the gravel was taken out and the casing carried down to rock again. A 6-ft. strainer was placed inside the casing at the bottom, and held in place while the casing was withdrawn to near the top of the strainer, and a lead seal swedged to the top of the strainer.

With a gasoline engine and small pump, the wells were pumped for 24 to 48 hours, until all sediment was taken out and the water ran clear. These wells with the small pump showed a discharge of over 100,000 gals. in 24 hours each.

In order to reach the same level as the original suction line, it was necessary to place the suction line for these wells 12 to 14 ft. deep, this being just above the water line, at a time when the ground water was the lowest known in years. This gave promise of an abundant supply. These wells were then connected to the suction line, with a gate valve to each well to facilitate cleaning when necessary.

During the low period of ground water it was found that air was being taken into the suction, and some trouble was experienced with the pumps, and there was considerable inquiry by water consumers as to what was put in the water that made it look like milk.

A test of the main suction line was made by shutting off all wells, and an air pressure of 90 lbs. was placed on it, without any loss for several hours, showing that the air must come from some of the old wells, put in in 1909.

All these wells on being uncapped showed from 2 to 6 ft. of water above the strainers; the only probable solution of the air trouble found was that when the wells were in use under suction the water level in the wells was drawn down below the top of the strainers, at times, admitting air. This must have been caused by the partial stoppage of the strainers, or a general low condition of water in the surrounding gravel. It was found upon test that no air came from the new wells, the water level in these being 6 to 8 ft. above the top of the strainers.

Some engineers having experience with this system of wells have suggested that the 4-in. wells are entirely too small, and that all such wells should be not not less than 6 ins. in diameter, but rather should be 8 to 10 ins., with no strainers when in water bearing gravel. They should have perforations or holes in the bottom of the casing equal to 1½ times the area of the pipe. Then, instead of drawing the water from the body of the well, a smaller suction should be dropped inside the outer casing well to the bottom, and connected to the suction.

This would obviate the trouble of air finding its way through the top part of the strainer, and allow the well to operate until nearly exhausted.

ACKNOWLEDGMENT.

The foregoing matter is from a paper by Mr. C. W. Wiles, of Delaware, Ohio, before the recent annual meeting of the American Water Works Association.

GENERAL

Data on the Use of Screw Spikes on the Delaware, Lackawanna & Western R. R.

(Staff Abstract.)

The general use of screw spikes in both new construction and maintenance on the Delaware, Lackawanna & Western R. R. was started at the beginning of 1910, and during the past five seasons there have been placed in new tracks and in maintenance of old tracks 5,120,000 flat-bottom tie plates and approximately 12,272,000 screw spikes.

As would be expected some mistakes were at first made, and no doubt later developments will change some of the present practice. As a whole, however, the screw spike installation has proven very satisfactory, and no conditions have developed such as to cause any doubt about the ultimate success of the undertaking. Many minor difficulties which had been anticipated have not developed. It was fully expected that no small amount of trouble would be experienced from derailments, changing out broken rails, difficulty in gaging track on sharp curves, etc. It is a pleasure to state that, to the writer's knowledge, we have never had a derailment where the screw spikes have not been very much less damaged than the cut spikes in the same locality, and very seldom has a derailment broken off any screw spikes or damaged them to such an extent that they did not continue to firmly hold the rail in place. There have been many cases of derailment where it was not necessary to remove a screw spike, whereas nearly every cut spike on the damaged side of the rail was destroyed. Again, there have been some derailments where it is reasonably certain that bad accidents were prevented by screw spikes in some of the ties holding the rails in position, whereas the cut spikes in the other ties were destroyed. As to relaying rails, or removing broken rails, it is to be expected that the use of screw spikes will require more time to do the work. It is stated that it is not the intention of the report to convey the impression that positive conclusions can be reached from the experience thus far gained. The author relies more upon his presentation of facts to show the value of screw spikes.

TIES IN USE.

The Lackawanna Railroad first commenced to creosote cross-ties on an extensive scale in 1910. During 1910 and since that time all main and sidetrack renewals have been made with creosoted ties, excepting such chestnut ties as were available. These chestnut ties were used in sidetracks and on branch lines, where the service is light.

From 1905 to 1909 a good many bridge-tie renewals were made with longleaf yellow pine, treated with 12 lbs. of creosote oil per cubic foot. These ties were steamed at a 25-lb. pressure for an average of eight hours before treatment. "Wolhaupter" flange tie plates (6x8½x⅝-in.) were placed on all the bridge ties, with the idea of protecting them. The dimensions of the ties varied with the bridge structure and were from 8x8 ins. to 10x10 ins. and 8x16 ins.

On the main-line bridges none of the treated bridge ties have lasted to exceed eight years. Many of them were renewed in six and seven years. In no case was the timber decayed, but the failure was due to the shattering of the wood fibers under the rail seat and tie plates. As stated above, these were all longleaf yellow pine ties, with a very small percentage of sap. This failure has been attributed (1) to the fiber being injured by the steaming process before treatment; and (2) to the destructive action of the flanges on the tie plates. A total of 535 of these ties (8x12 ins.) were placed on the eastbound track of a deck plate girder bridge on the Buffalo Division in 1906, and had to be renewed in 1914. Untreated ties of the same size, and purchased under same specifications, were placed on westbound track of the same bridge in 1905 and are still in service and in fairly good condition. The old flange tie plates were removed from the deck of both tracks in 1910 and replaced with flat-bottom plates and screw pikes.

For several years past there have been placed very few chestnut ties in main-line tracks. It was found that they did not last to exceed five or six years, on account of rail and tie plates cutting through them very rapidly. These same ties give excellent service and last many years in yard tracks or on branch lines where the traffic is light.

As far as possible, hardwood ties are used on curved track. Longleaf yellow pine ties are generally used throughout on straight track. They are used not because they are preferable to hard woods, but on account of the difficulty in getting a sufficient supply of hard woods. A considerable number of loblolly and wide-ringed shortleaf pine ties were treated and placed in various services. However, unless otherwise stated, sap longleaf pine ties are referred to where pine ties are mentioned throughout this report. A good many gum, beech and maple ties were treated and placed in 1910. These ties were used in many sharp curves and their present condition will appear later on.

TIE PLATES.

For several years it was the practice to use flanged tie plates. It was found, after some years' experience, that much damage was done to the ties by the use of flange plates. It was, therefore, concluded that their use should not be further considered, either in connection with treated or untreated timber.

A good flange plate, or something equivalent thereto in actual holding-power, is absolutely necessary to hold gage on many of the sharp curves. After a careful investigation of all available data on screw spikes, it was concluded to adopt them as a means of holding track to gage, and thus permit the use of a flat-bottom tie plate which would not destroy the fibers of the tie. Hence, since the spring of 1910, screw spikes and flat-bottom plates have been used generally in all ties placed in main tracks, heavy-running yard tracks and leads, but not in light-yard tracks. In no case have screw spikes been used without tie plates.

It is necessary to have a tie plate of sufficient size to provide a safe bearing area for the weakest kind of wood used. As the main-track ties are 7x9 ins. x 8 ft. 6 ins., it was considered not advisable to make the tie plates wider than 7 ins.

The first tie plates which were rolled for our screw-spike construction were 7x10¼ ins. x½ in., with raised lugs to support the heads of two screw spikes and with an intermediate shoulder on the outside of the rail. The plates were smooth on the bottom, and did not have a shoulder or raised lug for the screw-spike head on the inside of the rail. The following season the plates were lengthened to 10⅝ ins. and made ⅝ in. thick, with lugs for the inside screw spikes. Two holes were also punched for lag screws, one at either end. The first plates rolled were ½ in. thick; they were at once increased to ⅝ in. and about a year ago they were again increased to ¾ in. in thickness.

SCREW SPIKES.

The first change from the standard cut spike fastening occurred in February, 1909. The heads of the screw spikes have been somewhat increased from those first used, on account of the great deterioration from rust caused by brine dripping at certain points on the line. The standard screw spike now in use is shown in Fig. 1.

HOLES FOR SCREW SPIKES.

The first year that screw spikes were used an "Ajax" hand machine was used for boring all ties in the field, a template being used to spot the holes. Creosote oil was poured into all the holes as soon as bored. In 1911 a boring and adzing machine, manufactured by Greenlee Brothers, of Rockford, Ill., was installed at the creosoting plant. This machine operated more or less successfully, but was not of sufficient capacity nor heavy enough in construction to successfully handle heavy hardwood ties. Accordingly, two new and larger machines, manufactured by the same company, were installed the fore part of 1913. These two machines have operated successfully, and have, without difficulty, adzed and bored 5,000 ties per day.

During the year 1914, 523,935 ties were adzed and bored, the following data applying to this work:

Highest number of ties adzed and bored in one day by one machine..............	3,324
Highest number of ties adzed and bored in one day by two machines............	5,682
Average number of ties per day per machine while operating	3,011
Average number of holes bored per bit per sharpening	1,500
Average number of holes bored per bit...	11,000

It would not be safe to figure over 2,500 ties per day per machine, or 62,500 ties per month, working single shift.

Eight men are required to operate one machine. In addition to this it is necessary to have a foreman, who is also a machinist, to keep the machines in repair and keep the knives and bits sharpened and ready to put on the machine when required.

The cost per tie for adzing and boring, including the interest on the investment, depreciation, operation, running repairs, electrical current for operating the machines and trams, while the latter are taking ties to and from the machine, does not exceed 1½ ct. per tie.

The ties are carried to the machine on trams, which are dumped mechanically. The machine is fed by a conveyor. Two laborers place the ties on the conveyors. Two surfaces are adzed at the rail seat, exactly in the same plane, regardless of the shape of the tie. The depth of cut can be regulated as desired for perfect ties. The depth required to get all ties adzed perfectly for the full length of tie plates depends upon the irregularity of the ties. After passing the adzing heads, the tie is centered at each adzed surface by an overhead device to insure that the boring is done in the center of the adzed surfaces. The ties then pass by conveyor to trams and are ready for treatment.

These machines are automatic, and it is, therefore, imperative that all parts continue to work properly while the machines are running. Trouble with any one part puts the entire machine out of commission.

COST DATA.

The following data are a summation of the labor cost in connection with the construction of the Lackawanna Railroad of New Jersey.

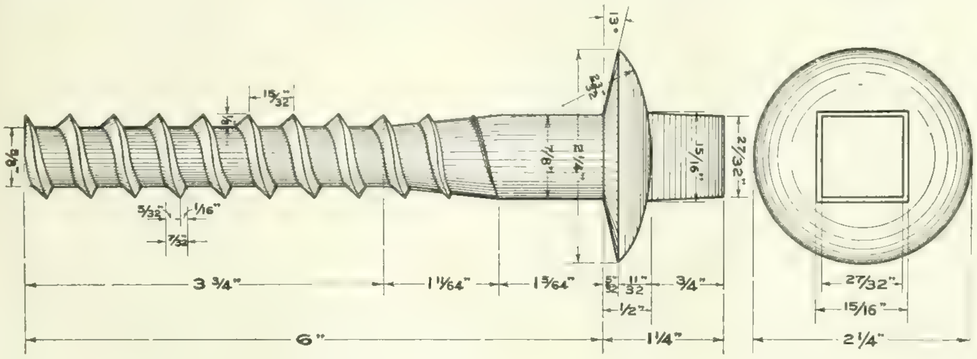


Fig. 1. Standard Screw Spike in Use on D., L. & W. R. R.

These figures cover the entire line, amounting to approximately 60 miles of main track:

	Per mile
Cost of boring by hand in the field. 2,880 ties at $0.035	$ 100.80
Cost of applying 11,520 screw spikes at $0.019	218.88
Cost of laying track, less boring and placing of screw spikes at $0.085 per foot	448.80
Cost of surfacing 5,280 ft. track at $0.17 per foot	897.60
Average cost of labor per mile of main track	$1,666.08

The above figures include the entire labor cost for putting the track in finished condition, but do not include any labor cost for the distribution of materials. It will also be noted that the cost of boring ties in the field on the above work amounted to 3½ cts. per tie, whereas the boring and adzing of ties, which is now done before treatment, has not cost to exceed 1½ ct. per tie.

CONCLUSIONS AFTER MORE THAN FOUR YEARS' USE OF SCREW SPIKES.

Ties.—(1) Treated beech, birch, gum, hard maple, elm and probably other similar woods may be safely used with oak on sharp curves where the traffic is especially heavy.

(2) From an economic standpoint, softwood ties, such as loblolly pine, should not be used on tracks of excessive traffic, nor is it advisable to use them on sharp curves with moderately heavy traffic. An expensive fastening device, such as an extra large and heavy tie plate or chair, securely fastened to the tie by fastenings independent of the spikes securing the rail, with sufficient room for rail movement on the tie plate, thus reducing the movement between plate and tie to a minimum, would probably make it practicable to use softwood ties on straight track and light curves with moderately heavy traffic. It is not believed, however, that loblolly pine, or similar ties, can be economically used with good results on heavy curves, regardless of the style of fastenings.

(3) As a rule, with woods which it will pay to treat, the poorer the quality of the timber the more elaborate and expensive the fastening must be if the mechanical life of the tie is made to approach the life of the treated timber.

(4) The hardest track to maintain, from a tie standpoint, is on sharp curves, elevated for high-speed trains, where the speed of freight trains is restricted on account of grade conditions. Where traffic is especially heavy, such curves should be provided wth the best of hardwood ties.

Tie Plates.—(1) Tie plates should be used on all ties where screw spikes are used.

(2) The tie plates should project well beyond the base of the rail on the outside and less on the inside to counteract the tendency of rail to roll out.

(3) As a rule, the required thickness of the tie plates will depend upon their projection beyond the base of the rail, and the traffic.

(4) Four holes should be provided for screw spikes, so that two extra holes will be available if needed.

(5) All holes should be punched from the top down and be as neat a fit for screw spikes as consistent, so as to make all screw spikes act together in resisting lateral pressure. The outside screw spikes should be so protected by the shoulder on the plate as to prevent the rail base from cutting into the screw spike neck; otherwise, in case of derailment and slued ties, it will be found impossible to remove the spikes without first straightening the ties.

(6) A raised lug, or shoulder, both inside and outside of the rail base, should be provided to give support to the screw spike heads. This shoulder assists in holding gage and materially reduces the breakage of spikes and damage to track in case of derailment.

Spikes.—(1) The size of screw spikes and the design of the thread should be carefully considered before a screw spike is adopted. Thereafter no changes should be made; otherwise the new screw spikes cannot be used in old holes without damaging the wood fiber.

(2) Where salt brine drippings are excessive, screw-spike heads must be made sufficiently large; otherwise there may be difficulty in the future in removing the screw spikes from the track, due to corrosion. During nearly five years' service no screw spikes have been found that were rusted within the tie, and there was no rust to speak of below the head, although some spike heads were rusted so badly that they could not be removed with the standard tool.

(3) The screw spike head should have tapering sides to prevent turning in the wrench socket after the size of the head has been diminished by rust.

(4) Any mechanical device for setting down screw spikes must automatically release when the screw spike is seated; otherwise the screw spike is apt to be damaged in case of hardwood or the wood fibers destroyed in case of softwood.

(5) Very little trouble is experienced by screw spike heads breaking off, either on account of track movement or derailed equipment. The heads are, at times, damaged to considerable extent by derailments, but as a rule the spikes are not broken, nor is their holding-power affected. Where screw spikes are broken off, a device for extracting the broken portion from the old hole without injury to the wood threads would be a valuable appliance.

(6) When screw spikes are fully seated, no further strain should be put on them, as this will tend to destroy the threads in the wood or injure the spikes.

Holes for Screw Spikes.—(1) All ties should be bored at the treating plant before treatment. This can be done while the ties are being adzed, and not only insures that the holes are bored sufficiently deep, but provides for good treatment of all wood adjacent to the spike holes.

(2) Where the ties are bored before treatment, the track must be to proper gage before the ties can be placed.

(3) The holes for screw spikes should be of proper dimensions for the class of wood used, with due regard to the size of screw spike used.

(4) A limited number of holes can be bored with one bit, after which its size will diminish so as to make it unfit for a hole of given size.

(5) Holes should be bored somewhat deeper than the length of the screw spike. There is no serious objection to boring the holes clear through the ties.

Gage.—(1) With oak, birch, hard maple, gum or longleaf yellow pine ties, gage can be maintained with a flat-bottom plate, using two screw spikes on straight line and two or three on curves.

(2) Heavy curves elevated for high speed, where heavy freight trains move at a slow rate of speed, are the hardest track to keep to gage.

(3) Double spiking should be done on the inside of the rail.

(4) Not only is the lateral and vertical resistance of a screw spike greater than that of a cut spike when both are first applied, but the lateral and vertical resistance of a loose screw spike is considerably greater than the lateral and vertical resistance of a loose cut spike.

(5) When the threads in the tie are entirely destroyed, a screw lining (any one of several different varieties) may be used with good results.

General.—(1) All ties should be bored and adzed before treatment. This insures good gage, a perfect bearing for the tie plates and good treatment under the rail seat and around the screw spike holes.

(2) In placing screw spikes, they should be driven by hammer only sufficient to make the threads take hold. If rigid instructions are not carried out, laborers will continually overdrive spikes and thus destroy the wood fibers near the top of the holes.

(3) Screw spikes with flat-bottom plates on hardwood ties will hold track to gage on sharp curves under heavy traffic. The holding power of screw spikes in hardwood ties, after more than four years' service, is not materially reduced.

(4) No screw spikes have ever been found so loose that they could be easily pulled out of the holes, and but few have been discovered which could be as easily extracted as a newly-driven cut spike. In no case, except with loblolly pine ties, have the threads in the wood been found weakened.

(5) Screw spikes in maintenance work can be most economically used where all rail is of a standard pattern, so that regaging of track is not necessary in relaying rail.

(6) Slight irregularities of track when frozen are liable to throw an excessive strain on screw spikes where there are but a few mixed with cut spikes.

(7) The best results with the screw spikes can be expected in new construction, and where the number of screw spikes in tie renewals predominate over cut spikes.

(8) In relaying rail, cut spikes should never

be driven in old screw spike holes, if the holes are to be again used for screw spikes.

(9) No effort should be made to draw up a low tie with screw spikes when the roadbed and ballast are frozen solidly.

(10) Screw spikes do not have to be continually set down, as do cut spikes, but should be gone over and set down properly after the plates are seated in the tie.

(11) Flat-bottom plates with raised shoulders or lugs for the screw spike head make but little noise and do not rattle at all where ties are adzed before treatment.

(12) It cannot be expected that the full life of all creosoted softwood ties, such as loblolly pine, will be realized without providing expensive fastenings from the start, and then it will probably be necessary to add some further device at a later date. Probably the most practical and least expensive device will prove to be one or the other of the lining devices to be placed in worn-out spike holes.

(13) The use of screw spikes for the past five years has not made it necessary to increase the number of section men per mile of track.

(14) Whether or not it will pay to use screw spikes will depend upon the cost of ties, their probable life and the amount of traffic.

ACKNOWLEDGEMENT.

The foregoing data were abstracted from a paper by G. J. Ray, Chief Engineer, Delaware, Lackawanna & Western R. R., in the Bulletin of the American Railway Engineering Association for March, 1915.

Some Data on the Design and Cost of Concrete Piles Used on Railroad Work.

(Staff Abstract.)

The following data apply to the construction, cost and use of concrete piles by various railway companies:

GENERAL DATA.

The concrete piles generally used are of the reinforced type, although in several cases plain concrete piles have been used.

The piles are usually of 16-in. short diameter, whether square or octagonal. The Santa Fe Ry. varies the short diameter, using the formula $D = 7$ ins. $+ \frac{1}{4}$ in. $\times L$, where L equals length of pile expressed in feet.

Concrete piles are used both tapered and straight section, the latter type being more commonly used.

A large variance is shown in the amount of steel reinforcement used, both longitudinal and transverse. The greater portion of the piles have ¼-in. rods for transverse reinforcement, whether spiralled or hooped. Steel mesh is used in a few cases, and in one case additional steel reinforcement is used in the head of the pile.

The Chicago, Burlington & Quincy R. R. is one of the roads that uses steel mesh for reinforcement.

The cost of the concrete piles at point of manufacture varies considerably; this is probably due in a large measure to the method of bookkeeping, or as to what is considered a proper charge against the actual cost of the piling; the number of piles manufactured and the available plant and labor for manufacturing the piles are also factors that may influence the cost.

The variation in the cost per linear foot of pile as given in Table I is also due to the use of different quantities of steel reinforcement, some roads using a design providing considerably more steel than others. For instance, the cross sectional area of steel used by the Burlington runs 4.25 lbs. per linear foot, by the Illinois Central 12.5 lbs. per linear foot, and by the Milwaukee 17.5 lbs. per linear foot.

The cost of driving the piles also varies considerably, but this should be expected, as the nature of the soil, the accessibility of the work, the traffic conditions, and the number of piles driven at a given structure affect the cost of driving to a certain extent. Thirty-five cents per linear foot, however, seems to be a fair average cost under ordinary condi-

TABLE I.—COST DATA SUBMITTED BY VARIOUS RAILROADS COVERING CONCRETE PILES.

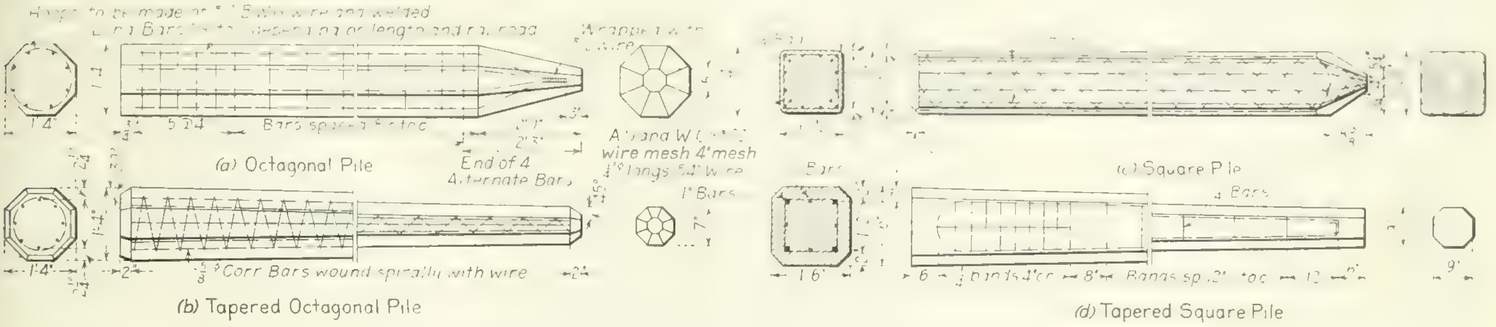
Railroad.	Cost of piling at point of manufacture, per lin. ft.	Cost of handling per lin. ft.	Cost of driving per lin. ft.	Total cost in place per lin. ft	Character of material through which driven.	Remarks.
Atchison, Topeka & Santa Fe..........	64 cts. manufactured under contract at bridge site.	32 cts. for handling and driving.		96 cts.	Missouri River mud mixed with sand. Boulders near bed-rock.	Contract provided free haul of material over company's lines. Cost of handling covers cost dragging pile from place moulded to place driven 40 cts. to 50 cts. per pile to cut off when not driven to grade.
Baltimore & Ohio...	71.9 cts.	10.1 cts.	51.7 cts., includes cost of drving and pulling steel. Steel approx. 5 cts. per ft. of pile.	$1.367	Strata of firm clay just below cut-off line.	Cost of making and handling based on 9,400 lin. ft. piling, which includes 125 ft. extra piling for breakage and 500 ft. driving heads. Cost of handling high because of special conditions. Driving based on 8,775 ft.
Canadian Pacific....	$1.06	39 cts. for handling and driving. Includes work train service.		$1.45		
Chicago, Burlington & Quincy..........	35 cts. per lin. foot, including loading on cars.		Cost of driving too variable to give cost unit.			Experience is that it costs little or no more to drive concrete piles than wooden piles.
Rock Island Lines..	85 cts., including cost of falsework, as skidways and forms. 67 cts. without above items.		38½ cts.	$1.23, including all expenses except freight, $1.05½ without cost of forms, skidways and freight.	Greater portion in Arkansas in sand fill. In Kansas and Oklahoma in natural ground 6 and 7 months same as hard pan.	Driven with drop hammer, which necessitated engine service and shifting of tracks to get to place where piling was to be driven.
Illinois Central......	66 cts.	12.3 cts. for unloading.	20.8 cts.	99.1 cts.		Average for 1,404 piles on Tenn. double track. Max. penetration, 23 ft.; max. length, 40 ft. Min. penetration, 12 ft.; min. length, 20 ft. Aver. penetration, 18 ft.; aver. length, 27 ft.
Northern Pacific....	65 cts. 69 cts.		Cost of driving too variable to give fair estimate. 98 cts. per lin. ft. average of 6,786 lin. ft. driven.			
Chicago, Milwaukee & St. Paul........	80 cts. in yards where locomotive derrick can be used.		On double track trestle not under traffic 204 piles at 39 cts.			
Fort Worth & Denver City...........	58 to 78 cts.; 60 cts. a fair average.		One job 4,278 lin. ft. at cost of 77 cts.			Cost of driving includes cost of unloading, train service, fuel, and work train expense.
New York Central & Hudson River.....			Contractor's record showed 10 cts. actual driving cost.	$1.38 to $1.60		
New York, New Haven & Hartford				Simplex piles cost 94 cts. in place, average for 191 piles.		
Penn. Lines (Northwest System).....			35 cts. for 2,800 foundation piles and 2,200 piles for retaining walls.			
Wheeling & Lake Erie	98 cts. for material and labor.		14-40 ft. piles for 29½ cts., 35-40 ft. piles for 28 cts. For scales 46-40 ft piles for 12½ cts.			

tions. This cost includes handling costs, which vary from 10 to 12 cts. per linear foot.

Several of the answers received show that it costs little more to drive concrete than wooden piling.

The general opinion seems to be that in cases where there is permanent moisture and there is no danger of future drying out, wooden piling is the cheaper; where the line of permanent moisture is low, concrete piling is the most economical.

No Eastern railroad seems to have used concrete piling for bridge bents. Several of the Western railroads have used concrete piling to a considerable extent and have found it to be good and permanent construction.



(a) Octagonal Pile (b) Tapered Octagonal Pile (c) Square Pile (d) Tapered Square Pile

Fig. 1. Typical Designs of Reinforced Concrete Piles Used on Various Railroads.

In many cases concrete piling has been used to support small abutments, where placed on embankments, as this type of construction is more economical on account of the saving in the cost of expensive high abutments.

TYPICAL DESIGNS OF REINFORCED CONCRETE PILES.

The four types of reinforced concrete piles most used by railroads are: (a) Octagonal piles; (b) tapered octagonal piles; (c) square piles; and (d) tapered square piles. Figure 1 gives typical details of each of these types.

COST DATA ON CONCRETE PILES.

Table I gives cost data submitted by a number of railroads covering the cost of manufacture, cost of handling and driving, total cost per linear foot, and general data explanatory of the costs.

ACKNOWLEDGEMENT.

The foregoing data were compiled by Sub-Committee C of the Committee on Masonry of the American Railway Engineering Association, and reported in the Bulletin for February.

Burnt Clay as Concrete Aggregate.

(Staff Abstract.)

The following data gave the results of some tests made at the Engineering Experiment Station of Iowa State College, and reported in *The Iowa Engineer*:

In April, 1914, some interesting tests were made to determine the value of refuse burnt material from an Iowa clay-products plant as aggregate in concrete. Two reinforced concrete beams were made, burnt clay being used as aggregate in one and crushed limestone in same in both beams. Some 6-in. cubes were also poured, using the same concrete as for the beams. The materials were mixed in the proportions 1:2:4 by volume.

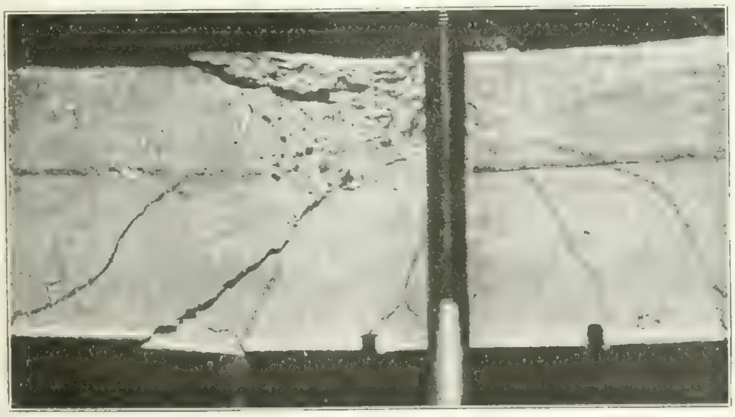


Fig. 1. Beam Containing Burnt Clay Aggregate Tested to Failure.

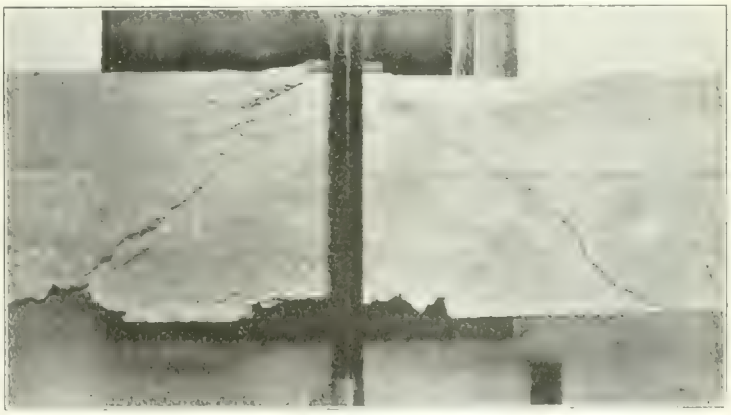


Fig. 2. Beam Containing Broken Stone Aggregate Tested to Failure.

The beams were 10 ins. wide, 20 ins. deep, and 10 ft. long, reinforced 1 in. above the bottom with four ¾-in. square corrugated bars, two of the bars being bent up 18 ins. from each end. Two vertical stirrups were also used near each end. The beams were designed to develop the strength of the concrete. They were tested at the age of 28 days, on supports 9 ft. apart, under center loading. supports 9 ft. apart, under center loading. Both beams failed by crushing near the point of application of the load and by diagonal tension in the center half of the length (see Figs. 1 and 2). The beam containing burnt clay aggregate failed under a center load of 65,000 lbs., while that containing crushed stone aggregate failed under a center load of 47,500 lbs.

The average strength of the 6-in. cubes was as follows:

Kind of aggregate.	Compressive strength at 28 days, lbs. per sq. in.	Compressive strength at 38 weeks, lbs. per sq. in.
Burnt clay aggregate..	1,250	3,680
Crushed stone aggregate	860	2,300

The results of tests to determine the weight and absorption of the burnt clay and crushed stone were as follows:

Material.	Weight in lbs. per cu. ft.	Absorption in lbs. per cu. ft.
Burnt Clay	71.0	5.50
Crushed stone	93.0	2.83

The results of the sieve analysis were as follows:

Material.	Percentage passing sieve No. — 1	2	4	8	30	50	100
Burnt clay	63.10	10.57	0.33	0.10	...	...	...
Broken stone ..	83.86	33.82	9.72	3.60	1.39	1.01	0.66

Although the scope of the tests was not sufficient to warrant stating any conclusion, they indicate a possible use of burnt clay waste products.

American motor trucks have been purchased by the Greek government for army use. These trucks are equipped with "army" bodies and are of two sizes, 1½ and 2½ tons.

Unit Costs of and Organization for Building Site Excavation.

Contributed by Wm. Wren Hay, Calgary, Alberta, Canada.

The following details of the costs of excavating over 27,000 cu. yds. of earth from a building site in Western Canada were compiled by the author during 1914. The excavation was "subbed" to a contractor with a grading outfit near at hand, and this outfit was set to work shortly after the work was awarded. The conditions were such that the grading outfit could not work to advantage to complete the job, and a small revolving steam shovel was cut in at the end of ten days. This small shovel was not able to complete the excavation in the time demanded by the general contractors, and a large shovel which had been working in a railroad cut nearby was rented for ten days to maintain the schedule. Conditions were such that not one of these equipments was able to work to the best advantage, and it is believed that the costs for this work were as low as could be, all things considered. The costs for the elevating grader were exceptionally low, as both horses and men were in excellent condition, and worked together without a hitch.

The excavated ground had a maximum length of about 400 ft. and a width of 200 ft. About half of the site was taken out to a depth of 6 ft. lower than the other half, the maximum side cut being 22 ft., the minimum cut, about 6 ft. The hole was close against a high railroad embankment at one end and there was a shallow swamp at the lower end. There was a large amount of ground water running through the site, but continual pumping enabled the contractors to keep the water level to the lowest grade. A sump pit was excavated at the lower end after the swamp was well drained, the level of the water in the sump during pumping being 1 ft. lower than the water level in a river distant about 1,500 ft. The top soil was in general a clay loam, easily removed, and the balance of the excavation was entirely in compacted gravel. There was a very small proportion of sand in this gravel, so that when once it was loosened, it was very easily handled. It is interesting to note that there was a friction head in this gravel amounting to 1 ft. in 100 ft., as the water 200 ft. from the pumps stood 2 ft. higher in the soil, though the flow from that side was towards the pump at all times. It must be understood that the costs given below are the direct charges against the earth excavated, and do not include any expenses other than those given in detail. Practically the entire amount of earth removed was used to fill on one side of the site, embankment being formed for three tracks at the end and two tracks through the middle of the structure.

Elevating Grader Outfit.—Maximum run, 450 ft.; haul, 200-1,000 ft.; material, clay oversoil and porous gravel; rate, 900 cu. yds. per 10-hour day; amount removed, 8,500 cu. yds.; cost of operating outfit ner day, $91.00; cost per cubic yard, place measure, 10 cts. Organization of Outfit:

Elevating grader –	
14 horses at $1 per day	$14.00
4 men at $2.50 per day	10.00
Scrapers	
4 horses	4.00
2 men	5.00
Transportation—	
12 horses	12.00
6 men	15.00
Trimming—	
2 horses	2.00
2 men	5.00
Foreman, 1 man at $5.00 per day	5.00
Equipment (rent)—	
Grader, $10 per day	10.00
6 dump wagons, $1 per day	6.00
3 scrapers, $1 per day	3.00
Total cost per day	$91.00

Model 20 *Revolving Steam Shovel.* (¾-cu. yd. Dipper).—Average length of move, 4 ft.; haul, 200-1,000 ft.; material, compacted, porous gravel; rate, 400 cu. yds. per 10-hour day; amount removed, 12,200 cu. yds; cost of operating, per day, $105; cost per cubic yard, place measure, 26½ cts. Organization of Outfit:

Shovel (see below)	$42 50
Transportation, 9 teams at $5.50 per day	49.50
Trimming, 2 teams at $4.50 per day	9.00
Foreman	5.00
Total cost per day	$105.00

Model 60 *Marion Steam Shovel.* (2½ cu. yd. Dipper).—Maximum length of cut, 260 ft.; maximum face of cut, 10 ft.; haul, 1,500-2,000 ft.; material, compacted gravel; rate, 750-1,000 cu. yds. per 10-hour day; amount removed, 6,600 cu. yds.; cost of operating per day, $170.75; cost per cubic yard, place measure, 21 cts. Organization of Outfit:

Shovel (see below)	$ 62.50
Transportation, 2 dinkey trains (see below)	63.25
Trimming, 2 crews	40.00
Foreman	5.00
Total cost per day	$170.75

The detailed items entering into the cost per day charged against the large shovel are as follows:

Shovel rent	$20.00
Craneman, $5 per day	5.00
Shovelman, $3.50 per day	3.50
Fireman, $2.50 per day	2.50
Pit crew, 4 men at $2.50 per day	10.00
Coal—	
3 tons at $4.50 per ton	13.50
½ team at $5 per day	2.50
Water, ½ team at $5 per day	2.50
Oils, etc.	1.00
Repairs	2.00
Total cost per day	$62.50

From time studies conducted by the author, it was determined that the actual time of this shovel chargeable to loading was slightly less than 50 per cent of the gross time of any single day's run. This is rather a low percentage for such a large shovel and was largely due to the unfavorable conditions. The concrete plant was in course of erection during the time that this shovel was operating, and it was necessary to operate the dinkey trains parallel to the fill and switch back along the embankment to the dumping point. The shallow fill necessitated constant shifting of the dinkey tracks, so that in addition to train delays, there were many delays from derailments. The time charged to changing trains amounted to from 25 to 35 per cent of the gross operating time, and delays due to derailments and casual delays, from 30 to 20 per cent. Practically no delay was caused while moving the shovel. The transportation equipment consisted of 17 four cubic yard, side dump, contractors' cars, made up into two trains of eight and nine cars each, and hauled by 14-ton dinkey engines. The cost of these trains per day is tabulated below:

Rent of equipment	$25.00
Engineers, 2 men at $3.50 per day	7.00
Dump crew, 4 men at $2.50 per day	10.00
Track crew, 2 men	5.00
Coal, 2½ tons at $4.50 per ton	11.25
Oils, etc.	1.00
Water	2.00
Repairs	2.00
Total cost per day	$63.25

It was observed that single cars were loaded in an average time of 0.875 minute, 2½ to 2¾ cu. yds., place measure, per car being loaded with an average of three dipper swings. Working in a railroad cut, against a 35-ft. clay face, this shovel and crew were several times observed loading a train of nine 4-cu. yd. cars in 4 minutes.

Similar studies were made on the work of the small revolving shovel. The percentage of the total operating time charged to loading averaged 60 per cent; moving, 30 per cent; and ordinary delays, 10 per cent. Under ordinary working conditions, loading into 1½ cu. yd. dump wagons, the outfit averaged 1 cu. yd. per minute, net, loading 1.4 cu. yds. of loose earth with 3¾ dipper swings per load. The average move was 4 ft., accomplished in an average time of 5.4 minutes. The detail cost per day for this shovel was as follows:

Shovel rent	$10.00
Craneman, $5 per day	5.00
Shovelman, $3.50 per day	3.50
Fireman, $2.50 per day	2.50
Pit crew, 2 men at $2.50 per day	5.00
Coal –	
2 tons at $4.50 per day	9.00
½ team at $5 per day	2.50
Water, ½ team	2.50
Oils, etc.	0.75
Repairs	2.00
Total cost per day	$42.50

Repairs for this shovel amounted to practically the same as for the large shovel, because this shovel had been out of commission for some time previous and was also doing heavy duty, whereas the big shovel had been in good running shape previous to being cut into this work, and the same time was doing light work. For the same reason, the coal consumption of the small shovel was high as compared with that of the large shovel.

BRIDGES

The Designing of Reinforced Concrete Slabs Subjected to Bending and Compression.

Contributed by Anders Bull, Public Service Commission for the First District, New York.

In this article a study will be made of the conditions arising when a reinforced concrete slab, stressed for plain bending is subjected to an additional compressive force acting in the direction of the steel reinforcement, and a simple method will be explained for determining accurately the stresses in such cases.

RESULTANT FORCE.

Consider a slab of an effective depth d (Fig. 1), stressed by the moment M and the compressive force P, applied at a distance a from the center of steel reinforcement. Let xd be the distance of the neutral axis from the extreme compressed fiber.

According to well known theory, the moment and the compressive force may be substituted by a single force $P' = P$, applied at a distance B from the neutral axis, where

$$B = \frac{\text{Total moment}}{\text{Compressive force}}.$$

If the line of action of the compressive force does not coincide with the neutral axis it will contribute to the total moment by an amount equal to $P\,[a - d\,(1-x)]$, therefore,

$$B = \frac{M + P\,[a - d\,(1-x)]}{P}.$$

Substituting for B the quantity $A - d\,(1-x)$, we have for the distance of the resultant P' from the center of steel reinforcement,

$$A = \frac{M}{P} + a. \qquad (1)$$

LOCATION OF NEUTRAL AXIS.

Substituting for the concrete stresses a single force acting through the center of gravity of the stress triangle, we have equations (2) and (3), in which b = width of slab, p = ratio of steel area to concrete area, f_s = stress in steel, f_c = extreme fiber stress in concrete, and e = ratio of the modulus of elasticity of steel to that of concrete (assumed to be 15).

For rotation about point C (Fig. 2):

$$b\,d\,p\,f_s\,d\,(1-\frac{x}{3}) = P'\,[A - d\,(1-\frac{x}{3})] \qquad (2)$$

For rotation about point S:

$$b\,xd\,\frac{f_c}{2}\,d\,(1-\frac{x}{3}) = P'A \qquad (3)$$

Further, assuming the stress at any point to be proportional to its distance from the neutral axis, and allowing for the different straining of concrete and steel, we have,

$$f_c : xd \therefore \frac{f_s}{e} : d\,(1-x) \qquad (4)$$

Eliminating the quantities f_s, f_c and P' from equations (2) to (4) gives:

$$x^3\frac{d}{A} + 3x^2\,(1-\frac{d}{A}) + 6\,x\,e\,p - 6\,e\,p = 0. \qquad (5)$$

Equation (5) shows that x may be considered as a function of only two variables, $\frac{d}{A}$ and p, the value of e having been fixed; and it is therefore possible to tabulate values of x as shown in Table I. By means of this table the location of the neutral axis for any set of values of $\frac{d}{A}$ and p may be easily and quickly determined.

DESIGNING THE SECTION.

Solving for p in equation (5) gives,

$$p = \frac{3x^2\,[1 - \frac{d}{A}\,(1-\frac{x}{3})]}{6e\,(1-x)} \qquad (6)$$

Substituting this value of p in equation (2), and reducing, we have,

$$b\,d^2 = \frac{P'A}{f_s\,\frac{3x^2 - x^3}{6e\,(1-x)}} = \frac{P'A}{K_s}. \qquad (7)$$

Equation (3) may be written in the following form:

$$b\,d^2 = \frac{P'A}{f_c\,\frac{x}{2}\,(1-\frac{x}{3})} = \frac{P'A}{K_c} \qquad (8)$$

In equations (7) and (8) K_s and K_c stand for the respective denominator expressions.

Formulas (7) and (8) are similar to the standard formulas used for plain bending, the only difference being that $P'A$ has been substituted for the bending moment.

K_s and K_c, being functions of the single variable x, may be tabulated, as shown in Table II. Two sets of values have been given, corresponding to the stresses specified by the Public Service Commission and the New York Building Code, respectively, the underscored figures being those that are governing for the design of the slab section.

Where other stresses are used, the corresponding values of K_s and K_c may be obtained by multiplying the specified f_s and f_c by the quantities S and C, as given in the second and third columns.

In determining the shearing and bond stresses the standard formulas may be used, viz.,

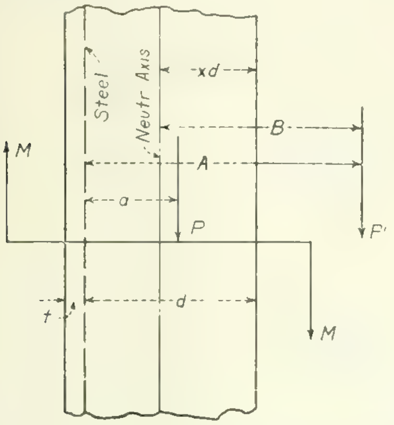


Fig. 1. Nomenclature Used in Locating Resultant Force—Reinforced Concrete Slab.

$$\text{Shearing stress} = \frac{R}{b\,j\,d}, \ldots\ldots\ldots\ldots\ldots (9)$$

$$\text{Bond stress} = \frac{R}{u\,j\,d}, \ldots\ldots\ldots\ldots\ldots (10)$$

where j represents the quantity $(1 - \frac{x}{3})$, R the transverse shearing force, and u the perimeter of the steel reinforcement.

It should be noted, however, that in a compressed slab the neutral axis changes with the bending moment, and its position may thus be different at the point of maximum moment and point of maximum shear.

For a given shearing force the shearing and bond stresses will reach their highest value when the resultant is acting through the middle third point of the slab section, when $\frac{d}{A} =$ 1.5, $x = 1.0$ and $j = \frac{2}{3}$. With the resultant *inside* of the middle third, the slab may be considered as of practically uniform material, therefore the distance between centers of flange strains (jd) becomes $\frac{2}{3}(d + t)$, where t = thickness of concrete outside of the steel reinforcement. This gives a slightly lower value for the shearing stress, while the bond stress may in this case be neglected, both the steel and concrete being in compression, for resisting which the steel is not being relied upon.

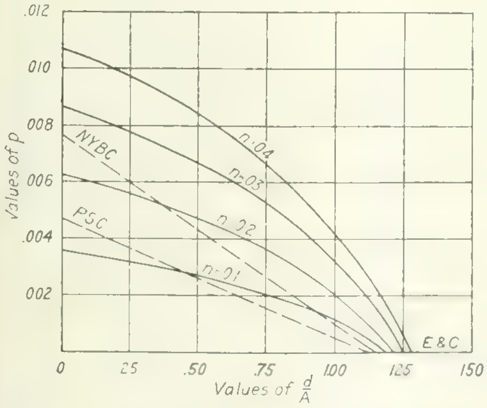


Fig. 3. Curves Showing Economic values of p as Functions of $\frac{d}{A}$ and n.

ECONOMIC SECTION.

The cost V of a reinforced concrete slab may be expressed as follows:

$$V = L\,b\,[(d + t)\,c + d\,p\,s], \qquad (11)$$

where L = length of span, c and s = cost per unit volume of concrete and steel, respectively, including erection; c is also supposed to cover any additional item the amount of which is proportional to the depth of the slab, such as excavation, acquirement of property, etc.

As a rule all the quantities on the right side of equation (11), with the exception of d and p, are fixed beforehand. V may therefore be considered as a function of d and p, but since p is a function of x and d (see equation 6), while d is a function of x (see equation 8), V may also be expressed as a function of x. By differentiating the latter function, the value of x may be found for which the cost of the slab will be a minimum.

Carrying out the computations we find that the following equation will have to be satisfied:

$$x^4\,2\frac{d}{A} - x^3\left(12\frac{d}{A} + 12e\frac{c}{s} - 15\right) + x^2\left(18\frac{d}{A} + 42e\frac{c}{s} - 27\right) \quad x\,48e\frac{c}{s} + 18e\frac{c}{s} = 0, \ldots\ldots\ldots\ldots (12)$$

From this equation the economic value of x for any given set of values of $\frac{d}{A}$ and $\frac{c}{s}$ may be determined. (By combining equations (6) and (7) an equation similar to (12) may be obtained; but, as the values of x found from this equation will all be above those x-values at which equation (7) is governing for the design of the slab section (see Table II), the latter equation is without practical significance.)

In Fig. 3 the corresponding values of p have been plotted, showing the economic steel proportion for different values of $\frac{d}{A}$ and $\frac{c}{s}$, the latter ratio having been substituted by the more convenient quantity n, representing the ratio

$$\frac{\text{Gross cost per cubic yard of concrete}}{\text{Gross cost per ton of steel rods}},$$

the volume of one ton of steel having been assumed as 0.15 cubic yard. These curves show that the economic steel proportion decreases with increasing $\frac{d}{A}$, becoming zero for $\frac{d}{A}$ = about 1.25, which means that theoretically it is not economical to use reinforcement when A is less than $0.8\,d$.

Where equation (12) gives a lower value for p than the one for which the concrete and steel are stressed to the same proportion of their respective allowable limits, the latter value should be substituted as the more economic. This value is governed by the quantities f_s, f_c and $\frac{d}{A}$, and is represented in Fig. 3 by the broken lines marked P.S.C. and N.Y.B.C., corresponding to the standards of the Public Service Commission and the New York Building Code, respectively.

The above results have also been incorporated in Tabl I, the underscored figures indicating those values of x which will, under ordinary conditions, give the most economic sections, with the proviso that the corresponding value of K_s should never be lower than that of K_c.

REMARKS.

The tables will also be found of value in computing the stresses in reinforced concrete arches. In this case the location and amount of the resultant P' and the shearing force R may be obtained directly from the pressure line.

While the tables have been computed on the basis of $e = 15$, they may still be used for other values of e. Substituting, for example, the value 14 is equivalent to the relative elastic efficiency of the steel being reduced in the proportion 15:14. The values given for p in Table I are therefore to be multiplied by the factor $\frac{15}{14}$, as are those given for S and K_s in Table II.

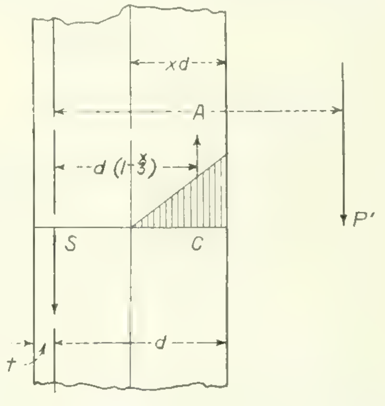


Fig. 2. Nomenclature Used in Locating Neutral Axis—Reinforced Concrete Slab.

Example.—It is required to design the side-wall slab of a subway section of the dimensions given in Fig. 4. The section is supposed to be in earth with rock as foundation and to be located under private property. Provision shall be made for future building loads to the amount of 3,000 lbs. per square foot on top of the roof. The allowable stresses are those specified in the New York Building Code.

Assume first that d = 13 ins. Allowing 2 ins. for t, and 400 lbs. per square foot for the weight of the roof slab, the compressive force will be,

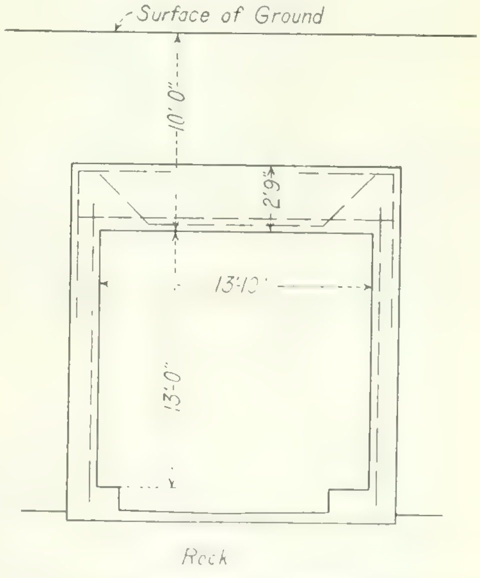


Fig. 4. Subway Section Assumed to Illustrate Design Procedure.

$$P = \frac{(13.8 + 2 \times 1.25) \times 3{,}400}{2} = 27{,}700 \text{ lbs. per foot.}$$

Considering the wall slab as simply supported at the top and bottom, and taking the span as the clear width plus the depth of the slab and the average intensity of the side pressure as 550 lbs. per square foot, we have for the bending moment,

$$M = \frac{14.2^2 \times 550 \times 12}{8} = 166{,}000 \text{ in.-lbs. per foot.}$$

If we assume that P is applied at the center of the slab we have:

$$a = \frac{d+t}{2} - t = \frac{13+2}{2} - 2 = 5.5.$$

$$A = \frac{M}{P} + a = \frac{166{,}000}{27{,}700} + 5.5 = 11.5;$$

$$\frac{d}{A} = \frac{13}{11.5} = 1.13;$$

and the required value of

$$K = \frac{P' A}{b\, d^2} = \frac{27{,}700 \times 11.5}{12 \times 13^2} = 157.$$

TABLE I.—VALUES OF x AS FUNCTIONS OF $\frac{d}{A}$ and p, for e = 15.

d/A = 0	0.1	0.2	03	0.4	05	06	07	08	09	10	11	1.2	13	1.4	1.5
p = .000										0	273	500	692	.857	1.00
.001	.159	166	175	185	196	210	228	251	.280	.322	382	470	589	727	869	100
.002	217	226	237	249	264	281	302	327	.360	403	460	536	635	753	878	100
.003	258	269	281	295	311	330	352	379	.413	455	510	580	668	772	885	100
.004	292	303	316	.331	348	368	391	419	453	494	547	612	693	787	892	100
.005	320	332	345	.361	379	399	423	451	485	526	.576	638	712	800	898	100
006	344	356	371	387	405	426	450	478	511	.552	.600	659	729	811	903	100
007	365	378	393	409	428	.449	473	501	534	574	621	677	744	.821	908	.100
008	384	398	413	429	448	469	494	522	554	593	639	693	756	830	912	100
.009	402	416	431	448	466	.488	512	540	572	610	654	706	767	837	916	100
.010	418	432	447	464	.483	.504	.529	.556	.588	.625	.668	719	777	844	.919	100
011	433	447	462	479	498	.520	544	.571	603	639	.681	.730	.786	.850	.922	1.00
012	446	461	.476	493	.512	534	.558	.585	.616	.652	693	740	794	.856	.925	100
013	.459	474	489	506	.526	.547	.571	598	628	663	703	.749	802	861	.928	1.00
014	471	486	501	519	538	559	.583	609	639	.674	.713	757	.808	.866	.930	100
015	483	497	.513	530	549	570	.594	.620	.650	.683	.722	.765	.815	870	.932	100
.016	493	508	.523	.541	.560	.581	.604	.630	.660	.693	.730	.772	.820	.874	934	100
.017	503	.518	534	551	.570	.591	.614	640	669	701	.738	.779	.826	.878	936	100
018	513	527	.543	.560	579	.600	.623	649	.677	.709	.745	.785	.831	882	938	100
.019	522	537	.552	.569	.588	609	632	657	.685	.716	752	791	836	885	940	100
020	531	545	.561	578	597	617	640	.665	693	723	.758	797	840	888	942	100
021	539	553	569	586	605	625	648	672	.700	.730	764	802	844	891	943	100
022	547	561	577	594	613	.633	.655	.679	.706	736	.770	.807	.848	894	945	100
023	555	569	585	.602	.620	640	662	686	.713	.742	.775	.812	.852	897	.946	100
024	562	576	.592	.609	.627	647	.669	.693	.719	.748	.780	.816	.855	899	947	100
025	569	.583	599	615	.634	.653	675	699	.725	.753	.785	.820	.859	.902	949	100
.026	576	590	605	622	640	660	681	705	730	759	790	.824	.862	.904	950	100
027	.582	.596	612	.628	.646	.666	687	.710	.735	.763	.794	828	865	906	.951	100
028	588	602	618	634	.652	.672	.693	.715	.741	.768	.798	831	868	.908	.952	100
.029	594	608	.624	.640	.658	.677	.698	721	.745	.773	.802	835	.871	.910	953	100
.030	600	614	629	646	.663	.682	703	726	.750	.777	806	.838	.873	912	954	100

P = Compressive Force
M = Bend'g Mom't, neglecting P
R = Shearing Force
p = Proportion of Steel
d = Effective Depth
b = Width of Slab
u = Perimeter of Steel
a = Dist of P from ℄ of Steel

$bd^2K_c \geq PA$, $bd^2K_s \geq PA$, $A = \frac{M}{P} + a$
Shear'g Stress $= \frac{R}{bjd}$, Bond Stress $= \frac{R}{ujd}$, $j = (1 - \frac{x}{3})$
Distance of Neutral Axis from ℄ of Steel $= d(1-x)$.
x is determined by $\frac{d}{A}$ and p (Table I)
K_c and K_s are determined by x (Table II)
Economic Values of x are underscored

TABLE II.—VALUES OF Ks AND Kc AS FUNCTIONS OF x.

x	1000S	C	P.S.C.		N.Y.B.C.	
			K_s	K_c	K_s	K_c
.17	1095	0802	21.8	48.1	17.5	52.1
.18	1238	0846	24.8	50.8	19.8	55.0
.19	1391	0890	27.8	53.4	22.3	57.8
.20	1556	0933	31.2	56.0	24.9	60.7
.21	1.731	0977	34.6	58.6	27.7	63.5
.22	1917	1019	38.4	61.2	30.7	66.8
.23	2.114	1062	42.2	63.7	33.8	69.0
24	2324	1104	46.4	66.2	37.2	71.8
25	2546	1146	51.0	68.8	40.7	74.5
.26	2781	1187	55.6	71.2	44.5	77.2
27	3029	.1229	60.6	73.7	48.5	79.9
28	3291	1269	65.8	76.2	52.7	82.5
29	3567	1310	71.4	78.6	57.1	85.1
.30	3857	.1350	77.2	81.0	61.7	87.8
.31	4163	1390	83.2	83.4	66.6	90.3
32	4464	1429	89.6	85.8	71.7	92.9
.33	4822	1469	96.4	88.1	77.2	95.5
.34	5177	1507	104	90.4	82.9	98.0
.35	5549	1546	111	92.8	88.8	100
36	5940	1584	119	95.0	95.0	103
37	6350	1622	127	97.3	102	105
.38	6840	.1659	136	99.6	108	108
39	7.231	.1697	145	102	116	110
40	7704	1733	154	104	123	113
41	8199	.1770	164	106	131	115
42	8719	1806	174	108	139	117
43	9263	1842	185	111	147	120
44	9834	1877	197	113	157	122
45	1043	1913	209	115	167	124
46	11.06	1947	221	117	177	127
.47	1172	1982	234	119	187	129
48	1241	2016	248	121	198	131
49	1313	2050	263	123	210	133
.50	13.89	2083	278	125	222	135
.51	1469	2117	294	127	235	138
.52	1552	2149	310	129	248	140
.53	1640	2182	328	131	262	142
54	17.33	2214	347	133	277	144
55	18.30	2246	363	135	293	146
.56	1932	2277	386	137	309	148
.57	2040	2309	408	139	326	150
58	2154	2339	431	140	344	152
.59	22.73	.2370	455	142	364	154
60	24.00	2400	480	144	384	156
61	25.34	2430	507	146	405	158
62	26.75	2459	535	148	428	160
.63	28.25	2489	565	149	452	162
64	29.83	2517	597	151	477	164
65	31.52	2546	630	153	504	165
.66	33.31	2574	666	154	533	167
67	35.21	.2602	704	156	563	169
68	37.25	.2629	745	158	596	171
.69	39.42	.2657	798	159	631	173
.70	41.74	.2683	835	161	668	174
71	44.23	2710	885	163	708	176
72	46.91	2736	938	164	750	178
73	49.78	2762	996	166	797	180
74	52.89	.2787	1058	167	846	181
.75	56.25	.2813	1125	169	900	183
.76	59.90	2837	1198	170	958	184
.77	63.88	2862	1277	172	1022	186
.78	68.22	2886	1364	173	1092	188
79	72.98	2910	1458	175	1168	189
.80	78.22	2933	1564	176	1252	191
.81	84.03	2957	1681	177	1344	192
.82	90.48	2979	1810	179	1448	194
83	97.71	3002	1954	180	1563	195
84	105.8	3024	2116	181	1693	197
85	115.1	3046	2302	183	1841	198
86	125.6	3067	2512	184	2010	199
87	137.8	3089	2756	185	2205	201
.88	152.0	3109	3040	187	2432	202
89	168.8	3130	3376	188	2701	203
90	189.0	3150	3780	189	3024	205
.91	213.7	3170	4874	190	3419	206
92	244.5	3189	4890	191	3912	207
.93	284.2	3209	5684	193	4547	209
.94	337.1	3227	6742	194	5393	210
.95	411.2	3246	8224	195	6578	211
96	522.2	3264	10440	196	8356	212
.97	672.4	3282	13450	197	11320	213
98	1078	.3299	21560	198	17240	214
.99	2189	3317	43780	199	35020	216
100	∞	.3333	∞	200	∞	217

According to Table II this value of K corresponds to $x = 0.605$; while Table I, for $\frac{d}{A} = 1.13$ and $x = 0.605$, gives $p = 0.0030$.

While the above section is satisfactory for the loads considered, its strength in the event of the roof being left exposed has also to be investigated. In the latter case we have:

$$P = \frac{16.3 \times 400}{2} = 3{,}260;$$

$$A = \frac{166{,}000}{3{,}260} + 5.5 = 56.5; \text{ and}$$

$$\frac{d}{A} = \frac{13}{56.5} = 0.23.$$

This value of $\frac{d}{A}$ gives, with the above steel proportion, $x = 0.285$ (Table I), and $K = 55$ (Table II). As, however, the required value of K is $\frac{3{,}260 \times 56.5}{12 \times 13^2} = 91$, the section is not strong enough for the reduced load.

As a larger proportion of steel is required the effective depth d is reduced to 12 ins., giving, for full roof load:

$$A = \frac{166{,}000}{27{,}700} + 5.0 = 11.0;$$

$$\frac{d}{A} = \frac{12}{11.0} = 1.09;$$

$$K = \frac{27{,}700 \times 11.0}{12 \times 12^2} = 176;$$

$x = 0.71$; and $p = 0.0097$; for which ¾-in. rods, spaced 5 ins. on centers, may be used.

If the roof is left exposed we have, for the latter section:

$$A = \frac{166{,}000}{3{,}260} + 5.0 = 56; \quad \frac{d}{A} = \frac{12}{56} = 0.21;$$

$x = 0.444$; and $K = 123$, while the required value is only $\frac{3{,}260 \times 56}{12 \times 12^2} = 106$. This section is, therefore, safe for both assumptions.

The shearing force R is greatest at the foot of the wall, being about 4,050 lbs. per foot. As the moment at the support is zero, we have:

$$\text{Shearing stress} = \frac{R}{b\,\frac{2}{3}(d+t)} = \frac{4{,}050}{12 \times \frac{2}{3} \times 14} = 36 \text{ lbs. per square inch.}$$

While the bond stress at the foot of the wall is negligible, it can, at no other point, exceed:

$$\text{Limit of bond stress} = \frac{R}{u\,\frac{2}{3}d} = \frac{4{,}050}{7.2 \times \frac{2}{3} \times 12} = 70 \text{ lbs. per square inch.}$$

As the allowable shearing and bond stresses are 40 and 80 lbs. per square inch, respectively, these values are on the safe side.

The desirability of determining accurately the effects of a compressive force is evidenced in the above example by the fact that, for $d = 13$ ins., the compression tends to increase the resistance of the slab against bending, while, for $d = 12$ ins., its effect is just the opposite.

Why Not a Rational Specification for a Wooden Pile?

To the Editors:—The typical specification for a wooden pile, as used by most railroads, municipalities, etc., and as advocated by most producers, reads about as follows:

The pile shall be so straight that a line stretched from center of butt to center of point will not leave the pile more than 1/100th (for example) of the length of the pile.

Several criticisms instantly arise in one's mind as to this specification, among which are:

(1) It is obviously impossible to stretch a line from center of butt to center of point; and therefore a substitute method has to be employed, which latter should logically also be substituted in the specification. Obviously the pile will naturally lie on a flat surface so that its greatest curvature is horizontal. A line is then stretched from the butt to the point over the centers of each; and, by sighting down vertically along the string, the distance between the projection of the string and the side of pile is noted.

(2) What relation should exist, if any, between the crookedness of a pile and its length? Obviously, again, the pile must be straight enough to be placed in the pile-driver. It also must not be so crooked that a blow of the hammer will bend it so as to damage it;

and it must not be so crooked that its final load will produce a bending moment in the pile large enough to produce stresses exceeding a safe maximum. This load condition and the phenomena during driving are practically identical in nature, except that one is static and the other dynamic. Now the theory of bent columns (or, what is the same thing, of eccentrically loaded columns, or of arches), must of necessity apply to piles.

Moreover, it is obvious that, for members of the general size and shape of piles, the length has no effect upon the stresses due to eccentricity of loading at any section, the latter being due only to the eccentricity and to the area of the corresponding section (see Fig. 1).

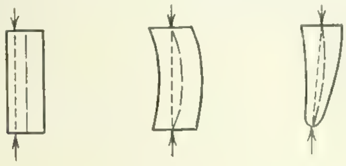


Fig. 1.

(3) What should be the maximum permissible crookedness? It would seem that it should depend upon the permissible maximum bending stress for the material composing the pile and upon the area of the latter. Most engineers would doubtless concede a relatively high unit stress as permissible for the condition of combined direct and bending stress in a pile. From this, it is seen that when all piles are designed to be uniformly loaded when finally in place, a greater bend is permissible in a pile of large diameter than in a smaller one, because a less unit direct stress will exist in the large pile. Such a specification may not make inspection easy and it may possibly be considered impracticable for other reasons, but its logical possibility is evident.

Of course different kinds of wood must have different permissible bends. Furthermore, the designer's load per pile will influence the allowable bend, if the limit placed on the total maximum unit stress is constant.

Assume, for example, a 12-in. round pile, with an area, where its bearing on the soil commences, of 100 sq. ins., designed for a loading of 30,000 lbs. For such a pile the direct stress is 300 lbs. per square inch. If a safe unit stress, due to combined compression and bending, of 2,400 lbs. is assumed, then 2,100 lbs. may roughly be assumed as the maximum permissible unit bending stress due to eccentricity of load at the section. (The unit stresses recommended by the Committee on Wooden Bridges and Trestles of the American Railway Engineering Association, Vol 10, p. 564, for long-leaf pine are: 3,800 lbs., ultimate; 1,300 lbs., safe and 1,300 $(1-l/60D)$, for long columns; 6,500 lbs., ultimate extreme bending, and 1,300 lbs., safe.) Since the moment of inertia is about 1,016 and the section modulus is 169.4, the maximum permissible eccentricity of stress at the ground level would be 11.9 ins. At a section approximately 8 ins. in diameter, with an area of about 50 sq. ins., where the total direct stress may have been reduced by half, the permissible unit bending stress may be assumed at 2,250 lbs. The moment of inertia is 196.7, the section modulus 49.2, and the permissible eccentricity 7.4.

Examples might be multiplied; but it would seem evident from the two given that a modification of the type of specification now in use might be advantageous. It seems obvious that the permissible bend should not be measured in terms of the length of the pile but rather in terms of its diameter at each point along its length. With this in view, the following wording with reference to yellow pine piles is submitted for criticism:

"The pile shall be so straight that a line held in contact with any two points selected so as to give the maximum deviation shall not be distant from the surface of the pile at any point more than the diameter of the pile opposite that point."

Very truly yours,

E. P. Goodrich

Consulting Engineer, Department of Public Works, Borough of Manhattan, New York City, April 27, 1915.

(Discussion based on this letter is solicited. The subject is one upon which many engineers should have data and opinions of value.—Editors.)

Concerning the Relative Costs of Plain and Reinforced Concrete Retaining Walls.

To the Editor: The bids received for constructing retaining walls along the banks of the Sandusky River, Tiffin, O., are of more than ordinary interest, as they show the relative costs of constructing plain and reinforced concrete walls.

The city asked for bids on both types of wall shown in section in Fig. 1, the total length of wall being 2,600 ft. There were 23 bids submitted. The lowest complete bid on the plain concrete design made the cost of this type of wall $5.75 per cubic yard, the total bid being $46,718.75; while the lowest bid received for constructing the reinforced concrete wall was $6.12 per cubic yard, plus 2½ cts. per pound for the steel reinforcement, or a total of $31,476.00. The contract was awarded for reinforced walls. The total bid for constructing the plain concrete wall was thus 48 per cent more than for the reinforced wall.

Considering 17 of the bids received for both types of wall, the average price for plain concrete was $6.117 per cubic yard, while the average prices for the reinforced type were $7.456 per cubic yard for concrete and 2.77 cts. per pound for reinforced steel. The average bid for constructing the plain concrete wall was thus about 32 per cent more than for the reinforced wall, although the reinforced wall (as indicated in Fig. 1) is theoretically more stable, both as to overturning and as to sliding. Moreover, a higher grade of concrete is used in the reinforced wall, and if the proportion of cement had been the same in both walls the difference in cost in favor of the reinforced concrete type would have been at least 7 per cent greater.

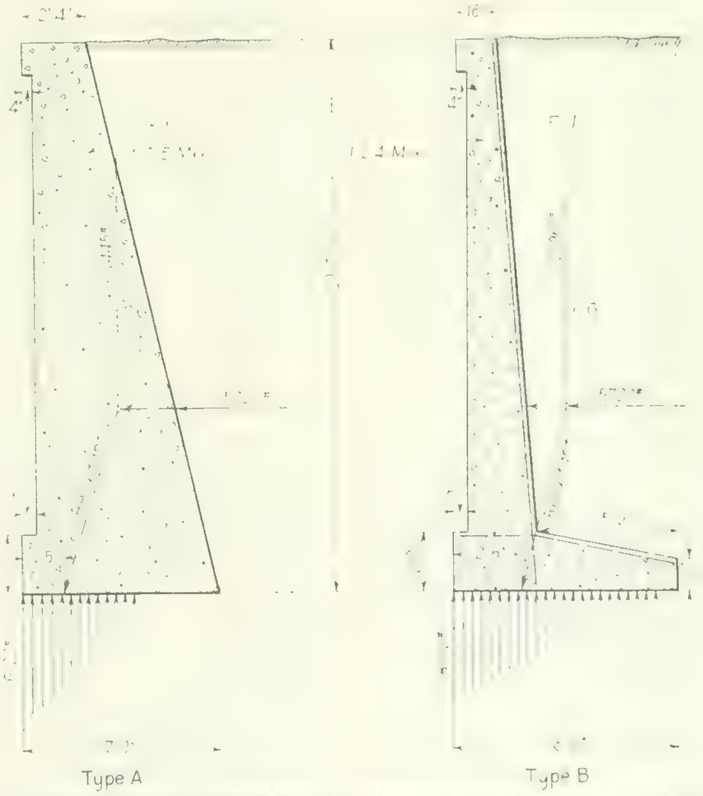


Fig. 1. Cross Sections of Comparative Designs for Plain and Reinforced Concrete Retaining Walls, with Graphic Analysis of Stability.

Very truly yours,

J. I. Oberlander, City Engineer.

Tiffin, Ohio, May 7, 1915.

A Summary of Bridge Work Done by Wisconsin Highway Commission During Period July 1, 1911-Jan. 1, 1915.

(Staff Abstract.)

The Wisconsin Highway Commission was created in 1911, and since that time its function, as regards bridge work, has been: (1) To prepare plans and specifications for all bridges built with state and county aid; (2) when requested, to give engineering advice regarding bridge work to township, village and county officers, and (3) to examine the plans of bridges built under the county aid law and approve same when found satisfactory. The following data from the second biennial report cover the bridge work done by the commission during the period July 1, 1911-Jan. 1, 1915.

STATE AID BRIDGES.

The work done during the fiscal year 1911-12 on state aid bridges included the surveying of the sites for 148 bridges, and preparing the plans and specifications for 91 bridges. During the year 1912-13 the sites of 298 bridges were surveyed, and the plans and specifications prepared for 243 structures. During 1913-14 the sites of 308 bridges were surveyed, and the plans and specifications for 339 bridges prepared.

During the biennial period covering the years 1911-12 and 1912-13 the sum of $389,177.66 was provided by towns, counties and state for bridge work under the state aid law. The work actually completed and accepted cost $231,359.10. On Dec. 31, 1913, work costing $105,398.07 was under construction, much of it complete except for minor details, which prevented acceptance. In some townships the amounts raised were not sufficient for the work done, thus incurring deficits aggregating $20,711.76, while in other townships there was a surplus of $72,802.81.

COUNTY AID BRIDGES.

Advantage was taken by the various township, county and village officers of the engineering service offered by the commission. Although the commission was organized in July, 1911, no state aid work could be done until 1912, although requests for engineering advice on county aid bridge work were so numerous from the start that the resources of the commission were taxed to the utmost.

During the fiscal year 1911-12 the commission's engineers surveyed 225 bridge sites and prepared and sent out plans and specifications for 84 bridges. During 1912-13, 254 bridge sites were surveyed, and plans and specifications prepared and mailed out for 258 bridges. During 1913-14, 336 bridge sites were surveyed and 362 sets of plans and specifications sent out.

This work was done in response to purely voluntary requests, in connection with bridges in which no part of the cost was paid by the state. From reports received, it is estimated that at least 90 per cent of the plans submitted have resulted in construction. The estimated value of county aid bridge work constructed from the commission's plans during the last six months of 1911 and during 1912 was $300,440; during the year 1913 the estimated value was $292,876; and during 1914 it was $401,284.

APPROVAL OF BRIDGE PLANS.

The county aid bridge law requires that bridges built under its provisions be approved by the commission. In accordance with this law the plans of 129 bridges have been submitted for approval up to Jan. 1, 1915. Obviously, it was impossible for the commission to make full examinations of the sites of these proposed structures. Moreover, the commission did not consider that it was the intent of the law to remove all discretion from local officials. It was therefore decided not to withhold approval unless the design submitted would provide a structure of less load capacity than that required by law. Where designs of inadequate capacity were submitted, these were returned with the necessary revisions indicated, so that they might be resubmitted, with corrections.

SPECIAL BRIDGES.

In addition to the duties imposed upon the commission by the state highway law, the legislature of 1913 imposed additional responsibilities as follows: The law was amended to provide state aid for bridges built under unusual conditions. It provided that any village, town, city or county might raise funds for the construction of a bridge across any navigable or meandered stream, and petition the State Highway Commission for state and county aid. Upon receipt of the petition it became the duty of the commission to decide whether or not the proposed bridge was a necessity and to ascertain its probable cost. If the bridge was found to be a necessity, and it was determined that it must, of necessity, be more than 300 ft. long, the commission was required to certify this fact and also the amount required to be paid by the county. The proportion to be paid by the town, village or city was 40 per cent, that by the county 40 per cent and that by the state 20 per cent. The law also provided that the total annual expenditure by the state should not be more than $30,000, and that state aid should not be extended to more than six bridges in any one year.

The commission received three petitions for state aid under this law; two of these were declared to be a necessity, while the third was declared unnecessary.

STANDARD BRIDGE PLANS.

The commission has prepared standard bridge plans, which are recommended for general use under Wisconsin conditions, as follows:

Spans, 6 to 12 ft., reinforced concrete slab bridges.

Spans, 12 to 35 ft., either reinforced concrete slab bridges, or steel I-beam bridges with reinforced concrete floors.

Spans, 25 to 36 ft., either through reinforced concrete girder bridges or steel I-beam spans with reinforced concrete floors.

Spans, 36 to 80 ft., either through Warren girder bridges with reinforced concrete floors or through plate girder spans with reinforced concrete floors.

Spans, 80 to 150 ft., through Pratt truss bridges with reinforced concrete floors.

The commission believes that each bridge requires individual treatment, and, although adhering as closely as possible to its standards, prepares separate designs for the substructure of each bridge. The commission firmly believes in the use of reinforced concrete bridge construction to the fullest extent practicable. Where spans longer than 40 ft. are used, or where it is necessary to use a roadway of unusual width, arches are recommended. No attempt has been made to standardize arch design, as such designs vary so greatly.

GENERAL SUMMARY.

During the period July 1, 1911-Jan. 1, 1915, the commission has designed 1,521 bridges, estimated to cost $1,653,764. Its engineers have been consulted voluntarily by about 600 municipalities in 70 counties, exclusive of state bridge work. The total cost of the bridge department during this period was $38,903.20, or 2.35 per cent of the estimated cost of the work supervised; this includes the cost of surveys, plans, letting and inspection. About 16,000 plans, covering bridge superstructure and substructures, have been mailed from the commission's office up to Jan. 1, 1915.

The stated weakness of the commission's bridge work has been in the inspection of construction. The demand for plans and specifications has been so great that practically the entire time of the bridge department has been devoted to supplying this demand. It is felt that this branch of the service should be substantially strengthened.

A set of accounting forms for bridge work has been prepared, and these forms are furnished free to the counties to enable them to keep accurate records.

Wire-Drag Surveys at Key West, Fla.—So valuable are the results of the wire-drag work done by the United States Coast and Geodetic Survey in the vicinity of Key West that the Navy Department has requested the extension of the work in the region farther to the westward. As Key West is a naval base, besides being a railway terminus, and an important commercial port, the necessity of having the whole region systematically examined with the drag is apparent. The principal work of the past season was a very close examination of the West Channel from a point west of Man Key for a distance of 10 miles to a point south of the eastern side of Marquesas Key, and an examination of the doubtful portions of the channel from Key West to Dry Tortugas. A depth of 28 ft. is indicated on the charts, but many shoals and coral heads with only 22 ft. were found. The coral formation in that region abounds in abrupt pinnacles, which it is impossible to detect with certainty with the sounding lead, as they are of very small area and project irregularly from the general contour of the bottom. The United States Engineers are improving the principal channels by blasting and dredging.

In all about 100 shoal spots were found with the drag during the season, and of these 13 were discovered in a single day. So numerous and so irregularly located were these shoal spots that they could not be described adequately by positions and bearings, and in order to show them it was necessary to publish sections of the chart with corrected soundings in the Notices to Mariners.

North and South Railway for Idaho.—Governor Moses Alexander of Idaho has announced that he would appoint a commission of three men to consider routes for a railway connecting the northern and southern portions of the state. It stated that if private capital cannot be interested in building the line the governor will call a special session of the legislature to consider constructing the road with state funds.

Engineering and Contracting

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Costs of Buildings in District of Columbia.—The cubic cost of buildings erected during the past fiscal year, all of which were designed by the municipal architect at Washington, D. C., is as follows:

Building—Name, number, description and location.	Cost.	Cubic contents. Feet.	Cost per cubic foot. Cents.	Heating plan.
Repair and storage building for fire department	$14,151	151,533	9.33	Steam, direct.
Alterations and addition to Birney School	48,105	332,820	14.45	Steam, direct, and fan system.
Alterations and addition to Congress Heights School	33,347	238,399	13.98	Steam, direct, and fan system.
Shelter sheds for farmers' produce market	11,769	98,000	12.00	
Alterations for accommodation of boilers and coal vault for District of Columbia jail	4,419	31,762	15.47	

CURRENT NEWS

The Doings of the Week.

General business and financial conditions during the past week sustained the advances of previous weeks and in some directions even manifested slight gains. The investment market showed its soundness in the prompt purchasing of large bond issues. The Pennsylvania R. R. $65,000,000 general mortgage, the Argentine Government loan of $25,000,000, the State of Tennessee $12,000,000 loan, and the Province of Alberta $4,000,000 issues were among the loans completed last week. The export trade showed gains over previous weeks; additional orders were placed for rails and cars; and large tonnages of steel and iron material were reported under negotiation. The grave international crisis that has prevailed during the past week seemingly has had little appreciable effect on business. In the construction field, the past week showed a slight falling off in the number of projects coming up for bids. But this has been the case all through the season. One week would bring out numerous undertakings and the next week would show a decrease. On the whole, however, a fair average showing was made during the past seven days. Several big jobs came up for advertising and a number of good-sized contracts were let. Plans also are well advanced on several big projects that will be offered for bids shortly. One feature of the week was the appearance of calls for bids for a considerable amount of work for cities in Canada and for Government departments. In the iron and steel trade plant operations continue at about 75 per cent capacity. Russia probably will place orders shortly in this country for about 100,000 tons of rails and larger amounts even are under consideration for the Trans-Siberian railroad. Large orders for cars also have been placed in this country by Russia. The Pennsylvania R. R. 138,000 ton rail inquiry includes 30,000 tons of 125-lb. sections. The National Tube Co. has obtained an order for 177 miles of 12-in. pipe from Louisiana oil interests. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending May 12 were as follows:

Finished Iron and Steel.	May 12.	May 5.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.17½	1.17½
Iron bars, Pittsburgh.........	1.20	1.20
Iron bars, Chicago............	1.15	1.15
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York.........	1.369	1.369
Tank plates, Pittsburgh......	1.15	1.15
Tank plates, New York.......	1.319	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York......	1.369	1.369
Skelp, grooved steel, P'gh....	1.12½	1.12½
Skelp, sheared steel, P'gh....	1.17½	1.17½
Steel hoops, Pittsburgh.......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.80	1.80
Galv. sheets, No. 28, P'gh....	3.40	3.40
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh........	1.35	1.35
Barb wire, galv., P'gh........	2.10	2.10

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—Railway construction is still in the doldrums. No developments looking to the taking up of any important projects occurred during the past week. The Union Station Co. of Chicago began calling for bids on the bascule bridge at West Monroe St., which will be a part of the new Union terminal development. The Wisconsin & Northern Ry. awarded a contract for a 10-mile extension in Wisconsin, John Duffy, Mountain, Wis., securing the job. The Norfolk & Western Ry. awarded a 100,000 cu. yds. contract.

Roads and Streets.—State, county and district highway construction continues to offer many opportunities to contractors. California is calling for bids on four contracts, about 26.3 miles in all; Illinois opens bids May 26 on three contracts; New Hampshire is asking proposals on two jobs; New York is calling for bids on a number of repair contracts. One of the larger road jobs of counties is that of Allegheny County, Pa. This county will open bids May 29 on highway improvements to cost about $500,000. Baltimore County, Maryland, is calling for bids on 4 miles of concrete paving. Corpus Christi, Tex., is asking proposals on about 86,000 sq. yds. of paving. Among the contracts let recently were the following: 5 miles of brick road near Wayne, W. Va., to cost $53,480; system of roads and bridges near Forney, Tex., for which $200,000 is available; paving Admiral Way at Seattle, Wash., to cost about $230,000; $70,000 road job for Wood and Ottawa counties, Ohio. The County Commissioners at Tavares, Fla., open bids June 7 on 112,000 sq. yds. modified asphalt.

Bridges.—Some very good-sized bridge undertakings reached the call for bids stage during the past week. Cincinnati, O., opens bids June 1 on the Park Ave. bridge over Kemper Lane, a reinforced concrete arch estimated to cost $165,000. County Commissioners at Hamilton, O., are asking bids on a $120,000 concrete bridge over Miami River; the Grade Crossing Commissioners at Buffalo, N. Y., open bids May 22 on subways and incidental work estimated to cost over $210,000. The Union Station Co., Chicago, is asking bids on a trunnion bascule bridge to be erected at West Monroe St. The contracts let last week include a considerable number of fair-sized jobs.

Drainage and Irrigation.—No important developments in either the drainage or irrigation fields appear to have come up for advertising during the past week. Several small drainage jobs involving excavation running around 100,000 cu. yds. are ready for bids. The contract for the 660,000 cu. yds. of ditch excavation for the Reed's Creek Drainage District of Dyer County, Tenn., was awarded to R. H. & G. A. McWilliams, Chicago and Memphis.

Waterworks.—A fair amount of work in this field is being advertised for bids, although no especially large undertakings appear to have come up. Hartford, Conn., opens proposals June 2 on the east dike of the Nepaug Reservoir development. Caruthersville is calling for bids on waterworks improvements and sewerage; Area, Ill., asks proposals on 18,700 ft. 6-in. water mains; Philadelphia, Pa., is calling for bids for laying 41,000 ft. of water pipe; Montrose, Colo., awarded contracts amounting to over $89,000.

Sewerage.—Philadelphia, Pa., awarded sewer contracts aggregating about $218,000; Siloam Springs, Ark., let a sanitary sewer job amounting to $43,711; Cleburne, Tex., is asking bids for sanitary sewers and sewage disposal plant; Wausau, Wis., and Kenosha, Wis., are asking proposals on sewer construction; Downingtown, Pa., is calling for bids on sewers and sewage disposal works. Sacramento, Cal., opened bids on sewer construction to cost about $12,5000, and also began advertising a new section of its trunk line system.

Buildings and Rivers and Harbors.—The Supervising Architect, Treasury Department, Washington, D. C., has commenced calling for bids on the building for the Interior Department offices at Washington. This will be 680,000 sq. ft. occupying a site 400 by 600 ft., and will be 7-story and basement, with face brick and limestone facing. The Quebec Streams Commission has asked tenders for the construction of the proposed storage dam at La Loutre on the St. Maurice River, Canada. Check for $150,000 is required with the bid for this work. West Palm Beach, Fla., opened bids on a reinforced concrete sea wall and other work, Jones & Garretson, at $70,682, being low bidder.

Railway Terminal Construction.

It is a rather curious coincidence that three of the biggest construction undertakings started recently by railways are for terminal developments. At Buffalo, N. Y., the Lehigh Valley has work under way on improvements that will call for an expenditure of about $5,000,000. The St. Paul Union Depot Co. is about to award the contract for the first construction in connection with its $15,000,000 project at St. Paul, Minn. At Chicago, the Union Station Co., which is in charge of building the $65,000,000 terminal for the Pennsylvania and other railroads, already has let several good sized contracts, has advertised others, and has plans well advanced for additional developments. Here is a probable expenditure of $85,000,000 for the betterment of terminal facilities in three cities. It is not a bad showing for an off year. If the railways can finance improvements like these, that are not direct revenue producers, it would seem that presently they will be able to find the funds to build new line extensions and branches that will give them returns on their investments.

Up and Down.

A couple of weeks ago everything was looking fine. Bank clearings established a record; export trade was booming; business and finance were nearly in old-time shape. Old man Pessimism had crawled into his hole, and young man Optimism had emerged from his. And then the Lusitania went down. So did stocks, premiums on municipal bond issues and three or four big construction contracts that were about to be let. But this did not last long. Stock-prices are commencing to rise again, rates for money remain unchanged, and the banks are vigorously encouraging business and credits. It was a very pretty little scare while it lasted. That the trying situation of the past 10 days caused practiclly no disturbance in business nor in the larger matter of finannc proves conclusively the strength of this country's financial and industrial position.

Bids on Street Paving.

An interesting method of taking bids on street paving is outlined in a proposed advertisement of the street and sewer department of Wilmington, Del. The bids are to be received in either one or two forms or both. One form calls for furnishing the labor and materials for grading, curbing, and constructing concrete foundation; the other form provides for this work and also for laying the pavement. Prices may be submitted on eight yardages ranging from not less than 5,000 sq. yds. to not less than 100,000 sq. yds. A list of the streets to be improved is published with the instructions to bidders and the specifications, and the prices bid are to apply to work on one or more streets to be selected by the street and sewer department from the list.

Dam Construction in Situ.

The greatest inventions of the European cataclysm seemingly have been made by the newspaper correspondents and their colleagues, the headline writers. A few weeks ago a gun with a range of 28 miles was discovered, and now comes a report of a new method of building dams. According to the press dispatch the Germans propose buying a steamer and loading her with thousands of tons of broken stone and cement. The boat is then to be taken to the narrowest part of the St. Lawrence River and sunk, in the hope that the "cement and stone will form a massive masonry dam," and thus prevent the transporting of Canadian troops and supplies by boat. The experiment will be watched with much interest.

PORT DEVELOPMENTS OF BEAUMONT, TEX.

Plans for Marine Terminals to Cost $3,000,000.

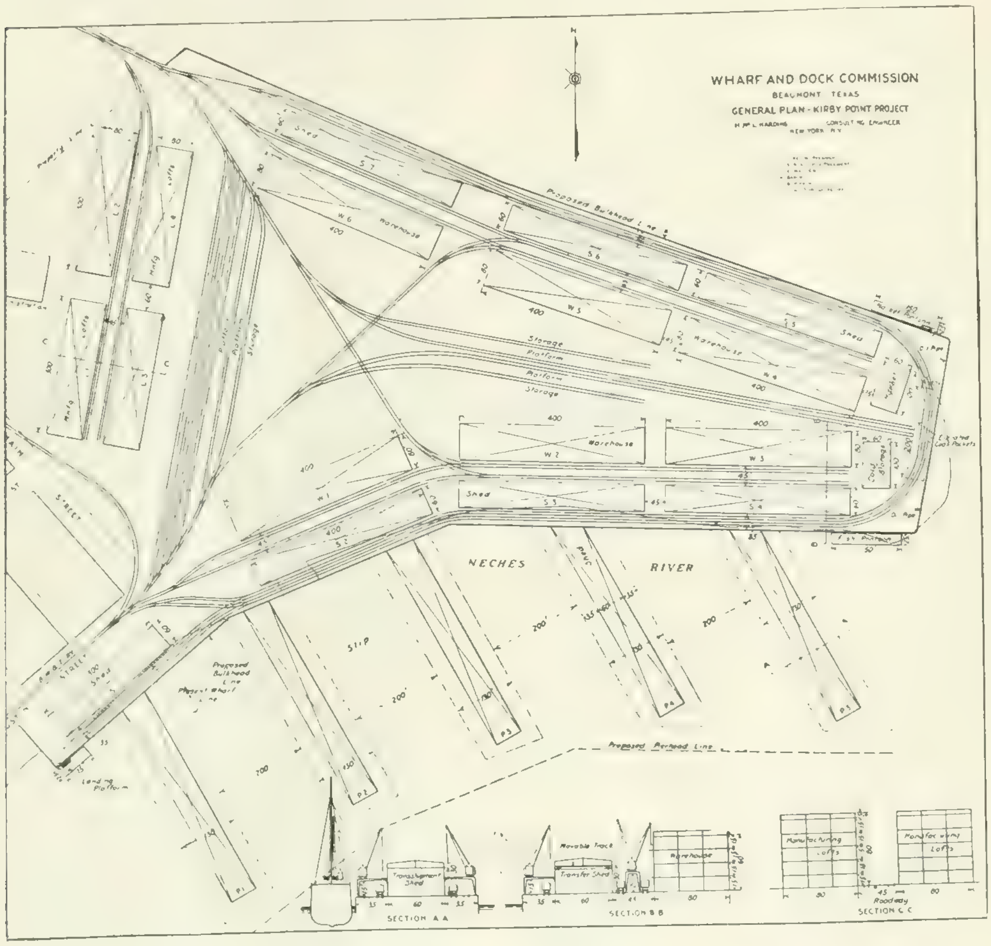
Concrete Quay Wall — Piers — Sheds — Warehouses—Handling Equipment.

Extensive marine terminal developments are proposed by Beaumont, Tex. On May 25 this city votes on a $100,000 bond issue for the first unit of the improvement. This issue provides for walls, terminal buildings and the installation of the necessary cranes and other machinery.

The city has acquired land at Kirby Point, on the Natches River. With the land and water areas there are now available about 55 acres for an industrial terminal. On the other side of the river bordering partially on the basin is another area of sufficient size for the largest commercial or through freight marine terminal for all of Texas. It is proposed to establish here a large railway service yard, including receiving, classifying and transfer tracks, a transfer station with large cotton, rice and other warehouses, as well as large open spaces for the storage of coarse and bulk freight not affected by climatic conditions. There also are excellent dry dock locations.

The accompanying illustration shows the plan and sectional elevation of the complete industrial terminal development. This terminal is designed for construction on the unit system. A unit length of quay is equal to 500 ft., the length of a large freighter. This unit would be provided with a proportional length of shed, warehouse, necessary railway tracks, and also the transferring and handling machinery. It is estimated that each unit complete, with the filling and paving, will represent a total investment, without the land, of about $300,000. The total cost of the seven units with the fish and farm markets and cold storage and administration buildings, the manufacturing lofts, sheds, railway approaches and storage tracks, will approximate $3,000,000. It is planned to construct the unitts to meet the demands of traffic.

The freight will be transferred by traveling jib gantry cranes and will be assorted by overhead traveling hoists. Other cranes in the rear of the shed will transfer the freight to any story of the warehouse. The terminal railway tracks and the present Belt Line R. R. will permit the switching of cars from any of the railroads entering Beaumont. At first along the river banks of the terminal there will be constructed only the concrete quay walls. The projecting piers will be put in later. The complete development provides for seven transfer sheds and five trans-shipment sheds. All of these will be of steel and will have a total holding or short-time storage capacity of 114,500 tons. The warehouses will be of concrete and will have a long storage capacity of 114,500 tons. The open storage plans for outside freight will have an area of about 300,000 sq. ft. The manufacturing lofts will be constructed of concrete and will have a combined floor area of about 620,000 sq. ft.



General Plan and Sectional Elevation of Marine Terminals for Beaumont.

The traveling gantry cranes will have the following characteristics: Normal load, 3 tons; over-reach, 45 ft.; horizontal distance between crane tracks, 32 ft.; maximum height of lift, 70 ft.; lifting speed (3 tons), 150 ft. per minute; lifting speed (1½ tons), 200 ft. per minute; motive power, electricity, either 550 or 220 volts D. C. There will be two types of cranes: the half arch and the full arch.

The plans for the first development provide for a bulkhead wall, transfer shed and warehouse, and necessary equipment. The wall will be of concrete above the low water elevation and will be supported on piling. The transfer shed will be 400 ft. long by 60 ft. wide and 30 ft. high. The warehouse will be 400 ft. by 80 ft. by 60 ft.

The marine terminals for Beaumont, Tex., were designed by H. McL. Harding, Consulting Engineer, New York City.

GRADE CROSSING ELIMINATION AT BUFFALO, N. Y.

Bids Asked on $300,000 Contract.

Reinforced Concrete—Excavation—Fill—Paving —Structural Steel.

Some good-sized contracts will be let this year in connection with the elimination of grade crossings at Buffalo, N. Y. Several projects involving considerable amounts of reinforced concrete, excavation and structural steel will come up for letting. One of the larger of these provides for work at Bailey Ave. The improvement at this point will include a viaduct over the Pennsylvania R. R. and a subway under the Lehigh Valley R. R. In addition the bridge and abutments of the Delaware, Lackawanna & Western R. R. will be raised.

The improvement will begin in the center of Bailey Ave. and will extend south about 635 ft. on center of street on an ascending grade of 4 per cent. It will then run along the center of diverted Bailey Ave. southwest, over the Pennsylvania R. R. about 203 ft. on a level grade with a minimum clearance of 20 ft. from underside of bridge to base of rail. After crossing this railroad it will extend southwest about 460 ft. on a descending grade of 4 per cent, thence west and southwest about 142 ft. on a descending grade of 2.6 per cent, and southerly about 202 ft. on a descending grade of 2 per cent. It will then pass under the Lehigh Valley R. R. in a subway of minimum clearance of 14 ft. and will extend southerly about 380 ft. to Seneca St. At Seneca St. the bridge of the Delaware, Lackawanna & Western R. R. will be raised about 4½ ft. The viaduct, subway, structure between same, and approaches will be 66 ft. in width. There will be retaining walls on the north approach, on part or all of the south approach and between the Pennsylvania and Lehigh Valley Railroad.

Bids will be opened May 22 by the Grade Crossing Commissioners for work in connection with the Bailey Ave. undertaking. This will include substructural work and approaches. The abutments will contain 1,650 cu. yds. of monolithic concrete. There will be two of them, each 28 ft. high and 95 ft. long. The foundations will be in earth 5 ft. deep. The work for the viaduct approaches to the bridge will contain 44,000 cu. yds. of filling, 5,000 cu. yds. reinforced concrete retaining walls, 10,000 sq. yds. block stone paving, 2,500 cu. yds. brick pavement, 42,000 sq. yds. concrete walks, 10,000 cu. yds. earth excavation, 1,400 cu. yds. reinforced concrete, 6,000 lin. ft. concrete piling, sewers, etc. The estimated cost of the substructure, including approaches and all substructural work is $210,000. Other work in connection with the Bailey Ave. improvement not included in the advertisement by the Grade Crossing Commissioners are the two bridges. The substructures of these will require 1,300 cu. yds. concrete and the abutments will be 25 ft. high by 115 ft. long. One bridge will have a span of 160 ft.; the other 103 ft. The estimated cost of the superstructure of the two bridges is $90,00.

The Grade Crossing Commission opened bids May 15 on the subway to be built under the Pennsylvania R. R. at Lord and South Sts., two structures being involved in the improvement. The estimated cost of the substructure work for both streets, including subway and approaches, was $78,000. The substructure, abutments and retaining walls required 4,200 cu. yds. of monolithic concrete. The subway approaches to these bridges required 21,000 cu. yds. earth excavation, 700 cu. yds. reinforced concrete in retaining wall, 3.200 sq. yds. block stone pavement ,14,000 sq. ft. concrete walks, sewers, etc. The bridges will be of steel, each 57 ft. span, and 91 ft. wide for 7-track. Their estimated cost is $75,000. The bridges were not included in the letting by the Commissioners.

Edward B. Guthrie, 436 Ellicott Square, Buffalo, N. Y., is chief engineer of the Grade Crossing Commission.

A 2,400,000-YD. DRAINAGE LETTING.

Work to Be Done in Polk County, Florida.

Mostly Floating Dredge and Dry Land Dredge Work.

One of the largest drainage lettings of the past two months is now being advertised for bids. The work is to be done for the Peace Creek Drainage District of Polk County, Florida. This district includes approximately 48,000 acres in the Valley of Peace Creek, a tributary of Peace River. A branch of the Atlantic Coast Line R. R. passes along the eastern border with stations at Dundee, Waverly and Lake Wales, from which the eastern and northerly parts of the district are easily accessible. The Lake Wales extension of the Seaboard Air Line Ry. crosses the southern part of the district and has stations at Alturas and Peace Valley. The western boundary of the district at its north and south extremities is 4 miles from Bartow and Winter Haven, respectively, towns on the Atlantic Coast Line R. R. A spur of this railroad reaches the extreme northern part of this district, and has a sidetrack called Lucerne.

The land to be reclaimed is largely swamp, its wet condition being due to the seepage from the surrounding country and lakes. The watershed of the district proper includes about 110,000 acres, 15 per cent of which is lake surface. The larger part of the lakes have no surface outlet, their level being regulated by evaporation and seepage, a portion of which finally reaches Peace Creek Valley. No water is discharged into the valley by streams, but there are occasional overflows from lakes which lie on the outer edge of the district. These will be controlled by weirs and levees.

The plan of drainage involves the construction of a main canal, 22 miles long, through the central part of the district. This, with the upper extensions, will make a continuous ditch 24¾ miles long, beginning with an 8-ft. bottom and ending with a 50-ft. bottom. The fall is fairly uniform, amounting to 27 ft. in that distance. One large branch, 9.8 miles long, with slope of 1 ft. to the mile, will pass through the southern lobe of the district. Extending out from the main canal will be branches leading from some lakes whose seepage and overflow have made swampy several belts of fertile land. These branches have a fall of 3 ft. to 4 ft. per mile. Another feature of the plan is the system of lateral ditches which extend in different directions along 80 rod subdivisions, with the object of furnishing each 40-acre lot of wet land with an outlet. These are to discharge into arterial ditches through large covered sewer pipes.

About 52 per cent of the district is swamp, and the larger part of the balance is sufficiently wet to be greatly improved by the proposed plan of drainage. In the district there are 25 residents, 200 acres in cultivation and about 8,000 acres in scattering pine timber. The rainfall from May to September is large, in some months being as high as 14.5 ins., and occasionally reaches 27 ins. in two months. The maximum annual precipitation between 1887 and 1912 was 69.9 ins., and the mean annual for that period was 52.3. The rain during the fall and winter seasons never exceeds 5 or 6 ins. per month, and averages 2.5 to 3.5 ins.

The Peace Creek Drainage District is organized under the laws of the State of Florida. A uniform tax of 25 cts. per acre was levied to meet the expense of organization and surveys. The estimated cost of the work is $258,877 and the amount of assessed benefits is $2,251,321. Bonds of the district in the amount of $256,000, bearing 6 per cent interest, are offered for sale.

The land through which the ditches pass is kept constantly wet and marshy by rainfall and by seepage from the surrounding higher lands and lakes. The soil of the marsh is muck of various kinds underlaid in some localities with clay, but more frequently with sand. The subsoil base is universally sand.

The 22-mile main canal passes through open land. It will have a bottom width of 14 ft. to 50 ft. and a depth of 7 ft. to 12 ft. The estimated excavation is 1,366.221 cu. yds. The Gordon ditch will pass through land generally open, will be 9.8 miles long with bottom widths of 8 to 20 ft. and depth of 7 to 10 ft. The estimated excavation is 379,777 cu. yds. There also will be 15 branch ditches 7 to 10 ft. wide and 7 to 8 ft. deep. A considerable part of these ditches pass through swamp bog and scattering woods. The estimated excavation for these ditches is 394,098 cu. yds. The lateral ditches designed to furnish outlets to 40-acre farms, in general, will be 5 ft. wide on top, 4 ft. wide on the bottom and 4 ft. deep. Their aggregate length is 80 miles. A part of them will pass through bog swamp land. Their estimated excavation is 292,647 cu. yds. The total length of all ditches is 142 miles, and the total estimated excavation is 2,432,743 cu. yds.

There will be 12 highway bridges having an aggregate length of 432 ft. and including a 60-ft., three 50-ft., two 40-ft. and six 24-ft. bridges. All bridges will be wooden trusses, 16 ft. wide, supported by cypress pile bents or abutments. There will be seven lake overflow weirs varying from 10 ft. to 30 ft. in length, and one sluice with gates for the control of Lake Hamilton.

The work is divided into six contracts. Contract No. 1 covers 11 miles of the main canal beginning at Clarks Crossing and extending to the outlet. The ditch will be 30 ft. to 50 ft. wide on the bottom and 7 ft. to 12 ft. deep. Estimated excavation is 678,000 cu. yds. Contract No. 2 also covers 11 miles of the main canal, beginning at the upper end and extending to Contract No. 1. Bottom width will be 14 ft. to 30 ft. and depth 7 ft. to 9 ft.; yardage, 688,000. Contract No. 3 includes the excavation of Gordon Ditch from Sta. 456 and extending to the junction with the main canal ditch. Bottom widths, 14 to 20 ft.; depth, 7½ ft. to 11½ ft.; length, 8 miles; yardage, 359,000. Contract No. 4 covers the excavation of Lake Jane Branch, Simmons Ditch and Gordon Ditch, from Sta. 456 to Sta. 520, the upper terminus of the Gordon Ditch. Bottom width of all will be 8 ft.; depth, 6½ ft. to 7½ ft.; combined length, 3.3 miles; estimated excavation, 53,000 cu. yds. Contract No. 5 includes the excavation of all other branch ditches which have a bottom width of 7 ft. to 10 ft. Contract No. 6 will consist of the excavation of all lateral ditches which have a bottom width of 4 ft., with side slopes of .5 in. 7 ft. and general depth of 4 ft.

Contracts Nos. 1, 2 and 3 will be excavated by floating dredges which will begin work at the upper end of the sections and work down stream. The side slopes will be ½ ft. horizontal to 1 ft. vertical. A clear berm of 10 ft. will be left between the edge of the ditch and the toe of the waste bank. The branch ditch covered by Contracts 4 and 5 will have side slopes of ½ ft. horizontal to 1 ft. vertical and a clear berm 6 ft. wide. The work may be done by either a floating dredge or a dry-land dredge. The lateral ditches constituting Contract No. 6 may be made by machine or by hand labor. The clear berm will be 3 ft

Bids for the construction of the 142 miles of ditches will be received until 1:30 p. m., June 1, at the office of the Peace Creek Drainage District, 77 Main St., Bartow, Fla. Benj. Getzoff is Assistant Secretary of District, and C. G. Elliott, McLachlen Bldg., Washington, D. C., is Chief Engineer.

Christiania Port Extension.—The harbor authorities of Christiania, Norway, have issued particulars of an international competition for designs for the extension of the port there. Prizes ranging from $800 to $2,500 are to be awarded. The designs must include plans for coal, timber, and ore-handling facilities, quays for goods and passenger traffic, railway junction and tracks, fish port and market hall, etc. Copies of program and maps may be obtained from the Harbor Engineering Board of Christiania at a cost of $6.70, which will be refunded upon their return. The competition ends Nov. 1, 1915.

RAILWAY CONSTRUCTION IN REPUBLIC OF PANAMA.

Earlier Projects and Work Now Under Way.

Contributed by R. W. Hebard, New York City and Panama.

The Isthmus of Panama had one of the first steam railroads ever built, the Panama R. R., completed in 1855, and outside of United Fruit Co. construction on its banana plantation, it never has had another since that date.

From 1893, at which time Col. Wm. F. Shunk made a reconnaissance for the then called Pan-American through rail route from New York to Buenos Ayres, every project considered by the Government of Panama has been that of a longitudinal railway extending from the City of David, in the Province of Chiriqui, to the City of Panama, a distance of 300 miles. Colonel Shunk's reconnaissance took him over this route in 1893 and he reported the route entirely feasible and estimated the cost of a standard gage line at about $5,000,000.

With the birth of the Republic of Panama in 1903, the attention of the then administration of Dor Amador, first President of the Republic, was turned toward the construction of this line, but it was not until the administration of his successor, Don Domingo Obaldia, that actual surveys were inaugurated to determine the cost and practicability of the route. The Government entered into contract with the Panama R. R. Co. to make complete survey for a standard gage line from Panama to the City of David, with a branch to the Province of Los Santos. The Panama R. R. placed five parties of engineers in the field and after some eight months of arduous field work, a projected location was made and estimates prepared. The estimated cost of the standard gage was given in the official report of the Panama R. R. Co. at $18,000,000 without rolling stock, and a narrow gage line was also estimated to cost, over the same route, the sum of $10,000,000 U. S. currency. The report submitted was purely a technical one and probable estimated earnings or the advisability of the Government of Panama's constructing the line were not touched upon.

The National Assamblea of Panama in session, during 1911, passed a law authorizing the President of the Republic to negotiate a loan of $10,000,000 upon the best possible terms and to offer the construction of the entire project, as located by the Panama R. R. Co., at public licitation. In conformity with this law the Government advertised in the principal European and American papers in March and April of 1911 for tenders for the construction of this work and the bids were publicly opened by the Secretario de Fomento in September of the same year. Three bids only were received, as follows: R. W. Hebard & Co., $9,875,000; L. Meyers & Co., cost plus 10 per cent; W. H. Knowlton, cost plus 5 per cent.

The Government not being able to agree upon the next step to take or as to what disposition to make of the proposals received, the National Assamblea was called into extraordinary session and the entire matter was submitted to it by the President for consideration and action. At this physiological period in the consummation of the project, the Executive found an Assamblea not in harmony with himself and the Assamblea adjourned without taking any action whatever.

On Oct. 1, 1912, Dr. Belisario Porras took office as President of the Republic and as the consummation of the railway program had been one of the principal campaign issues Dr. Porras early in his administration made it plain that his Government proposed to take up railroad construction, but along different lines than those contemplated by previous administrations.

The Republic of Panama was fortunate in having at this time a Chief Executive, and Secretary of Public Works, Don Ramon Acevedo, who thoroughly knew the interior provinces of the Republic and their necessities. Instead of the longitudinal railway, closely following the sea coast for 300 miles, the Government of Dr. Porras took the position that the development of these interior regions could be best attained by building sectional railways from certain points back into the interior and using the sea as means of transportation from these ports to the City of Panama. It was maintained that the longitudinal railroad could at best only develop a narrow strip of country lying between the Pacific and the Cordillera, and that the heavy construction cost and maintenance could never be offset by the development that could possibly follow.

The President was amply authorized by the National Assamblea of 1913 to make the necessary studies, negotiate a loan and undertake the work that might be considered advisable. In conformity with this law, the Government entered into contract in March of 1913 with R. W. Hebard & Co., Inc., to make thorough and complete studies of three separate projects, giving special investigation to the development of hydro-electric power and port improvement. A complete report was to be submitted to the Government giving estimated costs of the various projects, together with definite recommendations as to the advisability of constructing the lines studied.

Two parties of engineers were therefore placed in the field in April and the field work was concluded in November. Three distinct projects were studied. A line in the Province of Coclé, using the port of Aguadulce as the base and extending to the town of Penonomé and Santiago; a line from port of Mensabé in Province of Los Santos and extending to the town of Las Minas; a line in Province of Chiriqui from port of Pedregal and extending through city of David to Boquete, the heart of the coffee growing district of the Republic and which lies at an elevation of 4,000 ft. above sea level. A branch line extending from David to La Conception also was located. The total length of the three projects studied aggregate some 175 miles. Water power development was studied in detail in the Rio Los Santos in the Province of Los Santos and in the Rio Caldera in the Province of Chiriqui. It is considered unlikely, however, that this development would pay as, of necessity, the fixed charges incidental to its development must be spread over a relatively small train movement.

In the consideration of the gage to be adopted, it was decided to recommend a 36-in. gage as best meeting the actual conditions. The Costa Rico railroads are of 42 in. gage and the United Fruit Co. lines in Bocas del Toro are of 36 in. gage. It was considered extremely unlikely that the proposed Chiriqui line will ever make a connection with either of its two neighbors.

Upon the conclusion of the field studies the data secured were presented to the Government of Panama, which, in turn, submitted the entire matter to a Board of Engineers composed of Captain R. E. Wood, U. S. A., Captain W. H. Rose, U. S. A., and A. S. Zinn, member of American Society of Civil Engineers.

The Board of Engineers after careful study of the data submitted, recommended the construction of a steam 36-in. gage railroad in the Province of Chiriqui; the remaining projects studied having, for the time being, been abandoned.

In February of 1914 the Government of Panama entered into contract with R. W. Hebard & Co., Inc., New York City and Panama, R. P., for the complete construction of the entire project, ready to operate; the contract calling for completion by May, 1916.

Work was inaugurated by the contractors in March of 1914 and the construction operations gradually increased until at the end of the year over 1,200 men were engaged on the work.

The road under construction extends from the port of Pedregal, passing through the City of David to Boquete, at an elevation of 4,000 ft. above sea-level; the length of this line being 35 miles. From the City of David a branch line of 20 miles in length is being built as a part of the project, the terminal of this line being La Concepción.

The road is being substantially constructed throughout. Over certain sections of the line 70-lb. A. S. C. E. section of rail is being used and 56-lb. on the remaining portions. The ties are of native hard wood insofar as is possible, the others being of creosoted pine brought from United States. The road is to be ballasted throughout by crushed rock and river gravel.

For the smaller drainage openings corrugated culvert pipe is used. On the larger openings steel bridges, designed to conform to Cooper's E-30 loading, furnished by the American Bridge Co., are used in all cases.

The construction of the Chiriqui Ry. offers no special difficulties. The work is, on the whole, of a light character; the bridging of some ten mountain streams subject to frequent and sudden rises being the principal problem to contend with. The bridges are practically all of one design, through riveted truss spans. There are several crossings having 150-ft. spans resting on river concrete piers, with shore spans on either side.

The country traversed by the railroad is a broad open table land, sloping from the foot of the Cordillera—at an elevation of some 4,000 ft.—to the coast; the continental divide lying from 50 to 60 miles from the sea. The entire region is of a fertile soil and abundantly watered by the many streams originating in the mountain district and all emptying into the Pacific Ocean.

The northern terminal of the road—Boquete—has long been famous as producing some of the highest grade coffee in Central America. The Cordillera reaches an average elevation in this district of some 8,000 ft. above sea and the Chiriqui volcano, now extinct, has an elevation of close to 11,000 ft.

A note-worthy feature of the Chiriqui Ry. is its long, continuous heavy grade extending from Dolega to Boquete, a distance of 15 miles; the grade on this district varying from 4 per cent to 5 per cent for the entire distance.

The locomotives in use on this section of the road are a consolidation type 2-4-0 with 56 tons on drivers, manufactured by the American Locomotive Co.

The Chiriqui Ry. is being financed by the Government of Panama through a sale to the National City Bank of New York of an issue of 5 per cent 30-year Government bonds. The total estimated cost of the project, ready to operate, is $1,750,000.

The Chiriqui Ry. is being undertaken by the Government of Panama as a development project. The port of Pedregal is only 30 hours from the City of Panama by steamer, and it is confidently expected that the construction of the railroad will foment colonization and cultivation in a large measure, similar to that which has occurred with other Central and South American railroad projects.

Progress on the $65,000,000 Railway Terminal at Chicago.

Several good-sized contracts for work in connection with the new $65,000,000 terminal to be built at Chicago for the Pennsylvania and other railroads have been let in the last two or three weeks. The contracts for the foundations for the new freight houses were let a short time ago to the Blome-Sinek Co. of Chicago. This work involves approximately 45,000 cu. yds. of concrete, 20,000 lin. ft. of piling and 50,000 cu. yds. of excavation. On May 10 a contract was awarded to the W. J. Newman Co., Chicago, for building reinforced concrete and brick trunk sewers in Canal, Monroe and Clinton Sts., a concrete retaining wall and curb wall in Canal St., and curb walls in Monroe St. Bids are now being asked for the construction of the substructure and superstructure of the West Monroe St. bridge, and for furnishing and installing its elevator equipment. This bridge will be a trunnion bascule and will be erected over the south branch of the Chicago River. The bids will be received by the Union Depot Co., 521 West Adams St., until noon, June 1. Thos. Rodd is Chief Engineer.

A 50,000 to 100,000 Cu. Yd. Tail Race Excavation Job.

A good-sized rock job is being advertised by the U. S. Engineer's Office at Detroit, Mich. The work provides for deepening the present tail race of the U. S. Powerplant at Sault Ste. Marie, Mich., between the power house and the deep water at foot of St. Marys Rapids, a distance of about 2,250. It involves the construction of dikes and the removal of from 50,000 to 100,000 cu. yds. of material, mostly rock in situ, the amount depending upon the plan adopted for doing the work.

The work is located between the new lock under construction at the rapids of St. Marys River. The United States has the use of a railroad side track extending from the railroad bridge to within 200 ft. of the site of the work. By constructing a spur the contractor can make the site accessible by rail. Only shallow deck scows can reach the embankments adjacent to the work. The current in the present tail race is swift and dredging operations will increase the velocity. The present depth of water varies from 2 ft. at the crest to 4 ft. or more near the east end.

Bidders may submit proposals for doing the work under any one or more of the following plans: Plan I-60 provides for the dredging of the main cut 60 ft. wide and 10 ft. to 12 ft. deep through the present tail race and the construction of Dike A. Plan I-70 provides for a similar cut 70 ft. wide and 10 ft. to 12 ft. deep and the construction of Dike A. Plan II-60 provides for making the major portion of the main cut 60 ft. wide in the dry, and the minor portion by dredging as in Plan I-60; it also requires the excavation of a shallow auxiliary cut 50 ft. wide, principally in the dry, and the construction of Dikes A and B. Plan II-70 is the same as II-60, except that the main cut is to be 70 ft. wide. Plan III-40 provides for the dredging of a main cut 40 ft. wide and 14 ft. to 16 ft. deep through the present tail race, and the construction of Dike A.

The material east of 4140 is believed to consist of bowlders, cemented gravel, quicksand and hardpan overlying Potsdam sandstone ledge rock. The amount of the latter to be removed depends upon the grade to be made according to the plan adopted. Some of the bowlders in the overburden probably are too large to be handled with a dredge dipper. The material west of 4140 in the main cut is mainly Potsdam sandstone ledge rock, which usually requires drilling and blasting for its removal. Portions of the area are covered with overburden consisting of bowlders, cemented gravel, quicksand and hardpan. The material west of 4140 in the auxiliary cut (Plan II) is of the same general character as that in the main cut, but with a larger proportion of overburden, including large bowlders and driftwood or timbers.

Bids for the work will be received until noon, June 15, by Lt. Col. Mason M. Patrick, U. S. Engineer, 337 Federal Bldg., Detroit, Mich.

The $50,000,000 Lake Erie-Ohio River Canal.

The State Legislature of Pennsylvania has passed the bills authorizing the submission of bond issues to popular vote in several wetsern counties for financing the projected canal from Lake Erie to the Ohio River. As previously noted in these columns the estimated cost of the project is about $50,000,000. Engineering work has been under way for some time under the direction of a special commission of which William A. Magee, Pittsburgh, Pa., is Chairman. It is proposed to finance the construction by bond issues voted by counties in Pennsylvania and Ohio that would be benefited by the building of the water way. The contribution of Allegheny County would be about $20,000,000. Governor Willis, of Ohio, vetoed the legislation enacted by the Ohio Legislature that would enable the public to vote on the proposed bond issue in that state.

Road Repair Lettings in New York.

Bids were opened May 11 by the State Highway Commission of New York on 17 contracts for the repair of highways by state aid. There was less competition at this repair letting than was secured at the previous one on April 20. The figuring, however, appeared to be close, and on some of the contracts there was only a small margin between the high and low bids. On repair contract No. 744 the Dale Engineering Co., Utica, N. Y., was low at a price $93 below that of its nearest competitor. The Headley Good Roads Co., Philadelphia, won out on contract No. 646, its bid being $82 less than the next low bidder. On contract 737 there was a difference of only $9 between the two low bids. On all of the contracts the work called for surface treatments only. The following tabulation shows the high and low bids and the number of bidders on each contract. The names of the three low bidders and their bidding prices will be found under roads and streets in this section:

Repair Contract No.	Miles.	High bid.	Low bid.	Number bidders.
744	33.38	$17,113	$15,932	6
742	11.24	18,152	17,481	3
712	11.22	5,051	4,350	9
725	11.07	10,858	8,725	10
743	22.79	11,562	10,861	4
739	15.77	9,695	7,482	10
737	22.33	3,888	3,598	5
735	19.94	4,248	3,948	7
736	21.47	6,215	5,710	7
722	28.43	13,697	13,341	4
528	24.14	10,723	10,316	6
646	18.42	4,561	4,196	4
738	20.54	6,028	5,393	5
778	14.91	7,675	7,125	5
720	4.14	5,726	4,487	4
740	4.49	5,780	4,888	6
728	25.01	19,212	15,246	11

The next letting of repair contracts will be held on June 1. At this time bids will be opened on 27 contracts. About 25 of these contracts call for surface treatment.

$500,000 for Road Construction in Allegheny City, Pa.

A road building and improvement program calling for an expenditure of more than $500,000 is to be carried out this season by Allegheny County, Pennsylvania. The Grand Jury on May 14 approved the following pieces of work, on which bids will be opened May 29:

	Miles.	Est. cost.
Bethel road extension	3.92	$ 92,182
Brownsville extension road	5.74	106,190
Hope Hollow road	0.82	20,301
New Town and Rodi road	4.50	133,712
McCoy road extension	1.25	31,330
Round Hill road	2.37	48,494
Noblestown road	0.10	2,407
Braddock and Ardmore connecting road	0.33	9,687
Sankey road	0.10	2,676

John Gillespie, Pittsburgh, Pa., is Road Commissioner of Allegheny County.

Annual Meeting of American Water Works Association.

The thirty-fifth annual convention of the American Water Works Association was held at Cincinnati on May 10-14, 1915. The following officers for the coming year were elected: President, Nicholas S. Hill, Jr., of New York City; Vice President, Leonard Metcalf of Boston; Treasurer, James M. Caird of Troy, N. Y.; Trustees, Carleton E. Davis of Philadelphia and C. H. Rust of Victoria, B. C. Since the new constitution was adopted, two years ago, the officers have been nominated and elected by letter ballots. This form of election has proved unsatisfactory to many members, who feel that the delegates who attend the convention should elect the officers by a vote on the floor of the convention. This group of members also feels that the election at the convention was one of the interesting features of the convention in past years and should be restored. A constitutional amendment was adopted, after long discussion, providing for a nominating committee whose function it will be to nominate candidates for the various offices. Under this amendment a letter ballot will be used in voting on the nominees suggested by the nominating committee. The members of the nominating committee represent five sections of the country. The following men were selected to form the first nominating committee: Robert J. Thomas of Lowell. Mass., for New England; Morris R. Sherrerd of Newark for the Middle Atlantic States; John Caulfield of St. Paul for the Central States; M. L. Worrell of Meridian, Miss., for the Southern States; and H. Hymmen of Berlin, Ont., for Canada and the Western States.

The selection of the next meeting place was, as usual, the most interesting feature of the entire proceedings to the majority of the delegates. A total of 273 votes were cast, of which New York City received 142, St. Louis 94, Detroit 33, Richmond 3 and Erie 1. Accordingly the 1916 convention will be held in New York City. An important feature of that convention will doubtless be a trip along the Catskill aqueduct.

The water supply and purification works of the city of Cincinnati were inspected by the delegates. These works are impressive to everyone. Unquestionably Cincinnati has one of the very finest water works systems in the world. The new $15,000,000 works have been in operation for seven years and show every evidence of very expert maintenance and operation. This inspection alone justified attendance at the convention. Motion pictures were taken of the delegates as they inspected this plant, and as they landed at the plant from a steamer on the Ohio River. These pictures will be shown in the 10,000 theaters feasuring Pathe's weekly. By this means the association will be given wide publicity.

The affairs of the Association, generally, seem to be in a flourishing condition. There are now 1147 active members. The Treasurer reported a substantial balance in the treasury. An Iowa section has been formed and its constitution has been approved by the parent body. A California section is being formed.

The committee work of the Association is progressing.

There was the usual program of papers presented. Many of these had been published in the March journal of the Association and drew out but scant discussion. The paper by Charles P. Hoover of Columbus, Ohio, describing the manufacture of alum at the Columbus Water Softening and Purification Works was received with well merited interest, as it records a distinct forward step in water purification. The paper is published in this issue of ENGINEERING AND CONTRACTING. Mr. Philip Burgess of Columbus, Ohio, read a very important and constructive paper on the Mechanical Analysis of Sand. It will be published in a later issue of this journal. The paper by D. A. Reed of Duluth on Assessing Cost of Extensions in a Municipally Owned Plant was a valuable contribution to the literature of municipal taxation for public improvements. It is published in this issue.

NEWS LETTERS

St. Louis Items.

Mulvill Bros. of Alton, Ill., were awarded the contract for constructing 14 miles of road work at Potosi, Mo., by the Commissioners of the Potosi special road district. They are shipping 25 of their own teams on to this work.

Daniel Slavin, who was for 45 years section boss of the Bluff Line Railroad, between Alton and Jerseyville, Ill., died at his home in Alton Saturday night, aged 69 years. Slavin had a record of never having failed to report for duty. He was born in Ireland and came to Alton 45 years ago.

N. E. Craig secured 15,000 yards of team work from the Callahan-Walker Const. Co. on the levee at Apex, Mo.

Work was begun on the grading of the southeastern section of the Ranken tract, for use of which for switching purposes the Terminal Railroad Association recently received a permit from the Board of Public Service. The use of about one-third of the tract was granted by the permit which is contingent on a final settlement of the ten-year-old controversy between the city and the Terminal, according to a tentative agreement made between the Board of Public Service and the Terminal officials. The agreement is that the Terminal turn over its levee tracks to the city at the expiration of the franchises for them next December, and also build a double track connection between the free bridge and its tracks leading to Union Station. In return the city is to grant it permission to use the entire Ranken track.

Major E. M. Markham, U. S. Eng., Memphis, Tenn., will let about 4,500,000 cubic thousand yards of levee work in the Upper and Lower St. Francis and White River Levee districts on May 26th.

Big Riley of Clapp, Norstrom & Riley, took a run down from Chicago the other day to look over a couple of team outfits that are for sale in this neighborhood.

Hummer Kahl and Brother William came in from Cleveland, bought a couple of carloads of big mules at the stock yards, which they added to their outfit in Cleveland.

Wm. List of the List & Gifford Const. Co. was at the M., K. & T. headquarters last Wednesday and signed contract for the new work that was awarded them by this company in Oklahoma at the recent letting.

T. P. Newland is with Mulvill Bros. on the Potosi, Mo., road work.

L. B. Davis of the Davis Commissary & Supply Co. left here for Cape Girardeau, Mo., to look over the boarding camps that his company have on the Little River drainage work.

A. W. Jones, formerly engineer of the Missouri-Pacific Railroad, has been appointed general manager in charge of the contract work being done for the Little River drainage district near Cape Girardeau, Mo. A new company is being formed to take over the contract and interests of the late D. C. Stephens, who died in New York several weeks ago. There is approximately 9,500,000 yards of drainage ditches to be constructed in this district.

Elmer Gant has 17,000 yards of team work to let near Jacobs, Ill. Chester or Jacobs, Ill., will catch him.

J. F. Deppe, 57 years old, senior engineer of the Mississippi River Commission, died at his home, 7501 Reilly Ave., on May 10th. Deppe, who succeeded Thomas Middleton of Webster Groves as senior engineer of the commission on the latter's death about a month ago, designed and built the harbor boat Erastus Wells. Deppe suffered a stroke of paralysis a week ago and declined steadily until his death. He is survived by his widow, Mrs. Catherine Deppe, a son, Fred W. Deppe, a daughter, Miss Minnie K. Deppe, and a brother, Henry L. Deppe.

A. B. KOENIG.

PERSONALS

Mr. Robert S. Brown has opened a civil engineering office in Asheville, N. C.

Mr. J. P. Shumaker has been appointed city engineer of Xenia, Ohio. Mr. Shumaker graduated from Purdue University in 1912 and for the past three years has been an assistant in the Engineering Corps of the Pennsylvania Railroad.

Mr. C. J. Donaldson has been appointed county surveyor of Mountrail County, North Dakota, with headquarters at Stanley, N. D. Mr. Donaldson has been in the City Engineer's office at Great Falls, Mont., for some time past. He states that he would be glad to receive catalogues pertaining to general engineering work and county work as a whole

Mr. Wilbert R. Rosche announces the opening of an office for the practice of practical and consulting civil and mechanical engineering, with offices at 329 Thatcher Bldg., Pueblo, Colo. Mr. Rosche will specialize in the design of water and sewer systems, hydraulics and irrigation, steel structures, power-plant design and equipment, valuations and reports.

Mr. Lionel Ayres has been appointed city engineer of Duluth, Minn., succeeding Mr. John Wilson. Mr. Ayres was with the Northern Pacific Railway in the maintenance department from 1883 to 1886. For thirteen years following he was in the engineering department of the city of Duluth. Since 1899 he has carried on a private general practice, specializing in municipal engineering.

Mr. Charles Capper, for the past two years assistant engineer of Dallas county, Iowa, has established the Capper Engineering Co., Adel, Iowa. The company will have charge of the city engineering of Adel, the county drainage work of Dallas county, the engineering work of the Iowa State Farm at Woodward, and is also prepared to handle all general engineering work and contracting along the lines of hollow tile construction. Mr. Capper was formerly employed on government land surveys in Wyoming.

Mr. Bertram D. Dean has opened an office as consulting engineer at 2110 L. C. Smith Building, Seattle, specializing in engineering reports, cost reduction, and quantity estimating. He is a graduate of McGill University, class of 1898, and during the following six years held various positions with different steel companies. In 1904 he accepted the position of engineer for Puget Sound Bridge and Dredging Co., Seattle, remaining with them for eight years. In 1912 he went East to take charge of the reorganization of a construction company along the line of cost reduction, a line in which he has had particular success. Mr. Dean has been a member of the American Society of Civil Engineers since 1909.

Columbia University has appointed the following nonresident lecturers for the 1915-1916 session of the graduate course in highway engineering: Charles J. Bennett, state highway commissioner of Connecticut; John A. Bensel, consulting engineer; Will P. Blair, secretary, National Paving Brick Manufacturers' Association: Sumner R. Church, manager, research department, Barrett Manufacturing Company; Frederick A. Cleveland, director, Bureau of Municipal Research, New York; William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia; Morris Llewellyn Cooke, director, Department of Public Works, Philadelphia; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey and consulting engineer; Charles Henry Davis, president, National Highways Association; A. W. Dow, chemical and consulting paving engineer; Edwin Duffey, commissioner of highways, New York state; Lewis R. Ferguson, assistant secretary, Association of American Portland Cement Manufacturers; C. N. Forrest, chief chemist, Barber Asphalt Paving Company; Wilson P. Foss, Sr., President, New York Trap Rock Company; Walter H. Fulweiler, chief chemist, United Gas Improvement Company; E. P. Goodrich, consulting engineer; D. L. Hough, president, Cuban Engineering & Contracting Company; William A. Howell, engineer of streets and highways, Newark; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York; Walter R. Marden, vice-president and chief engineer, United Construction Company; H. B. Pullar, general manager, Pioneer Asphalt Company; Philip P. Sharples, manager, general Tarvia department, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemical engineer; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, New York; John Cassan Wait, attorney at law; George C. Warren, president, Warren Brothers Company.

INDUSTRIAL NOTES

The Modern Iron Works of Quincy, Ill., manufacturer of meter boxes and other waterworks appliances, has completed and placed in operation its new foundry buildings, replacing those recently destroyed by fire.

The White Oak Crushed Stone Co., Plainville, Conn., is installing a 36-in. Symons disc crusher.

The Chicago Pneumatic Tool Co. has moved its Eastern sales offices in New York City from the Hudson Terminal Bldg. to 52 Vanderbilt Ave.

CIVIL SERVICE NEWS

Irrigation Division Engineers; A. A. Weiland, State Engineer of Colorado, announces that an examination will be held on June 5 at Denver for the purpose of establishing an eligible list from which will be selected the engineer for Division 1. Must be residents of the Division. Application must be filed with the State Engineer.

The Cleveland, Ohio, Civil Service Commission announces examinations as follows:

Inspectors of Street Openings; $0.50 per hour; May 27.

Chainman; $540 to $660 per annum, June 3.

Paving Foreman; $4.00 per day; June 8.

Applications and information may be obtained from the office of the Commission Must be filed in person not later than noon of the second day preceding date of examination.

Within the next few months examinations will be held by the Illinois State Civil Service Commission for the following positions, the examination being open only to residents of Illinois.

Position.	Salary per month.
Assistant chief utilities engineer.	$300 to $375.00
Gas engineer	250 to 333.33
Railroad engineer	250 to 333.33
Electrical engineer	200 to 300.00
Telephone engineer	200 to 300.00
Service engineer	200 to 300.00
Mechanical engineer	160 to 250.00

These will not be examinations of the usual written type, but will be unassembled. Questions covering education and practical experience will be mailed direct to each applicant, who will write out his replies and send them to the commission. They will be checked over by competent examiners and all statements verified. Those qualifying in this part of the test will be orally interviewed later.

Application blanks may be secured by addressing the State Civil Service Commission at Springfield, Illinois, or at Room 904, 130 N. Fifth Ave., Chicago.

Some details relative to these positions and their requirements appeared on page 421 in our issue of May 12.

NEW CATALOGUES

Industrial Locomotives.—Paper, 9x6 ins.; 52 pp. J. D. Fate Co., Plymouth, Ohio.

Catalogue No. 2, describing the "Plymouth" gasoline industrial locomotives, shows a number of types and views of typical operations in mines, clay plants and other industrial plants.

Oil Burners.—Paper, 6x9 ins.; 8 pp. Hauck Manufacturing Co., 140 Livingston Street, Brooklyn, N. Y.

Bulletin No. 58, describing Hauck patent kerosene burners, heaters and torches for pipe lines, asphalt roads and shop work. Illustrated.

Wagon Loaders.—Paper, 6x9 ins.; 48 pp. Link-Belt Co., Chicago.

Catalogue No. 210 describing Link-Belt portable wagon and truck loaders. Gives illustrations, specifications and net prices of the standard types and shows some of the special machines built to meet individual requirements.

Road Machinery.—Paper, folder. The Galion Iron Works & Mfg. Co., 102 East Main St., Galion, Ohio.

Briefly describes Galion road making machines and shows in tri-color engravings the construction or special features. Line includes graders, scarifiers, plows, drags, scrapers, crushers, portable unloaders, culvert pipes, etc.

Concrete Handling Equipment.—Paper, 6x9 ins.; 24 pp. The Wylie Co., Fisher Building, Chicago.

Describes "Wyliechute" equipment for handling concrete and concrete construction materials. Shows views of a number of Wyliechute plants, and of the various styles of chutes, elevator buckets, receiving hoppers, concrete carts, spouts, tower sheave sets, etc. Gives dimensional data and diagrams.

Turbo-Gear.—Paper, 11x8 ins., 6 pp. Turbo-Gear Company, Industrial Building, Baltimore, Md.

Catalogue "A," giving detailed illustrated description of the "Turbo-Gear," which can be used either as a speed reducing or speed increasing gear and will run either right or left hand with equal efficiency. Made in seven standard speed ratios.

Tractors.—Paper, 7x10 ins.; 32 pp. The Holt Manufacturing Co., Stockton, Cal.

Bulletin A-69-108, describing the Caterpillar "45," a tractor for work on soft ground, loose sand and slippery roads, particularly for use on small farms, and in orchard and vineyard cultivation. Shows the caterpillars in various kinds of work, describes parts, and gives dimensions and specifications.

Concrete on the Farm.—Paper, 6x9 ins.; 80 pp. Universal Portland Cement Co., Chicago.

"Concrete for the Farmer" is the title of a booklet containing useful information, illustrations and data on the use of concrete on the farm. Gives detailed instructions as to the building of numerous farm structures such as silos, stock tanks, barns, ice houses, fences, culverts, etc.

Valves.—Paper, 6x9 ins.; 140 pp. Golden-Anderson Valve Specialty Co., Fulton Building, Pittsburgh, Pa.

Catalogue No. 18 showing the Golden-Anderson line of automatic cushioned valves. An elaborately compiled and comprehensive presentation of the construction, operation, adaptations and merits of these appliances. Numerous drawings, photographs and tables supplement the descriptive matter.

Rail Steel Reinforcing Bars.—Paper, 6x9 ins.; 64 pp. Calumet Steel Co., Continental-Commercial Bank Building, Chicago.

The process of manufacturing reinforcing bars rolled from standard section tee rails is briefly explained, and also the qualifications of these bars for their work. Specifications and reports of tests are included. The greater part of the book consists of illustrations of modern buildings which are reinforced with Calumet Rail Steel Bars.

CATALOGUE REVIEWS

Steel Bridges.—Paper, 11½x8½ ins.; 104 pp. Dominion Bridge Co., Ltd., Montreal, Canada.

One of the most interesting trade publications from the general reader's point of view, which has recently come to our notice, is that of the Dominion Bridge Co. (Catalogue S. I.). It consists of cuts taken from actual photographs of numerous structures erected by the company. These are accompanied by brief descriptions of the work, giving data as to the length, type, conditions under which the work was done, special structural features, etc. The photographs are exceptionally good and serve well to illustrate the scope of the company's work.

A brief introductory description of the organization, growth and plants of the company precedes the illustrations and includes a list of the larger structures erected, with date, weights, length of span, etc. The illustrations show varied work, including arch, bascule, cantilever, fixed and swing bridges, subways, ferry landing, vertical lift bridges, viaducts, steel frame buildings, coal handling plants, cranes, hydraulic gates, lift locks, water tanks, etc.

Among the notable bridges shown are the St. John, N. B., cantilever bridge, the Lachine bridge, near Montreal, the Coteau bridge, the Bout de L'Isle, at Montreal, the Alexandra bridge at Ottawa and the Fraser River bridge at New Westminster, B. C.

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS
H. P. GILLETTE C. S. HILL C. T. MURRAY S. C. HADDEN C. W. MALCOLM C. R. THOMAS

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The New Austin, Texas, Dam.

Fifteen years ago at this time engineers were discussing the failure of the Colorado River dam at Austin, Texas. A new structure replacing the dam which failed has just been completed on the same site and in this issue we publish the first of three articles which will describe and illustrate this important work. In this article our readers will find the history of the project and all the dates essential to a clear understanding of its antecedents and development. There is given between the lines even a vision of the wrangle that preceded construction and of the dispute that followed failure of the first Austin Dam. Few engineering works exhibit a more checkered career and few dam failures, and there have been too many that are notorious, have remained so long and so prominently in the memory of civil engineers.

It is not with reminiscence, however, that we are chiefly concerned at the present moment. The feature that stands out is that the new Austin Dam compared with the Austin Dam that failed is an example of new engineering in dam construction. The new Austin Dam is of a construction that was unknown to engineers in 1893. If our recollection serves even the first little reinforced concrete slab and buttress dams that we now know prophesied the hollow reinforced concrete dam in its several forms and great magnitudes of recent years had not been built and perhaps had not been imagined. In less than a score of years—in much less than that time in fact—engineers have had placed in their hands a construction that is entirely new of one of the oldest kinds of engineering structures.

Herein is, it seems to one, the great feature of the new Austin Dam work as compared with that which went to disaster on April 7, 1900. Herein too should be the great pride of the engineer in his profession. There is no finality in the form of engineering structures and no end to the change in structural materials and methods that the years bring to the service of the engineer.

Combining Utility and Good Appearance in Designing Water Works Structures.

The desirability of combining utility and attractiveness in the design of engineering structures has been commented upon many times. Most of the discussion along this line has had to do, perhaps, with artistic bridge design. We desire at this time to call attention to the opportunity frequently presented to the water works engineer to design structures of good appearance.

Many handsome water works structures have been built in various parts of the country. There are numerous water towers which have been designed to combine beauty with utility. There are many more, in conspicuous locations, which are simply ugly. Many of the latter could have been greatly improved in appearance by a not undue increase in first cost. The engineer will do well to bear in mind that he sees beauty in purely mathematical and economical lines, which does not appeal at all to the average person. Thus, an irate resident of an Omaha suburb recently spoke in the following disrespectful terms of an equalizing reservoir structure: "Shall we leave this weed-covered, corrugated wart of a thing standing up at the city's highest point to be a continual eyesore?"

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

The experience of many engineers in cities of all sizes in all parts of the country is that the costly improvement is not the one which is most criticised in the long run. The citizen wants public improvements "to look right and to act right," and unless these ends are attained low first cost of the unsatisfactory improvement cannot later be brought forward successfully to counterbalance shortcomings in these particulars. High first cost produces a form of dissatisfaction, among taxpayers, which endures for but a short season if the improvement obtained is otherwise pleasing and serviceable. It is not our purpose to encourage undue extravagance in the expenditure of public funds, but we desire to record the conviction that first cost can be, and usually is, given altogether too much weight in designing certain classes of engineering structures.

Last week we published a view of a well house situated in a park in an Iowa city. This week we publish several views of small pumping stations, some good looking, others not. This type of structure readily lends itself to aesthetic treatment at slight increase in first cost. We believe additional expenditure of public funds, within reason of course, to increase the attractiveness of such structures as well houses, pumping stations and water towers, will give permanent satisfaction to all concerned.

We shall be glad to publish, in our water works section, short descriptions and views of water works structures which have been designed with a view to combining utility and attractiveness.

Land Drainage and Mosquito Prevention.

A result of extensive land drainage work has invariably been the reduction in the prevalence of mosquitoes and to a large extent the eradication of malaria. Figured on a basis of the increased productive ability of the people formerly infected with this disease the benefit of land drainage to the community from that fact alone is sufficiently great to account for a large portion of the cost of such work.

In this connection the work of Le Prince, formerly sanitary engineer of the Panama Canal Zone, who is not a physician but a sanitary engineer, is of interest. Le Prince having less regard for theories and diagnoses than actual conditions established the fact that the Anopheles, or malarial mosquito would travel beyond 200 yards from its breeding place. Proceeding in spite of criticism he sprayed purple dye upon Anopheles mosquitoes breeding in a swamp one mile from sleeping quarters and later found mosquitoes dyed purple within the quarters—a practical demonstration that established incidentally the necessity of extensive land drainage operations to insure success in mosquito eradication.

However, with lands thoroughly drained and breeding places eradicated it is still possible to have epidemics of malaria. Yet such epidemics are frequently traceable to a single source and may be dealt with in much the same manner that typhoid epidemics are handled; the all prevailing and widespread source has been eradicated. For instance, one malarial epidemic in a southern mill village was traced directly to the importation of infected mosquitoes from other districts in box cars. Lumber was frequently loaded at night, when mosquitoes are abroad, at mills located in an infected district and was transported in closed box cars to the village, immediately unloaded and used in the construction of buildings. It was found that laborers upon entering the loaded cars were bitten by mosquitoes and that these laborers later developed malaria. The epidemic subsided after the shipments ceased.

The policy of the Mosquito Commission of New Jersey in developing a comprehensive ditch system for the drainage of marsh land is a result of long experience with other methods of mosquito eradication. In general the plan followed by that commission involves the digging of a network of small V-shaped ditches that dry the land. These ditches are constructed for the sole purpose of mosquito eradication.

While it is believed by many experts that the 22 varieties of Anopheles mosquitoes of which 20 varieties are capable of transmitting malaria after biting a person infected with malaria will breed in running water, many other types of mosquitoes will not breed except in stagnant water, and the eradication of these pests is an economic work of importance. Recent studies of the mosquito and his habitat have resulted in strengthening the belief that thorough drainage is the most effective method of mosquito eradication.

On most drainage projects the elimination of mosquitoes is frequently considered of minor importance. Yet we believe the prevalence of mosquitoes has a bearing upon the sale value of reclaimed land and that the construction of supplementary drainage works with a view to complete mosquito eradication is worthy of careful consideration.

A New Printing Telegraph.

Enumerating the advantage of the telephone over the telegraph, one of Bell's earliest reports speaks of the ability to convey messages directly and without the employment of a skilled operator such as is required in telegraphing. Recently there has been developed a printing telegraph of such design and relative simplicity as to make it seem likely that many messages will be sent directly from office to office, the sender having call for no more skill than is involved in operating a typewriter.

Without going into any detailed description of the apparatus, such as appears in the "Electrical World" of April 3, we may give some general idea of the design and usefulness of the new printing telegraph system which "marks an epoch in the history of the telegraph."

There is a "perforator" having a keyboard like that of a standard typewriter. The symbol of each letter is punched in a paper ribbon, which is fed automatically into a transmitter. The particular combination of five holes punched in the tape, for each letter, determines the combination of positive and negative currents sent through the wire to the receiver or printer. The printer records the message on a sheet of paper, in the same form it would appear if written by an ordinary typewriter.

The "perforator" has been operated at as high a speed as 92 words per minute. The normal speed of operation is 45 words per minute per "channel." By the quadruplex-duplex method 180 words in each direction, or 360 words for both directions, can be sent each minute over one pair of wires or circuit. It was primarily to accomplish this result, namely, great capacity for words over a single wire, that the Western Electric Co. and the Western Union Telegraph Co. collaborated in developing this remarkable device.

A noteworthy feature of this invention is the fact that it is the product of what may be termed a composite genius—a group of skilled minds co-ordinating in producing a desired result. To quote from "Electrical World":

> The success achieved is the result of the concentration on a single problem of a number of minds, each particularly well equipped with knowledge and experience for the consideration of some important phase of the problem.

The "multiplex principle" and the "five-unit code" devised 35 years ago by Baudot form the foundation of this new printing telegraph. Mr. Donald Murray incorporated the Baudot multiplex principle with machine-sending and column-printing.

One of the unique features of the printing part of the mechanism is its "unit construction." The printer, although but a small, compact device, consists of 12 distinct units, each of which has a separate function to perform. For example, one unit is the mechanism that moves the paper carriage and the paper across the type wheel. This unit, if out of order, can be removed in a few minutes without disturbing the adjustments of the other units. This is a feature that can well be adopted for many kinds of mechanism, particularly when electricity is the operating power.

We recently heard of a new device that can be attached to any typewriter, and can be adjusted to print letters in any one of innumerable codes. The typist strikes the keys, as in ordinary work, yet produces a letter written in code. Doubtless such an attachment could be provided for the printing telegraph, which might considerably facilitate the sending of messages whose contents are to be kept secret.

Co-operation of Engineers and Contractors Desired to Increase Our General Knowledge of Soils and of the Bearing Power of Soils.

Although numerous tests have been made in various parts of the country to determine the bearing power of particular soils, and notwithstanding the fact that the results of such tests have been reported from time to time, the average engineer's knowledge of soils and of proper bearing values is exceedingly limited. Only a few of the tests made have been reported, and in general full information has not been given on those reported. Often the tests have been made by engineers just prior to deciding upon the type of foundation to be used, and in order not to delay the progress of the design the tests have been both hurried and poorly conceived. In other cases the tests have been made by contractors mainly because of specification requirements, after the structure has been designed and just prior to its construction. Mainly because of these facts full information on the character of the subsoil, subsoil conditions, and manner of conducting tests has not been made available. Although in a few cases engineers have shown that they realized the importance of assembling data from every source, and of systematically studying the character and bearing power of soils, the engineering profession as a whole has done little to increase our general knowledge of this subject.

It is gratifying to note that a movement is now gaining impetus to give to this subject the attention that its importance merits. The American Society of Civil Engineers has appointed a committee, whose object is "To Codify Present Practice on the Bearing Value of Soils for Foundations, and to Report Upon the Physical Characteristics of Soils in Their Relation to Engineering Structures." The committee has already completed a partial bibliography of published articles treating of the physical properties and bearing values of soils, and has done some preliminary work on the classification of soils. Realizing that the co-operation of all engineers, contractors, and others possessing information on this subject is essential to the success of its work, the committee has issued a circular requesting replies to a list of questions submitted. We are publishing, in this issue, this list of questions, together with other pertinent information, with the request that the readers of ENGINEERING AND CONTRACTING co-operate with the committee by sending direct to its chairman any data in their possession. Compliance with the committee's suggestions as to the form in which the data should be reported will greatly aid progress.

The Philadelphia Sewerage Report.

On May 20 the final report of the Philadelphia Bureau of Surveys on the collection and treatment of the sewage of the city was presented to the city councils. The report recommends a comprehensive plan, the chief features of which are summarized, with the estimated costs, in an article published in our Current News section this week. Briefly, the sewage will be intercepted and conveyed to three disposal sites. Two of the disposal plants will at first consist of coarse screens, grit chambers and Imhoff tanks. The treatment so secured may later be supplemented by oxidation works as the flow of sewage increases. At the third disposal plant the works will consist of coarse screens, grit chambers and fine screens. Effluents from the plants will be discharged through submerged outfalls, with multiple outlets, into the Delaware River. The estimated cost of collecting and treating the dry weather sewage flow and the first flush of rainfall is $22,400,000.

The report consists largely of matter which has previously been made available to engineers. It has been the policy of the engineers in charge of the sewage disposal studies at Philadelphia to make public the results of these studies as early as possible, for the benefit of the engineering profession. Thus numerous papers before engineering societies and articles in technical journals have anticipated the conclusions and recommendations made in the final report, and have also made public the results of various auxiliary studies. Owing to this fact readers of this journal are already familiar with the Philadelphia studies in considerable detail.

The principal articles published in this journal relating to the Philadelphia work are as follows:

Examination of River Bottom in Connection with Sewage Disposal Studies, Oct. 29, 1913. Population Studies and Sewer Gagings at Philadelphia, May 13, 1914. Collection and Treatment of Sewage in Philadelphia, Aug. 26, 1914. There have been several other shorter articles.

We commend the course taken by the Philadelphia engineers in making public the results of their studies at the earliest possible moment. This procedure is by no means as common as it should be. The majority of engineering organizations carrying on special studies usually communicate their findings promptly, by means of correspondence, to other organizations carrying on similar work. This form of co-operation is effective as far as it goes, but by using the vehicles adopted by the Philadelphia engineers more timely information can be given out to a greater number of interested people, with less effort than by direct personal correspondence.

The final report brings together all the previously published data and, of course, gives additional data. The work has been carried on with care and with freedom from bias. The prominence accorded coarse and fine screening in the recommended works is a forward step in sewage disposal practice in this country. Although a world-wide study was made of sewage disposal processes, the simplest of all methods has been selected in the light of the local condition afforded by the high oxidizing capacity of the Delaware River.

The Use of Large Stone Chips in the Maintenance of Bituminous Roads.

The Maryland Highway Commission of which Henry G. Shirley is chief engineer after an experience with the maintenance of bituminous roads extending over several years has adopted the practice of using stone chips at least one inch in size. The chips are spread over the surface of the road, at seasons of the year when the bitumen is soft, in an even layer one stone thick and rolled. The rolling forces the stones into the surface of the road until they are flush with the pavement. When completed the surface has somewhat the appearance of a mosaic. Hard blue limestone is used and has been found to be quite satisfactory for this purpose.

The reason for the method of maintenance adopted by Mr. Shirley is obvious. It has been universally found in practice that small stone chips are either quickly ground to a powder by iron-shod traffic or are in a large measure swept from the road surface by automobile traffic. The use of sand is now quite generally avoided by maintenance engineers on the ground that it tends to build a mat or pad that becomes unmanageable when thick and also greatly increases the danger of waves in the pavement due to the pushing of the bituminous surface occasioned by the continual passage of automobiles, usually traveling in a single direction on one side of the road.

While this method of surface maintenance, or more properly termed surface improvement, is not new from an experimental standpoint —similar work having been done by Mr. Crosby, the former engineer for the commission— its application to road maintenance work on a large scale such as is in progress in Maryland is an innovation. From the standpoint of the road user it possesses advantages. The exposed stones roughen the surface and reduce the slipperiness of the pavement. Slipperiness has always been a fault of bituminous treated country roads especially since many of the horses that travel them are not sharp shod. The danger of automobiles skidding is also reduced. From the standpoint of increasing the life of the road the reduction in slipperiness permits the use of a relatively higher crown thereby insuring thorough drainage of the surface and increasing the durability of the road, the practice of most road engineers being to use as much crown as limiting conditions will permit. In this connection it may be said that experience has demonstrated in the city of Washington that asphalt streets and roads built with a high crown have usually a longer life than those streets or roads on which less crown is used.

While the labor cost of applying large stone chips in this manner is necessarily increased somewhat the road surface is improved by the thorough ironing out it is given by the roller. The greater availability of the supply of larger stone is also a factor worthy of consideration in many sections of the country. It is frequently difficult to secure an adequate supply of ½-in. and ¾-in. stone.

It is believed that the incorporation of large stone chips into the surface of the road is worthy of the consideration of engineers engaged in both maintenance and construction work. While difficulties are encountered and careful workmanship is required the results obtained are of sufficient value to warrant the additional cost.

WATER WORKS

Data on the Cost of Installing Small Water Works Systems in Massachusetts.

Contributed by Harry R. Crohurst, Silver Creek, New York.

It is the writer's hope, in presenting this article, that it will be of value to newly appointed water supply committees and to others interested in the cost of constructing small systems for supplying water. To those who have not yet reached that point where the services of an expert engineer can be retained, and to those who lack available funds with which to make an extended inspection of existing systems, it is hoped this article will be of special value.

In Massachusetts during the year 1904 180 of the 353 cities and towns were supplied with water from public supplies. Of the cities and towns supplied 106 derived their supply from surface sources, 67 from ground-water sources, and 7 from combinations of the two sources. In 1912 the total number of cities and towns supplied with water was 207, of which 110 were supplied from surface sources, 87 from ground-water sources, and 10 from combinations of ground-water and surface-water supplies.

The tendency during these eight years in the State of Massachusetts was, therefore, toward the development of ground waters as sources of supply, and, as it seems probable that future development will be in this direction, the following discussion will deal principally with systems which have either driven wells or large collecting wells as the source of supply.

In the following pages will be found the description of several small water works systems installed within the last few years in Massachusetts, a statement of the cost of construction and, where such data are available, the cost of operating the works after construction. The data submitted were collected from a personal inspection of the systems, from the reports of engineers superintending the construction, and from the reports of water supply committees. The data are as reliable as can be expected from superintendents' reports, and the reports of water committees which do not always group the expenditures under the proper heading.

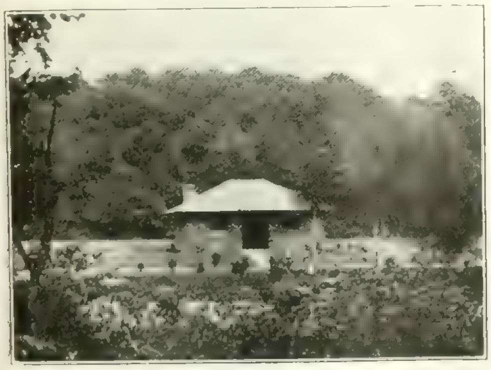


Fig. 1. View of Ashland, Mass., Water Works Pumping Station.

From these data, average cost data for the various parts of the works have been obtained which will serve, it is hoped, as an approximate figure in the estimation of similar proposed systems. As the conditions are never exactly similar in the construction of any two systems, as the market price of materials is always fluctuating, and as the cost of labor has increased during the past few years, too much reliance can not be placed on average figures. The final estimate of the cost of constructing any system should always be left with an engineer experienced in the construction of such works. Nevertheless, it is believed that the figures derived will serve in a general way in making the preliminary estimate of the cost.

ASHLAND WATER WORKS.

The town of Ashland is located in the valley of the Sudbury River, the main portion lying on a flat plain bordering the river, the northerly and southerly portions lying on the higher sides of the valley. The estimated population of the town in 1913 was 1,700.

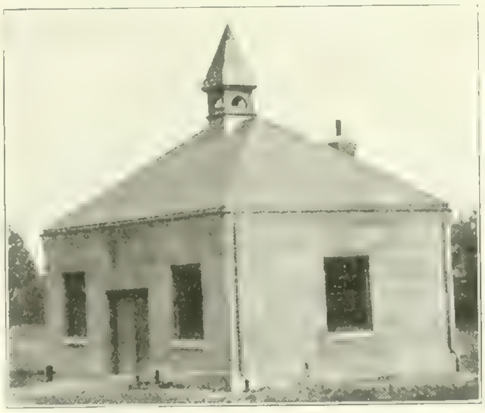


Fig. 2. View of Littleton, Mass., Water Works Pumping Station.

The system was constructed in 1911 under the supervision of William S. Johnson, civil engineer, of Boston. The source of supply is located on the northerly bank of the Sudbury River about a quarter of a mile from the center of the village. The water is taken from a coarse water-bearing stratum bordering the river.

The system consists of twelve 2½-in. driven wells varying in depth from 25 to 32 ft. with an average depth of 30 ft., a small field stone pumping station 25x33 ft. in plan with a red asbestos shingled roof, shown in Fig. 1, and a pumping plant consisting of two 17-HP. oil engines and two 7x8-in. Smith-Vaile triplex pumps.

The distribution system consists of a covered, reinforced concrete standpipe 40 ft. in diameter and 32 ft. high with a capacity of 300,000 gals., and 6½ miles of cast-iron mains varying from 12 to 6 ins. in diameter. On the system there are 66 gates and 52 hydrants, and the number of services connected at the end of the year 1913 was 250, all of which were metered.

In laying out the system no unusual conditions were encountered, and no large amount of rock was found with the exception of the main leading to the standpipe.

The cost of constructing the system to the end of the year 1913, not including service connections, as given in the 1913 report of the Board of Water Commissioners was as follows:

Bond issue		$ 55.22
Land		1,710.38
Legal expenses		122.65
Office expenses		74.76
Wells		1,266.89
Pumping station		2,122.95
Pumps and engines		1,358.20
Standpipe		5,812.00
Mains:		
Pipe	$15,116.38	
Gates, hydrants, specials	2,579.32	
Laying pipe	9,369.86	
Freight, express and miscellaneous	1,160.62	28,226.18
Engineering		2,285.20
		$46,034.34

During the year 1913 the average daily consumption of water was 20,000 gals., or about 12 gals. per capita, one of the lowest consumption figures in the state.

From the report of the Committee the cost of operating the works during 1913 was as follows:

Pumping plant	$ 77.95
Service repairs	27.74
Pipe repairs	262.17
Fuel	198.73
Wages	865.09
Office expense	62.91
Interest on bonds	2,000.00
Miscellaneous	27.37
	$3,521.87

From the above consumption and cost of operation the cost of supplying 1,000 gals. of water was 48 cts.

EAST BROOKFIELD WATER SUPPLY.

East Brookfield is a village in the town of Brookfield and is located on the Quaboag River about midway between Worcester and Springfield. The population of the entire town in 1910 was 2,204.

The source of supply is from the shore of Lake Lashaway, or Furnace Pond, just north of the village. The wells are located on the westerly shore and the water which is taken from a stratum of coarse water-bearing gravel is pumped through 1,325 ft. of 6-in. main to the standpipe from which it is distributed by gravity.

The system was installed in the fall of 1908 under the supervision of William S. Johnson, civil engineer, of Boston. The works consist of twelve 2½-in. tubular wells varying in depth from 19 to 24 ft., a small brick pumping station 24x30 ft. in plan with a slate roof, and a pumping plant consisting of two 8-HP. oil engines and two 5½x8-in. triplex pumps each having a capacity of 100 gals. per minute.

The distribution system consists of a covered wrought-iron standpipe 25 ft. in diameter and 50 ft. high with a capacity of 185,000 gals., and about 2.6 miles of cast-iron mains 12 to 6 ins. in diameter. On the system at the time of examination there were 80 services and 32 hydrants.

Fig. 3. View of Covered Steel Standpipe of Littleton, Mass., Water Works. Height, 40 ft.; Diameter, 30 ft.

The cost of constructing this system, not including service connections, was as follows:

Wells		$ 567.72
Pumping station		1,627.70
Pumping plant		3,050.00
Standpipe		3,150.00
Mains:		
Pipe	$8,480.40	
Hydrant, gates, specials	1,357.60	
Laying pipe	2,009.90	11,847.90
Engineering and inspection		1,384.07
Bills payable		1,300.00
		$23,927.39

Figures for the quantity of water pumped or for the cost of operating the works are not available.

LITTLETON WATER WORKS.

The town of Littleton is located on the flat plain bordering Beaver Brook. The central part of the town is comparatively flat while the westerly portion rises abruptly. The source of supply is from the ground near Beaver Brook a few hundred feet south of the town. The population of the town is 1,229.

The works were constructed in 1911 under the supervision of Lewis D. Thorpe, civil engineer, of Boston.

The system consists of nine 2½-in. driven wells varying in depth from 17 to 27 ft., a brick pumping station with a slate roof 35x25-ft. in plan, shown in Fig. 2, and a pumping plant consisting of a 25-HP. oil engine, a 25-HP. motor and a 7½x10-in. triplex pump.

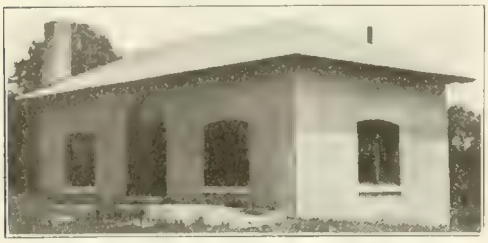


Fig. 4. View of Water Works Pumping Station at Medway, Mass.

The distribution system consists of a covered steel standpipe 40 ft. high and 30 ft. in diameter having a capacity of 275,000 gals., shown in Fig. 3, and 5.7 miles of 12 to 6-in. cast-iron mains. On the system are 17 gates, 37 hydrants, and 130 metered services.

The cost of installing the system, not including the cost of service connections, is given in the 1912 report of the Board of Water Commissioners as follows:

Wells		$ 431.31
Pumping station		2,929.00
Pumping plant		3,735.00
Standpipe		3,938.00
Land and right of way		1,575.83
Mains:		
Pipe	$19,036.88	
Gates and hydrants	1,175.00	
Express and freight	93.42	
Laying pipe	8,728.04	
Setting hydrants	74.00	
Rock excavation	1,225.00	
Miscellaneous	954.47	31,286.81
Engineering		2,000.00
		$45,895.95

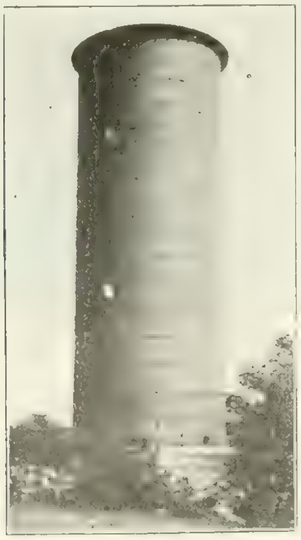


Fig. 5. View of Standpipe (30x80 ft.) of Medway, Mass., Water Works.

Records of the pumping have been kept since June 1, 1912. During the period from June 1, 1912, to March 1, 1913, a total of 9,144,000 gals. were pumped which is equivalent to an average daily consumption of 34,000 gals.

The cost of operating the Littleton works for the year ending March 1, 1913, was as follows:

Salaries	$ 580.00
Supplies	116.66
Fuel oil	219.77
Expenses	8.15
Freight	39.15
Repairs	25.38
Miscellaneous	42.85
Rent	36.00
	$1,067.96

MEDWAY WATER WORKS.

The town of Medway is located on the rising ground just north of the Charles River. The population in 1910 was 2,696. The principal part of the population is contained in two villages, Medway and West Medway, which are about a mile and a half apart. These two villages, containing about 12 miles of streets, are the only portions of the town which require a water supply.

The source of supply is from the ground in sand and gravel stratas lying near the Charles River south of the town.

The works were constructed under the supervision of E. Worthington, civil engineer, of Dedham in 1911 and 1912.

The system consists of 30 2½-in. wells varying in depth from 32 to 75 ft., each provided with a 3-ft. strainer point, a pumping station 40x20 ft. in plan of terra cotta blocks with cement plastering inside and out and having a wooden truss roof covered with slate, shown in Fig. 4, and a pumping plant consisting of two 32-HP. oil engines and two triplex single acting pumps. This plant was tested Sept. 11, 1911, by running both engines together for 11 hours successively. The economy test showed nearly 8,000 gals. pumped to 1 gal. of oil. The cost of oil taken at 6 cts. per gallon at the station shows a full cost of ¾ ct. per 1,000 gals. pumped into the standpipe.

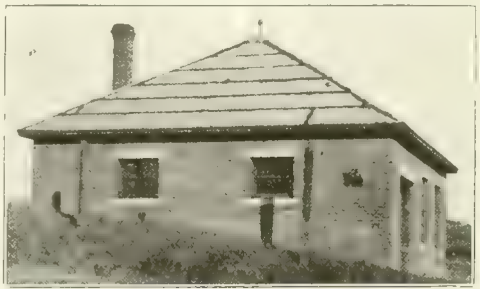


Fig. 6. View of Oxford, Mass., Water Works Pumping Station.

The distribution system consists of a steel standpipe 30 ft. in diameter and 80 ft. high with a capacity of 437,000 gals., see Fig. 5, and 12.35 miles of cast-iron mains 12 to 4 ins. in diameter. On the system there are 87 gates, 111 hydrants and 338 service connections which are only a part of the final number.

The cost of these works up to Feb. 1, 1913, not including service connections, was as follows:

Preliminary examination		$ 2,750.00
Legal bond issue		944.95
Land		1,303.65
Wells and connections		4,650.00
Pumping station		3,632.00
Pumps and engines		7,550.00
Standpipe		8,800.00
Standpipe foundations		2,325.00
Mains:		
Pipe and laying	$52,142.85	
Gates	1,454.00	
Hydrants	3,885.00	
Freight	92.12	
Rock excavation	5,000.00	
River crossing	1,000.00	
Repairs to roads	1,500.00	65,073.97
Engineering		3,002.40
		$100,031.97

The above figures were taken from the engineer's final estimate of the cost of all of the works.

At the present time record of the quantity of water supplied can not be obtained. The cost of operating the works during 1912 was as follows:

Administration	$ 631.98
General expense	71.17
Interest on bonds	4,325.40
Pumping station—	
Fuel oil	379.43
Cylinder oil	37.81
Labor	818.90
Coal	56.55
Supplies	94.49
	$6,415.73

PEPPERELL WATER WORKS.

The water works system of Pepperell were constructed during the summer of 1910 under the supervision of William S. Johnson, civil engineer, of Boston. The population of the town in 1910 was 2,953.

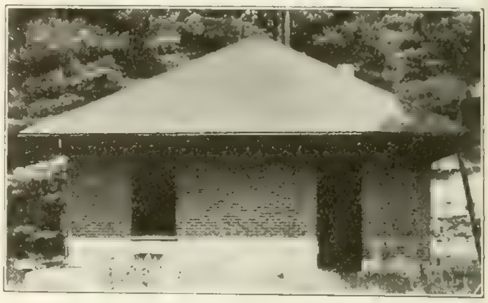


Fig. 8. View of Wrentham, Mass., Water Works Pumping Station.

The source of supply is from wells located near Gulf Brook just south of the Massachusetts and New Hampshire State line about three miles north of the town.

The works consist of 34 2½-in. wells having an average depth of 25 ft., a brick pumping station 30x20 ft. in plan with a slate roof, and a pumping plant consisting of two 25-HP. oil engines and two 8x10-in. triplex pumps each having a capacity of 250 gals. per minute.

The distribution system consists of a covered steel standpipe 45 ft. in diameter and 40 ft. high having a capacity of about 475,000 gals., and 16.42 miles of 12 to 6-in. cast-iron mains. On the system are 130 hydrants.

The cost of these works, not including service work, taken from the special 1910 report of the water commissioners, was as follows:

Bond issue		$ 154.35
Wells		2,544.37
Pumping station		2,852.38
Land for station and wells		750.00
Standpipe		6,728.98
Land for standpipe		600.00
Engines and pumps		6,062.52
Mains—		
Pipe and fittings	$49,069.34	
Laying	24,877.13	
Hydrants	3,033.80	
Valves, gates, specials	2,288.69	
Freight	1,099.65	
Inspection of pipe	270.86	
Miscellaneous	1,188.44	81,757.91
Engineering		4,000.00
		$105,450.51

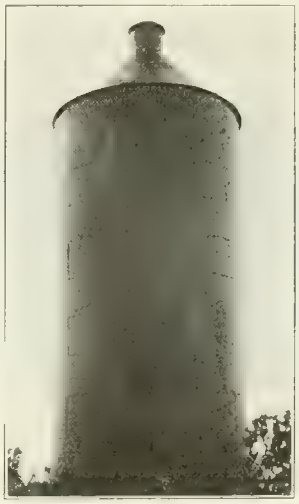


Fig. 7. View of Oxford, Mass., Water Works Standpipe (27x50 ft.)

The total consumption of water for the year 1912 was 40,282,000 gals., which is equivalent to an average daily consumption of 110,000 gals. or 37 gals. per capita.

The cost of operating the system for 1912 is given as follows:

Maintenance	$2,728.36
Services	657.84
Piping system	341.15
Meters	65.73
Interest	5,080.00
	$8,873.08

OXFORD WATER WORKS.

The town of Oxford is located south of Worcester on the flat valley bordering the French River. The population, which was 3,361 in 1910, is located in two villages, Oxford and North Oxford. The source of supply is from driven wells near a small brook flowing into the French River near North Oxford.

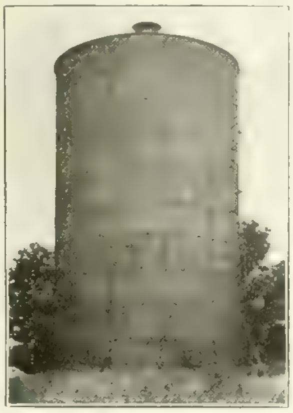


Fig. 9. View of Wrentham Water Works Standpipe (30x50 ft.)

The water works system was constructed in 1906 under the direction of Parker and Bateman, Civil Engineers, of Clinton.

The system consists of 8 2½-in. wells varying in depth from 23 to 28 ft., a brick pumping station 25x25 ft. in plan, shown in Fig. 6, and a pumping plant consisting of two oil engines and two triplex pumps.

The distribution system consists of a steel standpipe 27 ft. in diameter and 50 ft. high having a capacity of 220,000 gals., shown in Fig. 7, and 9.7 miles of cast-iron mains 10 to 2 ins. in diameter. On the system are 60 hydrants and 405 service connections.

These works are privately owned and the following cost figures are taken from the 1906 report of the company:

Preliminary engineering		$250.00
Wells		581.25
Station		1,720.00
Pumping machinery		3,200.00
Standpipe		4,564.95
Foundations		500.00
Mains—		
Pipe	$28,424.60	
Hydrants, valves, specials	5,098.07	
Laying	8,077.87	
Rock excavation	927.95	42,528.49
Land		1,425.00
Engineering		1,769.59
Miscellaneous		1,000.00
		$57,539.28

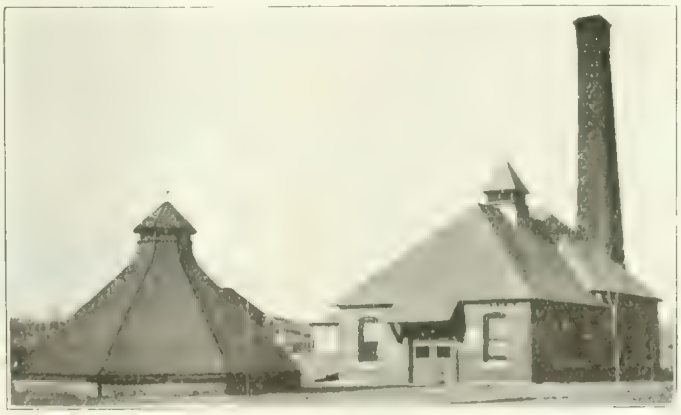


Fig. 10. View of Well and Pumping Station at Webster, Mass.

The cost of operating the Oxford plant for the year 1912 was as follows:

Labor	$884.34
Oil and gasoline	710.32
Interest on notes	913.53
Coupons on bonds	1,250.00
Dividends	1,717.50
Salaries	200.00
Repairs	164.27
Miscellaneous	268.07
	$6,108.03

The records of the quantity of water pumped are not available.

WRENTHAM WATER WORKS.

The Wrentham water works were constructed in 1907 under the direction of Edmund M. Blake of Boston. The population of the town in 1910 was 1,743, located principally in one main village.

The source of supply is from driven wells near the "Trout Ponds," so-called, about a mile south of the village.

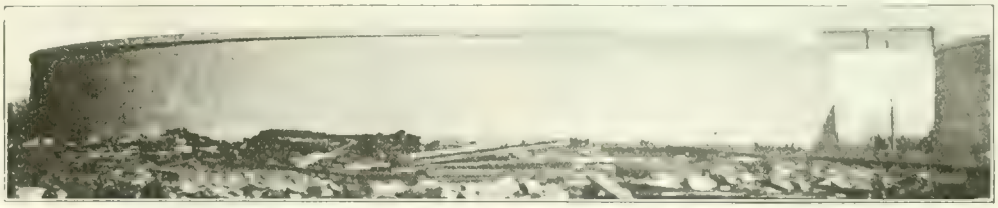


Fig. 11. View of One of Twin Concrete Reservoirs at Brockton, Mass. (160x26½ ft.).

The system consists of 9 2½-in. tubular wells having an average depth of 29 ft. The pumping station is a brick structure with a slate roof, 25x36 ft. in plan, shown in Fig. 8, containing two 25-HP. oil engines and two 8x10-in. triplex pumps each having a capacity of 250 gals. per minute.

The distribution system consists of a steel standpipe 30 ft. in diameter and 50 ft. high having a capacity of 265,000 gals., shown in Fig. 9, and 5.6 miles of cast-iron mains 10 to 2 ins. in diameter.

The cost of the system, not including service connections was as follows:

Wells		$1,048.22
Pumping station above foundation		1,646.97
Engines and pumps		5,933.55
Standpipe above foundation		5,204.63
Foundations (station and standpipe)		1,556.50
Mains—		
Pipe	$21,002.62	
Hydrants	969.68	
Specials	1,215.57	
Laying	9,410.39	
Bridge crossing	195.18	32,793.44
Engineering		2,500.00
		$50,683.31

The above figures are compiled from the 1907 report of the water commissioners.

GENERAL COSTS.

In Table I is given a summary of the total cost, the miles of mains, and the cost per mile of the systems which have been described. In a general way this will give some idea of the cost of installing an entire system.

COLLECTING SYSTEMS.

Driven Wells.—Driven wells used in collecting ground water consist of a wrought-iron tube from 1 to 4 ins. in diameter, usually 2½ ins., closed and pointed at one end and perforated for some distance therefrom. The tube thus prepared is driven into the ground until it penetrates the water-bearing stratum. The upper end is then connected to a main suction line running to the pumps. Small wells are usually arranged in one or two rows alongside the suction pipe and are connected to it by short branches. Each well should have a gate valve on the branch so that it can be shut off at any time from the system. In spite of most careful construction air will usually accumulate to some extent in the system, and to eliminate this air many plants are provided with an air separator placed on the suction main near the pump. The separator consists of a large drum through which the water passes at a slow velocity, the air accumulating at the top from which it is expelled by a vacuum pump. Where sand is drawn up with the water a sand chamber should be provided to prevent wear in the pumps.

TABLE I.—COST DATA ON SMALL WATER WORKS IN MASS.

Place.	Total cost.	Miles of mains.	Cost per mile of main.
Ashland	$46,034	6.5	$7,082
East Brookfield	23,927	2.6	9,200
Littleton	45,896	5.7	8,052
Medway	100,032	12.4	8,067
Pepperell	105,451	16.4	6,430
Oxford	57,539	9.7	5,930
Wrentham	50,683	5.6	9,050

In the installation of wells at Ashland the bid for driving and connecting was as follows:

	Per ft.
Driving	$1.67
Connecting	28.40
Laying suction	.37

Pipe to be furnished by the town.

At Pepperell the bids were as follows:

Driving, per ft.	1.55
Connecting, per well	32.00

For small systems the cost of wells and connections under favorable conditions will average about $3.25 per foot. This includes driving the wells, connecting, and piping to the station. Assuming a system to consist of a group of 10 wells with an average depth of 30 ft., the cost of installation would be approximately $1,000.

Large Dug Wells.—Large wells for the collection of ground water are constructed with diameters varying from 10 ft. to 100 ft., the most commonly selected being 30 to 50 ft. The depth is dependent on several factors,—the distance to the water-bearing strata with an allowance for the lowering of the water level during dry periods, an allowance for storage to permit of such lowering of the

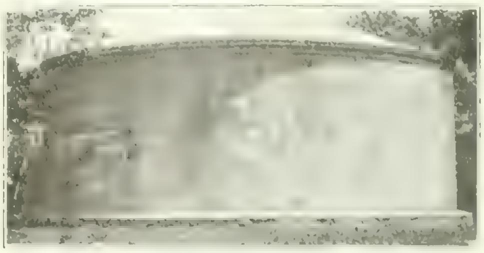


Fig. 12. View of Concrete Water Works Reservoir at Weston, Mass.

water level as is estimated will be the most economical with the form of pumps employed or such as will be necessary to secure the desired amount of water. The yield of large wells varies between 100,000 to 3,000,000 or 4,000,000 gals. per day. Under ordinary conditions the yield of large circular wells will be somewhat less than 1,000,000 gals. per day.

The large well possesses several advantages over the driven well. On account of its storage capacity the pumps can be run at a variable rate and this serves to increase greatly the real yield of the large well over that of the smaller driven well. In pumping from a single large well there is the advantage of having short lines of suction pipe. Trouble is often experienced in small wells due to clogging and to the entrance of fine sand. In the large well this is eliminated as the water enters the well at a low velocity and such fine material as does enter is eliminated by sedimentation.

Fig. 13. View of Waltham, Mass., Water Works Reservoir (100x43 ft.).

The chief disadvantage of the large well is the large initial cost as compared to the driven well. The cost increases very rapidly with the depth and also very quickly where large quantities of water are encountered. Except where used as a pump pit it will seldom be economical to construct a large well deeper than 30 or 40 ft.

Large wells, therefore, will be suitable for places where the water-bearing strata can be reached at moderate depths, where the excavation is not difficult and where the pumping plant is to be operated only a few hours of the day at a relatively high rate. The tubular well is best adapted for localities where the supply is to be derived from a large area and from strata irregular in character, and for penetrating deep strata.

Large wells usually have a rubble masonry foundation laid dry, through which the water rises into the well, and side walls either of brick laid in cement or of reinforced concrete. All such wells are covered to prevent pollution and to exclude light.

TABLE II. COST OF DUG WELLS IN MASSACHUSETTS.

City or town.	Date of construction.	Depth, ft.	Diameter, ft.	Cost.
Attleborough	1904	25	40	$14,400*
Avon	1890	20	20	2,650
Canton	1899	25	40	5,054†
Mansfield	1888	20	25	6,270
Marblehead	1890	30	30	7,200
Monson	1895	24	70	6,763
Needham	1890	24	22	4,615
North Attleborough	1884	26	30	3,872
Ware	1887	25	25	4,725
Webster	1894	30	25	13,344
Winchendon	1895	26	29	6,035

*Part of this cost was for new conduit connecting new well with the old one.

†The contractor claims the cost of this well was $8,000

Large wells have recently been constructed in the towns of Franklin, Winchendon, and Leicester.

The town of Franklin constructed a well 20 ft. in diameter and 28 ft. deep in 1911. The cost of the well was $3,621.79, and the cost of suction pipe and fittings $1,548.44, making a total cost of $5,170.23.

The well at Winchendon constructed in 1911 is 38 ft. in diameter and 25 ft. deep. The cost was $8,836.52, of which $1,021.40 was for the 14-in. suction and fittings.

The source of supply of the Cherry Valley Water District in the town of Leicester is from two dug wells 30 ft. in diameter and 15 ft. deep. The wells are of rubble masonry, the upper few feet being laid in cement and the remainder laid dry. The bids submitted for two wells, 30 ft. in diameter and 10 ft. deep, were as follows:

Bids.	Additional per ft. of depth below 10 ft.
$4,379	$190
6,445	300
6,500	400
6,958	400

The total cost of the two wells was $5,698.

In Table II is given the cost of some of the older dug wells in Massachusetts.

A view of the Webster well and pumping station is shown in Fig. 10.

PUMPING STATIONS.

The cost of constructing the pumping stations in the various towns described has been as follows:

Ashland	$2,120	25x33 ft.
East Brookfield	1,628	24x30 ft.
Littleton	2,929	25x35 ft.
Medway	3,632	20x40 ft.
Pepperell	2,852	20x30 ft.
Oxford	1,720	25x25 ft.
Wrentham	2,200	25x26 ft.

The average cost of single story brick or field stone stations with a slate roof supported on a wooden frame will be about $3.25 per square foot of floor surface. For a station 25x30 ft. in plan, giving floor space large enough for two units consisting of an engine and pump, the cost will be about $2,500.

Fig. 14. View of Lexington, Mass., Concrete Water Works Standpipe (30x105 ft.).

PUMPING MACHINERY.

Recent installations of pumping machinery in small works have shown a tendency toward oil engines and vertical triplex pumps direct connected so that either engine can operate either pump. A very common combination is a 25-HP. Mietz-Weiss or Hornsby-Ackroyd oil engine and an 8x10-in. Smith-Vaile triplex pump, which will discharge about 250 gals. per minute against a maximum pressure of 130 lbs. at 40 revolutions per minute. The cost of a plant consisting of two such engines and pumps will be about $6,000 erected and connected. The cost of two 8x10-in. triplex pumps and two 25-HP. motors at North Chelmsford was approximately $3,500. At Uxbridge the cost of two 8¼x10-in. triplex pumps and two 35-HP. motors was also about $3,500.

DISTRIBUTION SYSTEM.

The cost of the distribution system, which is the biggest item in the cost of the works, will vary with the current prices of cast-iron pipe. The price of pipe may be anywhere from $35 to $18 per ton, a fair average being $25 per ton of 2,000 lbs. The price of pipe in the Pepperell system was $23.40 per ton for straight pipe and $50 for special castings. At Ashland the price was $22.40 for straight pipe and $50 for specials. Special castings, which include bends, tees and crosses, will constitute about 3 per cent of the weight of the straight pipe in the system.

The cost of laying pipe is usually figured on a foot basis for all ordinary work with an addition for all rock encountered in the trenches.

The contract prices for laying pipe in the towns above were as follows:

	12-in.	10-in.	8-in.	6-in.	Rock.
Ashland	0.40	....	0.28	0.22	2.50
Littleton	0.40	0.31	0.25	0.23	3.50
Pepperell	0.37	0.32	0.24	0.22	2.50
Wrentham	...	0.29	0.27	0.25	3.75
Average	0.39	0.31	0.26	0.23	3.00

Assuming Class C pipe, New England Water Works Specifications, to cost $25 per ton and using the above average as the cost of laying, the following tabulation gives the cost of laying pipe per foot and per mile:

Size, ins.	Cost per ft.	Cost per mile.
12	$1.35	$7,075
10	1.06	5,595
8	0.90	4,805
6	0.60	3,168

To the above cost should be added the cost of special castings which will be about 2½ to 3 per cent of the weight of the straight pipe in rural work. At 3 per cent the additional cost for specials will be $330 per mile of 12-in. pipe, $264 per mile of 10-in. pipe, $198 per mile of 8-in. pipe, and $132 per mile of 6-in. pipe; specials taken at $55 per ton.

The rock excavation in the trenches will have to be paid for separately and can not be estimated but it will usually average from 3 to 10 per cent.

Gate valves used in the system will cost, including the setting, as follows:

Size.	Cost.
12-in.	$40.00
10-in.	30.00
8-in.	25.00
6-in.	15.00
4-in.	10.00
Gate boxes	3.50
Hydrants set	30.00

In the statement of the costs given in the first part of this article, the cost of service connections was omitted. In new systems where service connections are made the water department usually lays the service pipe from the main to the foundation wall of the building, but the cost from the property line to the foundation is paid for by the taker. There is, therefore, an uncertainty as to how much of the total cost the town has had returned to it, and for this reason it has seemed best to omit it from the cost of the works.

Fig. 15. View of Elevated Steel Tank at Brockton, Mass.

Service pipes are usually ¾ to 1 in. in

diameter and are either of wrought-iron, cement-lined wrought-iron, or lead. In making the connection the main is tapped and a brass "corporation cock" screwed in. The cock is then usually connected to the service pipe by means of a lead goose-neck to allow for settlement in the main. At the curb is usually placed a curb cock and valve box at which point the supply to the consumer is controlled.

The cost of the service connection from the main to the property line will ordinarily be from $10 to $15.

STANDPIPES.

The standpipe in the system serves to store the water pumped during the day to be used for night consumption and, also, as an auxiliary supply to be drawn upon in case of fire. During the last few years the tendency has been to construct standpipes of reinforced concrete instead of steel. The first cost is nearly the same, and the cost of maintenance of the concrete structure is not nearly as great as in the steel tank. In Table III is given the cost of standpipes constructed both of steel and concrete.

TABLE III.—COST OF STEEL AND CONCRETE STANDPIPE IN MASSACHUSETTS.

Place.	Capacity.	Cost.
Steel Standpipes.		
East Brookfield	185,000	$ 3,150
Littleton	275,000	3,938
Medway	437,000	11,125
Pepperell	475,000	6,729
Oxford	214,000	5,065
Wrentham	465,000	6,000
Concrete Standpipes.		
Brockton	4,000,000	41,000
Leicester	200,000	5,000
Lexington	550,000	20,000
Waltham	2,000,000	29,700
Weston	441,000	9,000

An example of a large installation is shown in the Twin Reservoirs at Brockton, constructed in 1910, one of which is shown in Fig. 11. Each tank is 160 ft. in diameter and 26½ ft. high and has a capacity of 4,000,000 gals. The cost of both tanks was $82,000.

The Weston concrete standpipe is shown in Fig. 11.

The Waltham tank, see Fig. 13, has a capacity of 2,000,000 gals., and is 100 ft. in diameter and 43 ft. high.

The Lexington standpipe, see Fig. 14, is 105 ft. high and 30 ft. in diameter,—an example of a high standpipe.

The cost of the standpipe will vary with the height and, of course, with the capacity. A suitable covered standpipe of about 300,000 gals. capacity can be constructed either of steel or concrete for about $6,000 or one of 500,000 gals. capacity for about $10,500.

In some places where the consumption is small and a large storage capacity is not required elevated tanks are constructed instead of steel or concrete standpipes. In 1908 the city of Brockton constructed two high-service systems to supply high points in the city. In these systems two elevated tanks 100 ft. high and holding 50,000 gals. were constructed. These tanks cost approximately $3,100 each. One of the tanks is shown in Fig. 15.

The South Walpole water tower of the Walpole Water Works consists of a tank 20 ft. in diameter and 35 ft. high with a capacity of about 80,000 gals., supported on a steel frame 45 ft. high consisting of eight uprights with lateral supports. This tower was constructed in 1896 and cost $4,370.

GENERAL.

The items which can not be readily estimated are the cost of land, rights of way and water rights, cost of preliminary engineering, legal services, and engineering supervision. In making estimates 10 per cent is usually added to the estimated cost to cover engineering supervision and contingent costs. In 14 small systems in Massachusetts the average cost of engineering supervision was 4 per cent of the total cost of construction. The maximum cost was 6 per cent and the minimum 2 per cent of the total cost. The cost of land and rights of way varies ordinarily from 1 to 4 per cent of the total cost, but in some cases may reach as high as 20 per cent of the total. A fair allowance would be 3 to 4 per cent for land and rights of way. From such data as are available the cost of preliminary examinations amounts to about 3 or 4 per cent of the total cost.

Under ordinary conditions an allowance of 10 to 15 per cent should be sufficient to cover the cost of preliminary engineering, administration, cost of lands and engineering supervision.

In closing it is well to repeat that caution should be used in applying average data to specific problems.

The foregoing article was submitted by the writer, about a year ago, as a part of his examination in applying for a position in the United States Public Health Service. The data given were collected while the writer was in the employ of the Massachusetts State Board of Health. The data are here submitted by the writer in the hope that they will be of some use to the readers of Engineering and Contracting.

The New Austin Dam and Power Plant.

Contributed by Frank S. Taylor, Resident and Directing Engineer, Austin, Texas.

I.

This development just completed after nearly three and one-half years of work, presents several new and extraordinary features of design and construction. The principal, original and note-worthy departure from general practice are; the two sections of dam having crests at different elevations; the automatic crest gates; the arrangement of the sluice gates; and the reinforced concrete turbine chambers, all of which will be hereafter described in their proper places.

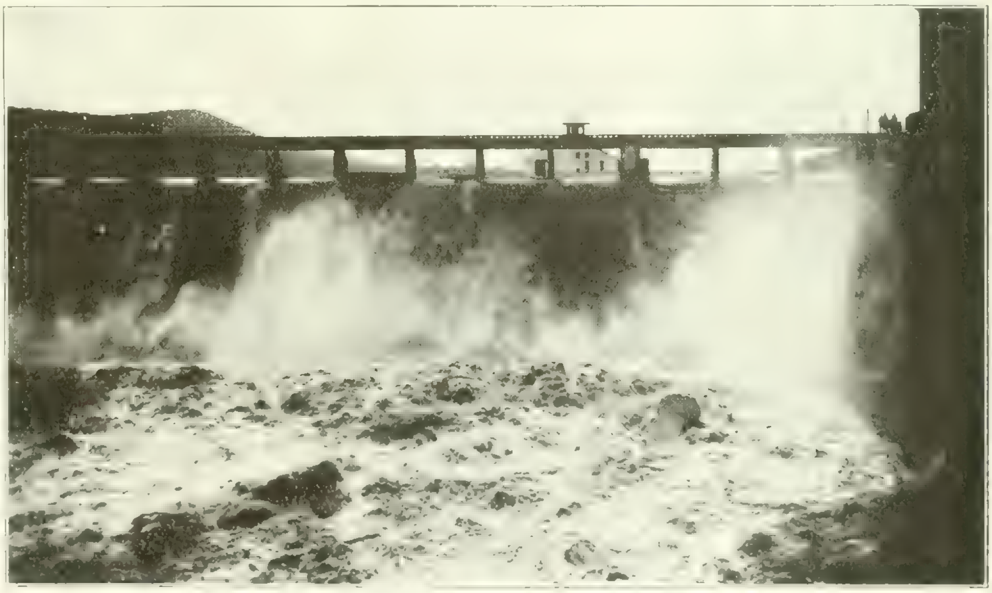


Fig. 1. The Austin Dam Under Flood of April 25, 1915.

HISTORICAL.

In May, 1893, the first dam across the Colorado River near Austin, Texas, was completed, and the electrical power and pumping plant, which were driven by the water power derived from the impounded waters of the dam, put into operation. At that time, the development attracted world-wide attention, due to the fact that it was then the greatest dam in the world, when both height and length were considered, and the lake formed by it was one of the largest artificial bodies of water ever impounded. The dam was a gravity section made of cyclopean concrete masonry, and overlaid on both the upstream and downstream sides with cut red granite blocks. Its height was 60 ft. above low water, and the total length was 1,235 ft., of which, practically, 1,100 ft. were spillway, 110 ft. bulkhead on the eastern end, and 25 ft. bulkhead on the western end. The whole development was a municipal undertaking, the money being raised on bonds of the city of Austin, of which $1,400,000 were issued.

The entire river bed for many miles up and down stream, and, in fact, practically all the underlying rock of the county, is limestone, varying from so-called "dobe," which is a disintegrated limestone, up to the hardest variety. The river bed is seamed with fissures, and there are small cavities of frequent recurrence, ranging from a few inches to several feet in the largest dimension, and these cavities are encountered sometimes as far as 20 ft. below the surface of the river bed.

Shortly after the work of construction of the first dam was begun, foundation difficulties began to manifest themselves, and these were followed by other difficulties produced by the *personnel* of the city government. The engineers in charge could not get their instructions followed, their plans executed or specifications fulfilled. They resigned, one after the other, and their places were filled by other engineers who also, successively, resigned. In spite of these difficulties, some 600 ft. of the western end of the dam were placed on good, firm rock. The rest of the work was done more with a view to completing the dam than to finding a foundation to support it. The draft tubes from the old power station were so located that they discharged against the down-stream toe, and the waters from these draft tubes eroded the soft strata underneath the toe, so that the dam did not rest on a supporting foundation from upstream to down-stream side, but merely from the up-stream side down to the point where erosion had ceased. This condition continued for seven years, when the inevitable end was reached.

On April 7, 1900, under a flood of 133,000 cu. ft. per second, which gave a thickness of water of nearly 11 ft. over the crest, a section of about 200 ft. long, tilted backwards under the stress, slid down stream, righting itself as it moved, and finally came to rest about 100 ft. below the axis of the dam. The impounded waters, rushing through the opening thus formed, eroded the remaining portions of the dam, thereby widening the gap until some 450 ft. of the total length of the dam was thus removed. The power house was wrecked, and several people who were in it at the time, were drowned.

This failure was another factor which brought the Austin dam again prominently before the engineering profession, and the peculiar conditions of its failure, together with the other features first mentioned, have made it the most widely known of any modern example of dam construction. This catastrophe deterred the municipality from undertaking the reconstruction of the dam, although for several years it was agitated from time to time by citizens. Engineers were employed to report on the location of the dam, and several different reports appeared, the general opinion being that the character of the river bed, the limestone and arrangement of the strata made it impossible to construct a safe and watertight dam at the point where the old structure had been built.

About six years ago, the municipality, at a considerable expense, had a series of rock borings made, some passing through the crest of those portions of the dam still remaining, the others made in the gap which was caused by the breaking out of that section on defective foundation, with the result that it was found that the underlying rock was good, hard, and compact after a certain depth below the river bed, and below the footing of the old dam, was reached. This encouraged the citizens and municipality to undertake some means whereby the dam could be rebuilt.

After many proposals from the city to private companies, and from companies to the municipality, a franchise was granted to Wm. D. Johnson of Hartford, Conn., on Sept. 11, 1911, which provided that the dam and power plant would be constructed by Johnson or his assigns, and on completion, turned over to the city, Johnson to receive $100,000 in cash on completion and acceptance, and $64,800 per annum in semi-annual payments for 25 years, making a total payment of $1,720,000, the cash value of which is approximately $1,000,000. In order to carry out the terms of the franchise and to do the construction work, a corporation was formed called the City Water Power Co., which issued $750,000 face value of five per cent, gold, sinking fund bonds, and these bonds were underwritten by Lawrence Barnum & Co., bankers, of New York.

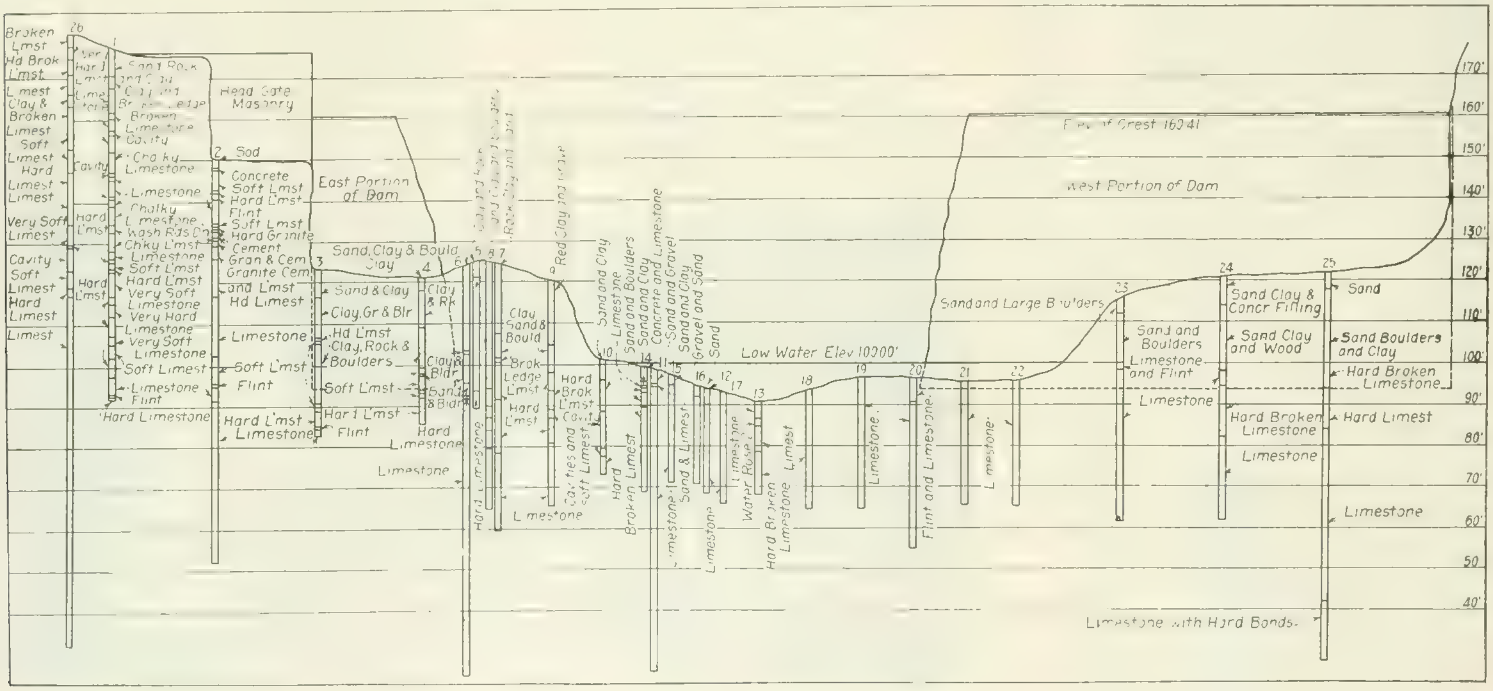


Fig. 2. Boring Record on Site of Austin Dam.

NEW PLANS.

The designs for the new development were begun early in 1910, and work finally begun on Sept. 22, 1911. This work was prosecuted on force account from this latter date until June, 1912, when a contract was entered into with the Wm. P. Carmichael Co. of St. Louis to take over the work and bring it to completion. Work progressed until April, 1913, after which, practically, nothing was done until Jan. 10, 1914, the entire period between these latter dates being lost by reason of an unprecedented series of heavy floods culminating in the flood of Dec. 3, which was the highest ever recorded in the history of the river, or memory of any person acquainted with it. It is estimated that the quantity of water passing down the river on that date was between 220,000 and 230,000 cu. ft. per second.

After a considerable study of the situation, it was decided that the new development could be made best and most cheaply on the same site as that of the original dam. While the foundation work for the new dam was more costly than it would have been if the location were changed upstream some 800 or 900 yards, this expense was more than counterbalanced by the ability to use the existing section, which comprised 520 ft. length of dam, in good condition and on satisfactory foundation, together with all the bulkhead masonry, which was thoroughly good, though not on proper foundation. Also, the larger portion of the old power house, still standing, could be utilized. The most suitable character of structure with which to fill the gap is a hollow dam, having an inclined deck, thus neutralizing the overturning moment, having buttress walls sunk well into the rock to resist sliding, and with a cut-off wall on the upstream side going down into a trench cut in the rock to such a depth that all waters would be definitely stopped from following any permeable seams.

There was, however, one difficult condition to be met, which was that in order to get the proper amount of power and lake storage, the height of the water level would have to be raised from the old elevation of 60 ft., to 65 ft., above low water, which meant that with 11 ft. of water over the crest, during times of flood, the maximum water level would be 76 ft. above low water instead of 71 ft. That portion of the old section which had given way, failed under a 71 ft. elevation of the water level, and it was imperative that that portion of the old section remaining and which would form a part of the new dam, should not be again subjected to as great stresses as it had previously withstood. This required that, the maximum water level should never rise even as high as 71 ft. above low water. It appeared as if these two conflicting conditions could not be reconciled. However, after considerable study, the arrangement of crest gates, later to be described, was adopted. With this arrangement, the new section of dam was built only 51 ft. high from low water to crest, or 9 ft. lower than the old section. Piers were built 20 ft. apart on both the old and new sections, the upper levels of the piers being the same over the whole length of the structure. Crest gates were placed between the piers, the gates on the old section being 6 ft. high, and those on the new section, 15 ft. high, so that the upper edges of the crest gates are all at the same level, which is 66 ft. above low water. When the water level is at an elevation of 65 ft., or less, the crest gates are tightly closed. An increase of 6 ins. in the elevation of the lake level will make the crest gates automatically overturn, letting the water flow out over the crest of the dam. When the level has fallen 12 to 15 ins., or about down to the 64-ft. elevation, the crest gates automatically close. During periods of flood, the crest gates are open, and the greater portion of the flood water is taken over the crest of the new section. It is estimated that with a discharge 200,000 cu. ft. per second, the thickness of the water over the crest of the new section, will be 18 ft., the thickness of the water over the crest of the old section being 9 ft. This means that the present dam will pass 50 per cent more water than passed over its crest when the old dam failed, but the elevation of the water is only 9 ft. above the crest of the old dam, while it was 11 ft. above the crest when the weak section went out in 1900. Since the overturning moment varies as the cube of the head of water against the dam, and the sliding force varies as its square, the stresses to which the old section will be subjected can never equal those which it has already resisted. The depth of the water below the low water elevation varies from 5 to 20 ft., so that the total depth of water behind the dam varies from 70 to 85 ft.

FOUNDATION.

As has been pointed out, the river bed and the whole surrounding country is underlaid with limestone, which has many crevices, seams and cavities in it, and these are to be found at varying depths below the surface. About twelve years ago, two United States government engineers made a short report for the city of Austin, in which they gave an adverse opinion concerning the character of the river bottom for supporting a dam. Of course, at that date, the only type of dam that these engineers considered was the ordinary gravity section. About six years ago, the city had a number of borings made by the Sullivan Machinery Co., definitely to determine the character of the river bed. There were considerable amounts of broken limestone, soft limestone, cavities, seams and fissures encountered, and the records obtained from these borings prove, conclusively, that in order to build a dam across the river at this point, the defects in the strata underlying it would have to be corrected. It was decided to fill all the underlying seams and cavities with grout, and, on the reconstructed river bed, to build a hollow dam of reinforced concrete, of such form that there could be no uplifting force from any leakage of water under it. Furthermore, as a portion of this new section, a cutoff wall would be sunk in a trench cut in the rock on the upstream side and carried to such a depth that its lower edge would be below all permeable strata.

After the excavations were made, it was found necessary, in many places, to go even deeper than indicated by the borings, before a proper quality of rock could be reached. With the type of dam adopted for the new section, it is only necessary that the underlying rock be able to carry the superimposed weight, there being no uplift.

The unit pressure adopted for the wall footings was 166 lbs. per square inch with a few walls where this pressure was carried up to 200 lbs. per square inch. Wherever the rock was hard and firm for a depth of 4 ft., it was considered satisfactory to resist these bearing pressures. Trenches were cut in the rock to receive the footings, and in the bottoms of these trenches, at intervals, drill holes were made 4 ft. in depth. Wherever these drill holes passed continuously through solid rock, the trench was accepted as suitable to receive the footing. Wherever the rock was hard but a cavity encountered, grout was forced into the cavity and allowed to harden before the footings was built upon it. Wherever soft and defective stone was found below the bottoms of the building trenches, the excavation of these trenches was continued until some point was reached below which the thickness of the good rock was at least 4 ft. This practice applied to the trenches in which the buttress and supporting walls were built. The cutoff wall was carried down, in many instances, a considerable depth below the footings of the buttresses. This wall, which runs transversely across the river on the upstream side of the dam, was poured in a trench which had previously been tested by numerous drill holes made in the bottom of the trench, and, where defects were found, they were remedied by grouting. These test holes were first made 12 ft. apart in the bottom of the trench. Compressed air was turned into them, one by one, to discover whether or not there was any underground connection between adjacent holes. Wherever the compressed air in entering one hole, would blow out of one or more of the other holes, it was considered that the entire seams or crevices between the two holes, were reached by the drill holes then made. Grout would then be forced into one of the holes until it began to blow out of the others. It was then considered that the rock lying below the cutoff wall trench and extending between the holes that the grout had entered through, and those it had begun to blow out of, had been made tight and impervious to water. Wherever no connection could be established between the holes 12 ft. apart, intermediate holes were drilled, thus making the drill holes only 6 ft. apart along certain portions of the cutoff wall trench. If, after this was done, no connection could be established between adjacent holes, additional holes intermediate to those 6 ft. apart were then drilled, bringing the distance apart of the holes to 6 ft.

In nearly every instance, where these holes were made, water flowed freely through them, sometimes spouting up 3 or 4 ft., thus proving, conclusively, connection between the holes made inside the cofferdam and the surrounding body of water. As grout would be forced into the holes, the velocity of water flowing out of them would gradually diminish, until it would entirely stop. In many cases, where grout was forced into a hole, the flow of water through other grout holes, sometimes as far distant as 50 ft., would be stopped and the grout would finally show, rising out of adjacent holes, proving that the underground seams between these two holes had been thoroughly filled with grout.

The grout used consisted of 1 part Portland cement to 2 parts of sand mixed with sufficient water to form a practically liquid mixture. The apparatus used to force the grout into the holes comprises a cylinder of steel plate, 20 ins. in diameter by 3 ft. long, supported vertically on three legs, the bottom being conically shaped, tapering from the diameter of the cylinder down to a 2-in. discharge opening. The upper end of the cylinder was provided with an interior cover, held tight by the air pressure from within. Entering the cylinder near its upper end is a connection for a 1-in. air pipe. The grout constituents were poured into the cylinder and compressed air admitted to the lower end of the cylinder, causing the mixture to boil and mix thoroughly. This operation usually required about one minute. After thoroughly mixing, the cover was lifted into place and the air pressure turned into the cylinder near the upper end, forcing the grout out of the lower end and into the grout holes. In order to make a proper connection between the discharge end of the pressure grouting cylinder and the holes in the rock, short sections of wrought iron pipe were sunk into each hole and cement poured around them and allowed to set, so that the upper end of the pipe provided a screw joint by which connection was made between the pressure hose leading from the grouting cylinder and the hole to be grouted. Usually, a light air pressure would be applied under which the grout would flow easily, and, as the hole began to be filled to a greater extent, the air pressure would be increased until when the hole was finally filled, the pressure would be raised to 80 lbs. per square inch.

By this method and using great care in locating and filling the holes, a good foundation was secured and through material of such a character that certain engineers had reported that it would be impossible successfully to construct the dam across the river at this locality.

Subsequent to the completion of the work, a cofferdam was built on the downstream side of the river and pumped out, and all leakage observed. There was practically no leakage through the foundation, or through the strata below the cutoff wall, and the entire work showed to be one of the most water tight dams that has ever been constructed.

A succeeding article in our issue of June 2 will describe the dam and its appurtenances.

ROADS AND STREETS

Study of a Water Supply by Pumping for Concrete Road Construction.

(Contributed.)

Frequently road builders are confronted with the difficulty of obtaining suitable water supply in connection with concrete construction. In highway work the contractor cannot always arrange for an unfailing suppply of water such as his brother contractor in the city may obtain, simply by entering into a contract with the municipality to pay a stated sum of money for such quantities of water as he may need, at the same time feeling sure that the supply required will always be available when needed. In country highway work the contractor must, in nearly all cases, depend upon streams, ponds, lakes or wells for water supply, and not infrequently must pump water several miles to the point where concrete is being mixed and placed. This has been the experience in concrete pavement construction on that portion of the old National Pike between Zanesville and Hebron, Ohio. Toward the end of the summer many of the streams from which water had been obtained, ran very low or nearly dry, and water had to be pumped a distance of 2½ miles, in some cases over grades as great as 10 per cent for a distance of 1,000 ft. Such problems as this require that careful layout of pipe lines and pumping plant facilities be planned and installed so that the cost of obtaining water may be kept at a minimum.

For purpose of illustrating possible contingencies to be provided for in work of this kind, the accompanying sketch of pipe line requirements for water supply between the towns *X* and *Y*, shown by Fig. 1, has been prepared. Eight and one-half miles of 16-ft. concrete pavement containing approximately 80,000 sq. yds., and lying between the towns mentioned, is presumed to be the piece of work that must be served by the pipe and pumping system to be used. Common labor is estimated at 22½ cts. per hour; pipefitter, 30 cts. per hour; pumping engineer, $3 per day. In the progress of construction all pipe will be hauled a distance of 8½ miles, as it will be taken off the cars at town *X* and after completion of the work, shipped from town *Y*.

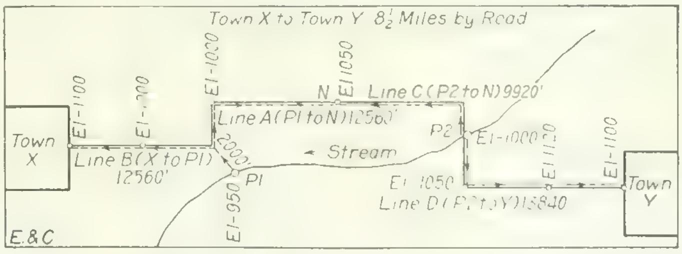


Fig. 1. Plan Showing Water Supply for Concrete Road Construction.

Presuming that concrete will be laid at the rate of about 500 sq. yds. a day, the job will require 213 calendar days for completion. This is based on the experience that not more than 75 per cent of calendar days can be counted as working days, owing to holidays, Sundays, and interruptions caused by unfavorable weather. On the accompanying sketch, points P—1 and P—2 indicate consecutive positions of pump location. Table I shows the heads against which the water must be pumped.

TABLE I. — SHOWING TOTAL HEAD AGAINST WHICH WATER MUST BE PUMPED.

Line.	Length of pipe, ft.	Friction head, ft.	Static head, ft.	Total head, ft.
A	12,560	189	100	289
B	12,560	189	150	339
C	9,920	119	80	199
*D	13,840	208	120	328

*The highest elevation of the line determines the static head regardless of its location with respect to the ends of the line. Syphon action is not to be considered in determining the static head.

From Table I, one pump working against a head of 346 ft. or 150 lbs. is shown to be sufficient to deliver 15,000 gals. per 10-hour day. Fifteen thousand feet of 2-in. pipe will be sufficient to supply water for the entire job. Taking up and relaying this pipe as the work progresses will involve the laying of 47,000 ft. of pipe. A conservative estimate of time required to move the pump, set it up, and place in running order, and to take up the pipe line *A* and place it in position to pipe line *C*, will be two days' time.

Two-inch Butt Weld pipe weighing 3.6 lbs. per lineal foot will cost new, about 10 cts.

per foot net, f. o. b. at place of purchase; 2-in. pipe with connections can be rented for 3 cts. per foot for the construction season the contractor paying the freight both ways. Harris Brothers Co., 35th & Iron Sts., Chicago, supply pipe at the above terms and also sell second hand pipe. McDowell & Company, Galveston & Western Ave., N. S., Pittsburgh, Pa., and Foster-Songer Company, Park Bldg., Pittsburgh, Pa., also supply pipe on about the same terms. Two-inch gate valves cost $3.00, 1-in. globe valves cost 75 cts., and T's from 2 to 1 in. cost 20 cts. each. Only gate valves should be used in the main 2-in. line.

An efficient pump would be a 3½x4-in. Deming, single-acting triplex plunger pump outside guided and outside packed, delivering 25 gals. per minute when operating at 50 revolutions per minute, when fitted with 16x4-in. tight and loose pulleys. Approximate shipping weight for this pump is 1,100 lbs.; cost $125. To operate this pump against the maximum head equivalent to a pressure of 150 lbs. will require not less than a 5 H. P. gasoline engine. A gasoline engine of suitable type for this purpose can be bought for from $100 to $125. Belting, relief valve and such connections as necessary would cost about $15.

This equipment will supply 25 gals. per minute working against a head not exceeding 346 ft. (To the actual vertical head, 1.5 ft. must be added to each 100 ft. of pipe, to compensate for friction.) The estimate of pumping costs follows:

Cost of equipment to be credited to the job:	
10 2-in. gate valves, at $3	$ 30.00
50 1-in. globe valves, at 75c	37.50
50 T's, 2 ins. to 1 in., at 20c	10.00
400 ft. of hose, at 15c	50.00
Deming single-acting triplex pump	125.00
4-hp. gasoline engine	125.00
Belting relief valve, etc	15.00
Incidental accessories	50.00
	$ 452.50
Charge 0.17 per cent of equipment cost per day for depreciation and upkeep for 213 days	$ 163.85
15,000 ft. of 2-in. pipe, rental and freight, at $0.3¼ per ft	487.50
Labor for placing and removing pipe line and equipment:	
Hauling 15,000 ft. of pipe pumping equipment and accessories 8½ miles, 30 tons at 50c per ton-mile	127.50
Laying and removing 47,000 ft. of pipe at 50c per 100 ft	235.00
Setting of pump and engine twice	20.00
Cost of pumping, including fuel and labor, say, 160 working days at $5	800.00
	$1,833.85
Add 10 per cent for contingencies	183.39
Net cost of water for 80,000 sq. yds. of concrete pavement	$2,017.24
Net cost of water per square yard of concrete pavement	$0.0252

Organization of Road Work Under the Illinois Highway Commission.

(Staff Article.)

On July 1, 1915, there will become by legislative enactment, as noted in Current News of this issue, a fund of $2,750,000 available for state-aid road construction in Illinois for two years succeeding this date. The appropriation for the preceding two years' work was $1,100,000. The state-aid roads under the law comprise 15 per cent of the mileage in counties of the first class, 20 per cent of the mileage in counties of the second class and 25 per cent of the mileage in counties of the third class, or approximately 15,000 miles of road in all. If all of the new $2,750,000 is utilized according to law, the next two years will witness the expenditure of $5,500,000 in road construction under state direction. It will be useful, therefore, to review briefly the organization of the directing body and also to study the work, so far as records appear, of this body in handling the previous expenditure of some $2,200,000. Incidentally an outline of the origin and development, to the time of the present organization, of state participation in road work, will be of value.

WORK OF ORIGINAL COMMISSION.

The first official action to be taken by the state of Illinois for the improvement of public highways was that of the year 1905, when the Legislature created a State Highway Commission consisting of three unsalaried members. Under this act, there was also created the position of State Highway Engineer, with provision for such technical and clerical assistance as was found necessary to carry on the proposed work. The primary functions of this commission were not to accomplish any considerable mileage in road construction, but rather to make an economic investigation into all phases of the rural highway problems of the state. With this purpose in mind, steps were taken towards the construction of hard roads of various types and under as varied conditions as it was practicable to arrange for the work to be done.

During the years from 1906 to 1912, some 30 or 40 miles of gravel or macadam road construction per year was carried out under state supervision. During the construction of these roads accurate cost data were taken in order that the public in general might become familiarized with the probable expenditure necessary in case it saw fit to carry on hard road construction on a more extensive scale.

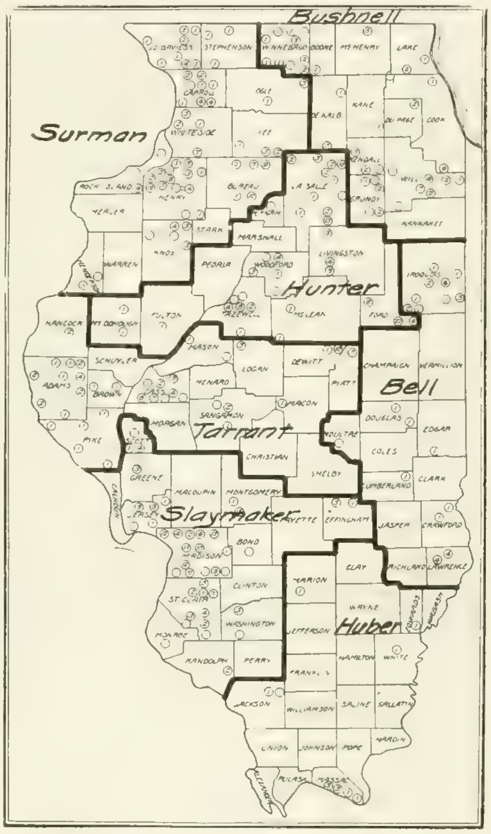


Fig. 1. Sketch Map Showing Seven Geographical Divisions for Road Work.

These construction cost data have been published by the commission from time to time in bulletin form as well as in the regular annual report. There was no provision made, however, for the maintenance of these roads after construction, with the result that in many cases they have been permitted to reach such a condition as to necessitate expenditures of considerable magnitude in order to restore their original serviceableness. These restoration expenditures have been considerably heavier than the expenditures that would have been necessary to maintain the roads in proper condition had the maintenance work been looked after promptly upon the detection of weaknesses in the road.

In the construction of these roads, many different kinds of road binders have been used and their behavior, as well as that of the road itself, has been the constant study of the commission with a view of ascertaining the most economical materials and methods for procedure in rural road construction on an extensive plan. In addition to this experimental road work, there has been carried on continuously a vigorous campaign in favor of the more modern types of culvert and bridge construction. For normal conditions, the use of concrete for culverts and small bridges has been strongly recommended and for the larger bridges great modifications have been brought about from past practice in the way of the substitution of concrete substructure for wood or steel tubes and of concrete and creosoted block floors in the place of untreated oak floors. Generally, over the state, there has been constructed under the supervision of this commission firstclass concrete bridges and culverts to the end that structures of this type and quality have been adopted in many of the counties of the state to the exclusion of all other types of construction for similar structures. In all this work engineering services have been rendered to the local township or county concerned absolutely free of any charges whatever. In addition to the free engineering services, the local communities have been favored with the free use of state machinery in the construction of hard roads.

The law creating the State Highway Commission provided also for the preparation of crushed rock for road construction. At each of the two state penitentiaries rock quarrying and crushing machinery has been installed and rock for road construction has been furnished the people f.o.b. cars at the quarry. For the shipment of this rock for road construction practically all railroads of the state granted the special rate of half a cent per ton per mile, which freight charges were in all cases paid by the local community receiving the rock.

ORGANIZATION OF PRESENT COMMISSION.

On July 1, 1913, the State Highway Commission in question was abolished and there went into effect a law providing for another State Highway Commission consisting of three salaried members appointed by the Governor. The new law provided for the creation of a State Highway Department and also for the offices of Chief State Highway Engineer and Assistant State Highway Engineer, to be filled by appointment by the Governor. Aside from these appointive positions, all positions in the Illinois State Highway Department are filled from the eligible list of the State Civil Service Commission, which list is maintained by competitive examinations held from time to time, as the occasion requires.

Next in line under the Assistant State Highway Engineer is the Road Engineer, immediately under whom there is an assistant. The state of Illinois is divided up into seven geographical divisions, Fig. 1, each division being in charge of a division engineer who has practically absolute control and authority over construction work going on within his territory. The division engineer reports directly to the offices of the department at Springfield. On each job under construction there is a resident engineer who reports directly to his division engineer.

At the head of the Bridge Department is the bridge engineer, immediately under whom is an assistant. The office work in connection with both road and bridge matters are carried on under the immediate direction of either the road engineer or the bridge engineer, or their respective assistants.

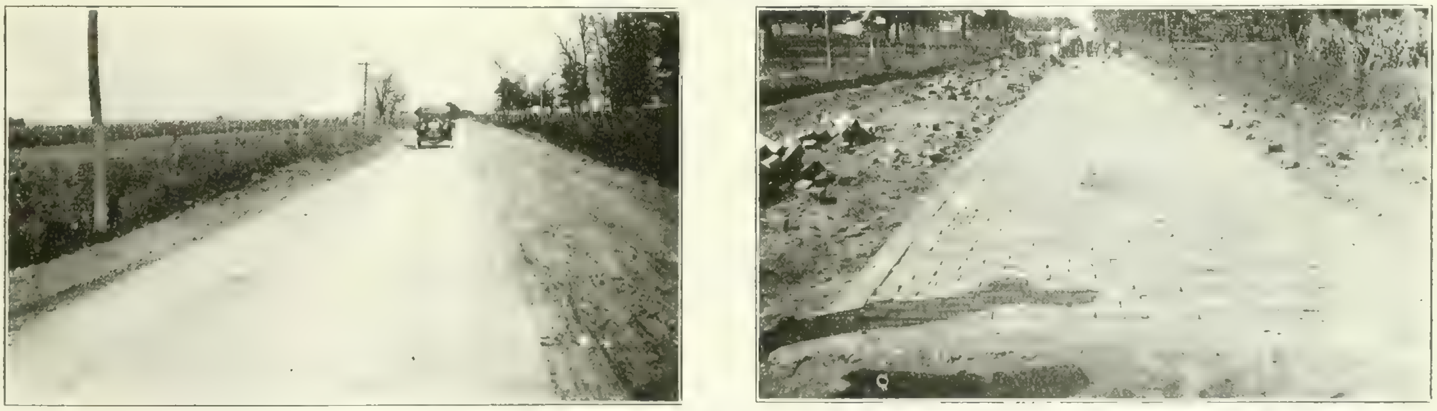
WORK OF PRESENT COMMISSION.

On July 1, 1913, there became available by state appropriation, as previously stated, the sum of $1,100,000 for state-aid road construction to be expended over the two years following. In order for a county to receive its proportional part of the state allotment it was obliged to first provide itself with a county superintendent of highways and then to meet the state allotment with an equal appropriation. The office of County Superintendent of Highways having been provided for in the statute there is at present in practically every county of the state a qualified and experienced person whose sole aim it is to teach the economics with respect to materials, methods and management in connection with both roads and bridges. After having first been certified by the County Board of Supervisors the candidate for the office of County Superintendent must pass the state civil service exam-

Figs. 2 and 3. Ten-foot Concrete Roads with Macadam Shoulders.

(Excavation for macadam shoulders and lateral drains is shown completed in Fig. 2.)

Figs. 4 and 5. Brick Roads with Concrete Curbs and Grouted Gutters.



Figs. 6 and 7. Typical 10-ft. Brick Roads.

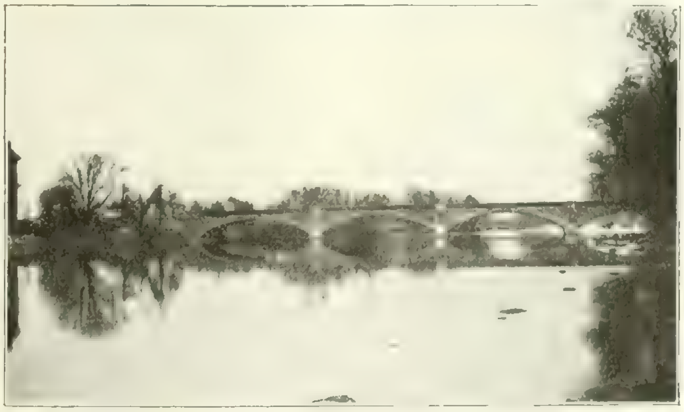


Fig. 8. Four-span Concrete Arch Bridge; 65-ft. Spans and 20-ft. Roadway.

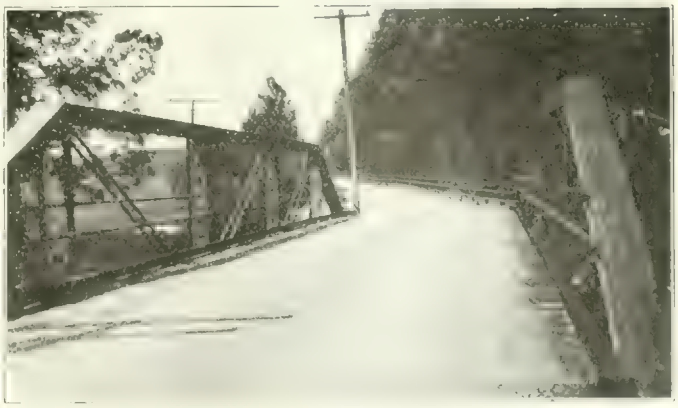


Fig. 9. Steel Bridge Floor of 3-in. Creosoted Plank Treated with Asphalt.

ination and then must receive his appointment from the Board of Supervisors of the county to whom he reports thereafter. While his salary is paid out of the county funds, yet he is a deputy of the State Highway Department and is required by law to render such services as the department requires.

Because of the legal proceedings attempting to question the constitutionality of the so-called Tice law, contracts for the construction of state aid roads could not be advertised until July 1, 1914. Beginning on July 1, how-

TABLE I.—CONTRACT PRICES ON STATE AID ROAD WORK IN ILLINOIS IN 1914.

TEN-FOOT CONCRETE ROADS.

COUNTY	Section.	Route.	Length, feet.	Concrete pavement, sq. yds.	Mac. shldrs. Width, ft.	Mac. shldrs. Square yards.	Value of cement in job.	Con. price of job, exclud. cement.	Con. price of job, includ. cement.	Con. price incl. cement. pro. per mile.	Grading: Cubic yards.	Grading: Con. price (prorated).	Bridges, con. price (prorated).	Shldrs., con. price prorated: Macadam.	Shldrs., con. price prorated: Earth.	Misc. items, con. price (prorated).	Conc. pavement proper: Con. price (prorated).	Conc. pavement proper: Con. price, pro. per mile.	Conc. pavement proper: Con. price, per sq. yd. (pro.).	Mac. shldrs.: Con. price, pro. per mile.	Mac. shldrs.: Con. price, per sq. yd. (pro.).
Adams	A	5	7,200	8,000	4	6,400	$ 3,082	$ 13,898	$ 16,980	$12,450	6,215	$ 1,965	$ 980	$ 2,426	$......	$ 150	$ 11,459	$8,400	$1.43	$1,780	$0.38
Boone	B	1	4,000	4,444	.	......	1,617	6,455	8,072	10,650	5,367	1,728	320	......	142	......	5,882	7,760	1.32	......	.....
Carroll	A	2	7,200	8,000	.	......	3,045	10,490	13,535	9,920	7,871	2,096	1,185	......	160	......	10,094	7,400	1.26	......	.....
Cass	A	5	3,300	3,667	.	......	1,348	4,500	5,848	9,360	2,265	620	......	......	40	......	5,183	8,300	1.41	......	.....
Clark	A	1	4,506	5,007	.	......	1,993	6,650	8,643	10,130	5,325	1,725	800	......	250	152	5,716	6,700	1.14	......	.....
Clay	A	5	3,300	3,667	2½	1,833	1,370	4,298	5,668	9,070	752	230	......	983	75	......	4,380	7,000	1.19	1,570	0.53
Crawford	A	6	2,700	3,000	.	......	1,275	5,600	6,875	13,410	3,400	1,142	843	......	168	......	4,722	9,260	1.58	......	.....
Crawford	B	3	18,049	20,051	.	......	8,070	18,990	27,060	7,920	7,618	2,514	2,060	......	880	......	21,606	6,340	1.08	......	.....
De Kalb	A	1	6,009	6,677	.	......	2,365	7,299	9,664	8,490	4,400	1,430	266	......	760	26	7,182	6,300	1.07	......	.....
De Kalb	C	1	15,723	17,470	.	......	6,235	21,399	27,634	9,270	11,280	3,629	1,050	......	1,939	......	21,016	7,000	1.19	......	.....
Du Page	A	1	10,800	12,000	4	9,600	4,280	17,867	22,147	10,830	7,480	2,166	580	3,550	950	......	14,901	7,290	1.24	1,740	0.37
Fayette	A	6	7,065	7,850	4	6,280	2,970	9,995	12,965	9,680	3,440	1,030	480	1,900	188	......	9,367	7,000	1.19	1,415	0.30
Franklin	A	1a-1	4,378	4,865	.	......	2,107	6,611	8,718	10,500	3,490	970	674	......	280	325	6,469	7,800	1.33	......	.....
Grundy	A	2	9,000	10,000	4	8,000	3,521	15,489	19,010	11,150	4,770	1,520	210	3,525	1,090	......	12,665	7,430	1.27	2,070	0.44
Iroquois	A	7	13,000	14,444	.	......	5,420	15,890	21,310	8,700	9,775	3,120	590	......	770	......	16,830	6,840	1.16	......	.....
Iroquois	B	7	13,365	14,850	.	......	5,590	16,980	22,570	8,950	8,409	2,680	670	......	780	......	18,440	7,320	1.25	......	.....
Jefferson	A	3	3,500	3,889	4	3,111	1,520	5,482	7,002	10,560	1,623	480	28	1,920	100	14	4,460	6,730	1.14	2,900	0.62
Jersey	A	2	3,100	3,444	.	......	1,300	4,475	5,775	9,840	1,190	405	85	......	82	......	5,203	8,820	1.50	......	.....
Kankakee	A	1-9	9,200	10,222	4	8,177	3,750	17,112	20,862	11,970	6,050	1,770	896	3,730	680	......	13,786	7,910	1.35	2,140	0.45
Lawrence	A	5	4,680	5,200	4	4,160	2,160	9,680	11,840	13,360	5,276	1,716	1,020	2,070	280	......	6,754	7,620	1.30	2,350	0.50
Lee	A	5	9,000	10,000	4	8,000	3,631	16,449	20,080	11,780	4,060	1,330	780	4,050	545	......	13,375	7,840	1.34	2,380	0.51
Livingston	A	11	12,430	13,811	4	11,048	4,966	19,484	24,450	10,400	5,330	2,215	800	3,750	1,285	......	16,400	7,000	1.19	1,590	0.34
Logan	A	3	3,000	3,333	4	2,666	1,180	3,566	4,746	8,370	1,251	390	......	800	172	......	3,384	5,960	1.01	1,400	0.30
Logan	B	7	3,600	4,000	4	3,200	1,541	5,639	7,180	10,560	1,505	505	825	1,107	225	......	4,518	6,630	1.13	1,630	0.35
Logan	C	8	3,600	4,000	4	3,200	1,420	4,962	6,382	9,390	1,607	526	......	1,010	215	......	4,631	6,790	1.16	1,500	0.32
Logan	D	13	3,600	4,000	4	3,200	1,441	5,569	7,010	10,310	1,660	540	135	1,225	218	......	4,892	7,180	1.22	1,800	0.38
Macoupin	A	1	11,055	12,283	4	9,827	4,709	16,108	20,817	9,960	8,075	2,615	664	3,180	320	......	14,038	6,700	1.14	1,520	0.32
McHenry	A	1	2,600	2,889	4	2,311	1,137	4,736	5,873	11,930	1,060	350	595	1,430	62	......	3,436	6,980	1.19	2,920	0.62
McHenry	B	11	1,500	1,667	4	1,333	670	2,950	3,620	12,750	550	180	28	810	35	410	2,157	7,590	1.29	2,890	0.61
Menard	A	7	2,400	2,667	4	2,135	1,015	4,860	5,875	12,910	4,696	1,330	215	1,260	58	......	3,012	6,630	1.13	2,740	0.59
Moultrie	A	5	6,300	7,000	.	......	2,660	8,415	11,075	9,280	3,200	900	490	......	395	450	8,840	7,410	1.26	......	.....
Peoria	A	4	6,159	6,843	4	5,475	2,731	12,529	15,260	13,070	5,253	1,740	1,760	2,120	620	70	8,950	7,650	1.30	1,810	0.39
Rock Island	A	11	4,969	5,521	.	......	2,080	7,250	9,330	9,930	3,079	1,014	640	......	180	200	7,196	7,650	1.30	......	.....
Rock Island	B	3	1,800	2,000	.	......	750	3,050	3,800	11,130	2,786	790	180	......	90	......	2,740	8,030	1.37	......	.....
Schuyler	A	5	5,400	6,000	.	......	2,250	6,766	9,016	8,840	3,311	1,080	223	......	60	......	7,653	7,480	1.28	......	.....
Tazewell	A	9a	4,280	4,756	4	3,804	1,810	7,729	9,539	11,780	2,829	960	780	1,620	480	......	5,699	7,030	1.20	2,000	0.43
Tazewell	C	11	1,800	2,000	4	1,600	752	2,738	3,490	10,240	827	270	243	550	194	56	2,177	6,380	1.09	1,620	0.34
Tazewell	D	10	4,000	4,444	4	3,556	1,625	7,800	9,425	12,400	1,467	577	296	1,529	446	......	6,577	8,660	1.48	2,020	0.43
Whiteside	A	6	2,800	3,111	4	2,489	1,261	7,249	8,510	16,100	2,992	930	1,380	1,570	102	......	4,528	8,540	1.46	2,960	0.63
Will	A	2	9,300	10,333	4	8,267	3,690	14,590	18,280	10,390	6,170	1,970	600	2,240	410	......	13,060	7,420	1.26	1,260	0.27
Will	B	13	10,800	12,000	4	9,600	4,311	17,949	22,260	10,880	6,650	2,100	860	3,880	630	......	14,790	7,230	1.23	1,890	0.40
Williamson	A	8	6,300	7,000	.	......	2,790	8,986	11,776	9,880	5,300	2,030	410	......	570	......	8,766	7,350	1.25	......	.....
Woodford	A	1	7,300	8,111	4	6,489	2,964	12,436	15,400	11,140	6,365	1,760	610	2,770	810	......	9,450	6,840	1.16	2,010	0.43
Total or average (10-ft. concrete roads)			274,009	304,637	.	135,761	$114,402	$420,970	$535,372	$10,320	186,024	$59,058	$25,221	$55,005	$17,726	$1,953	$376,409	$7,250	$1.23	$1,900	$0.41
EIGHTEEN-FOOT CONCRETE ROADS.																					
Cook	A	32	2,623	5,246	.	......	$ 2,055	$ 4,700	$ 6,755	$13,590	1,450	$ 610	$......	$......	$ 276	$.....	$ 5,869	$11,810	$1.12	$.....	$....
Cook	B	38	7,111	14,222	.	......	5,455	13,400	18,855	14,000	4,800	1,717	307	......	880	......	15,951	11,800	1.12	......	.....
Cook	C	3	24,000	48,000	.	......	18,580	44,900	63,480	13,960	17,100	6,040	945	......	3,605	......	52,890	11,600	1.10	......	.....
Cook	D	19	16,235	32,470	.	......	12,200	22,880	35,080	11,410	3,920	1,627	......	......	1,245	......	32,208	10,500	1.00	......	.....
Cook	E	29	19,142	38,284	.	......	15,250	43,900	59,150	16,070	14,800	5,900	2,450	......	3,320	......	47,480	12,890	1.21	......	.....
Kane	A	1	16,275	32,549	.	......	12,493	29,787	42,280	13,720	9,380	3,676	......	......	2,354	......	36,250	11,770	1.11	......	.....
La Salle	C	11	7,324	14,648	.	......	5,559	20,721	26,280	18,950	19,451	5,150	1,510	......	775	......	18,845	13,600	1.28	......	.....
Sangamon	A	2	2,000	4,000	.	......	1,715	4,025	5,740	15,150	964	313	600	......	40	......	4,787	12,600	1.20	......	.....
Sangamon	B	3e	2,200	4,400	.	......	1,890	5,035	6,925	16,600	784	260	695	......	45	......	5,925	14,220	1.35	......	.....
Sangamon	C	5	2,200	4,400	.	......	1,810	4,025	5,835	14,000	965	314	240	......	45	......	5,236	12,500	1.19	......	.....
Sangamon	D	6-7	2,000	4,000	.	......	1,690	4,030	5,720	15,090	1,066	340	435	......	40	......	4,905	12,900	1.22	......	.....
Sangamon	E	9	2,350	4,700	.	......	1,990	5,500	7,490	16,830	3,700	1,195	546	......	46	94	5,609	12,600	1.19	......	.....
Total or average (18-ft. concrete roads)			103,760	207,520	.	......	$ 80,687	$202,903	$283,590	$14,430	78,380	$27,142	$ 7,728	......	$12,671	$ 94	$235,955	$12,010	$1.14	.....	.....
VARIABLE WIDTH CONCRETE ROADS.																					
Lake	A	6	10,600	12,450	var.	8,365	$ 4,855	$ 19,900	$ 24,755	$12,320	7,885	$ 2,220	$ 1,611	$ 4,278	$ 627	$ 775	$ 15,244	$7,580	$1.22	$2,130	$0.51
Total or average (all concrete road)			388,369	524,607	.	144,126	$199,944	$643,773	$843,717	$11,470	271,289	$88,420	$34,560	$59,283	$31,024	$2,822	$627,608	$8,530	$1.19	$1,930	$0.41

TEN-FOOT BRICK ROADS.

COUNTY.	Section.	Route.	Length, feet.	Brick pavement, sq. yds.	Mac. shldrs.		Value of cement in job.	Con. price of job, exclud. cement.	Con. price of job, includ. cement.	Con. price, incl. cement, pro. per mile.	Grading		Bridges, con. price (prorated).	Shldrs., con. price prorated		Misc. items, con. price (prorated).	Brick pavement proper			Mac. shldrs.	
					Width, ft.	Square yards.					Cubic yards.	Con. price (prorated).		Macadam.	Earth.		Con. price (prorated).	Con. price, pro. per mile.	Con. price, per sq. yd. (pro.).	Con. price, pro. per mile.	Con. price, per sq. yd. (pro.).
Champaign	A	3	6,600	7,353	.	.....	$ 1,970	$ 14,500	$ 16,470	$13,180	3,730	$ 1,130	$ 1,270	$.....	$ 330	$ ...	$ 13,740	$11,000	$1.87	.....	.....
Champaign	B	5	6,160	6,844	.	.....	1,722	12,678	14,400	12,310	3,100	940	360	.....	305	.....	12,795	10,930	1.87	.....	.....
Champaign	C	7	5,700	6,333	.	.....	1,600	13,150	14,750	13,660	4,450	1,000	100	.....	280	.....	13,070	12,080	2.06	.....	.....
Coles	A	17-8	6,000	6,667	.	.....	1,761	13,989	15,750	13,840	3,832	1,285	725	.....	370	.....	13,370	11,730	2.01	.....	.....
Douglas	A	3	4,500	5,000	.	.....	1,230	9,100	10,330	12,130	1,660	560	100	.....	280	.....	9,390	11,050	1.88	.....	.....
Douglas	B	11	2,520	2,800	.	.....	680	5,300	5,980	12,530	960	320	.....	.....	160	.....	5,500	11,460	1.96	.....	.....
Edgar	A	2	4,200	4,667	.	.....	1,360	10,400	11,760	14,790	2,280	160	1,150	.....	210	.....	9,940	12,500	2.14	.....	.....
Edgar	B	6	4,500	5,000	.	.....	1,330	10,235	11,565	13,570	1,520	460	470	.....	270	.....	10,105	12,240	2.08	.....	.....
Fulton	A	2	2,620	2,911	.	.....	740	6,180	6,920	13,550	1,372	610	409	.....	182	.....	5,719	11,230	1.94	.....	.....
Fulton	C	16	5,400	6,000	.	.....	1,585	12,615	14,200	13,950	4,490	1,250	840	.....	375	.....	11,735	11,500	1.92	.....	.....
Jackson	A	4	3,380	3,906	.	.....	1,180	9,615	10,795	16,870	5,220	1,920	.....	.....	205	160	8,210	12,800	2.10	.....	.....
Ogle	A	3	8,500	9,444	.	.....	2,300	21,400	23,700	14,720	7,034	1,690	1,010	.....	480	.....	20,520	12,740	2.17	.....	.....
Warren	A	1	5,500	6,111	.	.....	1,424	11,936	13,370	12,860	2,425	800	30	.....	180	.....	12,360	11,870	2.02	.....	.....
Warren	B	12	4,000	4,444	.	.....	1,641	9,156	10,200	13,160	2,498	860	50	.....	130	.....	9,160	12,100	2.06	.....	.....
Total or average (10-ft brick roads)			69,610	77,193	.	.....	$ 19,936	$160,254	$180,190	$13,660	44,570	$13,285	$ 6,814	.....	$ 3,757	$ 460	$155,914	$11,800	$2.01	.....	.....
EIGHTEEN-FOOT BRICK ROADS.																					
Fulton	B	3	3,234	6,468	.	.....	$ 652	$ 14,648	$ 15,300	$24,950	3,725	$ 1,350	$ 901	$.....	$ 403	$.....	$ 12,646	$20,600	$1.95	.....	.....
Stephenson	A	9	3,000	6,000	.	.....	1,541	12,789	14,330	25,230	4,551	1,515	310	.....	330	.....	12,175	21,430	2.03	.....	.....
Total or average (18-ft brick roads)			6,234	12,468	.	.....	$ 2,193	$ 27,437	$ 29,630	$25,090	8,276	$ 2,865	$ 1,211	.....	$ 733	.....	$ 24,821	$21,015	$1.99	.....	.....
VARIABLE WIDTH BRICK ROADS.																					
Bond	A	7	1,575	2,661	.	.....	$ 820	$ 7,290	$ 8,110	$27,190	7,200	$ 1,570	$.....	$.....	$ 140	$ 560	$ 5,840	$19,580	$2.19	.....	.....
Vermilion	A	2	16,100	21,566	.	.....	6,410	47,895	54,305	17,830	13,680	4,620	3,700	.....	1,220	.....	44,765	14,700	2.07	.....	.....
Total or average (var. width bricks)			17,675	24,227	.	.....	$ 7,230	$ 55,185	$ 62,415	$22,510	20,880	$ 6,190	$ 3,700	.....	$ 1,360	$ 560	$ 50,605	$17,140	$2.13	.....	.....
Total or average (all brick roads)			93,519	114,188	.	.....	29,359	242,876	272,235	15,930	73,726	22,340	11,725	.....	5,810	1,020	231,340	13,400	2.02	.....	.....

Where the term "prorated" or its abbreviation, "pro," is not in parenthesis it signifies what a mile length would have cost at the same rate; and where it appears in parenthesis it signifies what the contract price would have been, as determined by the unit estimating data.

ever, and ever since, the force has been actively engaged in the supervision of state-aid roads in the vast majority of the counties of the state.

All state-aid roads thus far designed or built are of either concrete or brick type and the widths are almost invariably either 10 or 18 ft. The 10-ft. widths may or may not be constructed with macadam or gravel shoulders, depending largely upon the will of the County Board of Supervisors as well as upon the traffic conditions that must be satisfied. All state-aid roads are built by lump-sum contract, but the cement required is furnished the contractor f.o.b. cars destination by the State Highway Department, who having received competitive bids for furnishing all cement for state-aid roads for a given period, awarded the contract for the furnishing of such cement at a specified price, regardless of future fluctuations in the market. In Table I are the contract prices that have been received on practically all the state-aid roads that have been awarded since July 1, 1914. As being explanatory of the several headings, attention is called to the note at the bottom of the table. In connection with 10-ft. concrete roads, note that the contract price of the pavement proper, per square yard, is $1.23, whereas the corresponding price for the 18-ft. road is $1.14, even though the 18-ft. road is thicker than the 10-ft. road. This matter is largely accounted for by the fact that the 18-ft. roads in Cook County, as well as in some other counties, made the job of considerable size and thereby sharper competition was obtained than where short 10-ft. roads were built. Correspondingly, note that in the 10-ft. brick roads the contract price of the pavement proper is $2.01 per square yard, while in the 18-ft. brick road the corresponding price is $1.99 per square yard. As before mentioned, bids for the construction of these roads were received at a lump-sum figure exclusive of the value of the cement in the job. In order to work up the tabulation on this sheet, the value of the several items entering into the construction of the road are prorated so as to total up an amount equivalent to the contract price, this prorating having been done in accordance with unit estimating data. The idea of the state furnishing to the contractor all of the cement to be used in the construction of the job, presents a feature in the construction of concrete and brick roads that well merits consideration.

GENERAL POLICY OF ROAD CONSTRUCTION.

This state system of roads comprises a little more than 15,000 miles of the highways of the state. They are to be known as state-aid roads. It has been determined to make this system of roads of as permanent materials as can be used in the construction of highways. When once improved the state is forever to maintain the roads at its expense.

For improving the roads the legislature makes an appropriation from time to time. These appropriations are apportioned to the various counties in proportion as the counties paid money into the road fund the previous year. One exception to this rule is made, viz.: that if any county pays 40 per cent or more of the taxes of the state it receives back 25 per cent of what it pays in to be used for road purposes. The money is apportioned to the various counties by the State Highway Commission. The fund being once appropriated by the legislature it is held in the state treasury subject only to the order of the State Highway Commission.

All of the automobile license fees go into the road fund and will be appropriated from time to time by the legislature, together with such an amount as the legislature shall determine upon from the general fund each session.

The various counties are required to meet the apportionments allotted to them with a like sum of money. If any of the counties fail to provide a sum equal to the amount apportioned to them in a given length of time, it is then reapportioned to those counties that have met the amount of the apportionment with a like amount of means.

Under such an arrangement the practical benefits to be obtained are considered to be:

(1) All the state-aid funds are expended on one general system of roads reaching into every community in the state.

(2) This state-aid system can all be constructed of concrete or brick within 20 years without injuring any citizen in the matter of a tax burden.

(3) The state will never be called on to assist in the construction or maintenance of any other highway, the rest of the roads being left to the township authorities to improve and maintain.

(4) The work once begun, it will ultimately be completed and then there will not be a home in the state further than 4½ miles from a state-aid road.

CONCLUSION.

The information given above is based on data supplied by the engineers of the Illinois Highway Commission. It is only an outline of the organization and of its work, a full account of which in detail would necessitate a volume to accommodate it.

BUILDINGS

Design and Construction Features of the Palmer Memorial Stadium, Princeton, N. J.

(Staff Article.)

The Palmer Memorial Stadium, at Princeton University, Princeton, N. J., which was completed during the latter part of 1914 at a cost of about $300,000, is a reinforced concrete structure with a seating capacity of 41,527 persons. It is similar in general shape and arrangement to the reinforced concrete stadium at Harvard University, although its seating capacity is greater. The exterior of the structure has been developed as a colonnade consisting of a series of large columns surmounted by intervening arches, while the center of the curved end contains two large towers and an archway.

In plan the Princeton stadium is horseshoe-shaped, with two straight parallel sides, each about 454 ft. long, connected at one end by a three-centered curved portion (see Fig. 1). The total length of the structure is about 652 ft., its width, center to center of outside columns, is 520 ft., and its height, to the top of the main entrance towers, is 72 ft. At the lower, or inside, face of the stadium there is a 3-ft. passageway around the entire structure. The clear playing field is about 250 ft. wide by 510 ft. long. The structure is surrounded by a high iron picket fence forming an enclosure into which the spectators are admitted through turnstiles located opposite to the main entrance at the curved end. From this enclosure the people enter the stadium through 26 runways located at uniform distances around the structure. These runways are inclines and extend from the exterior ground level to openings located at about mid-height of the stadium.

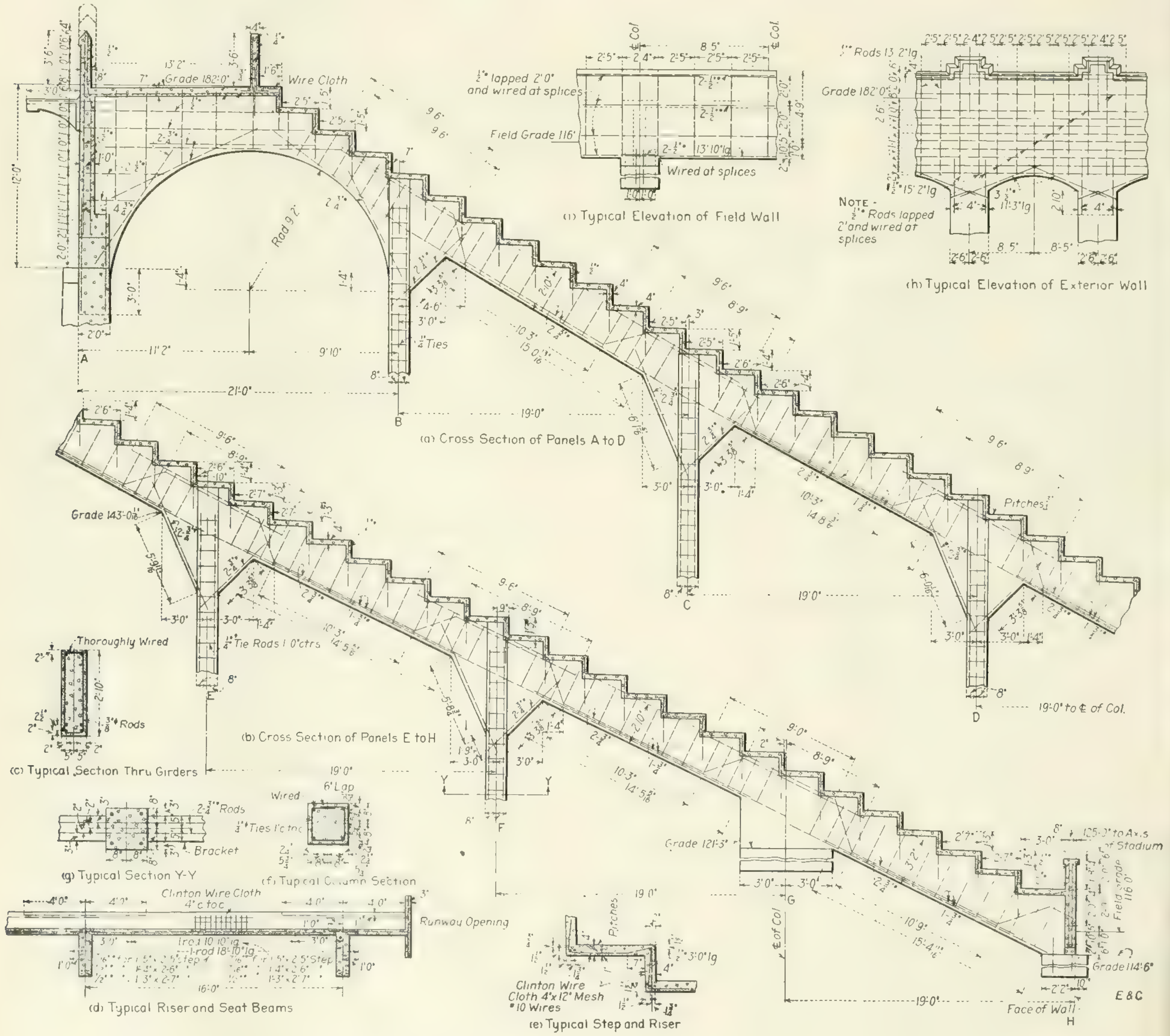
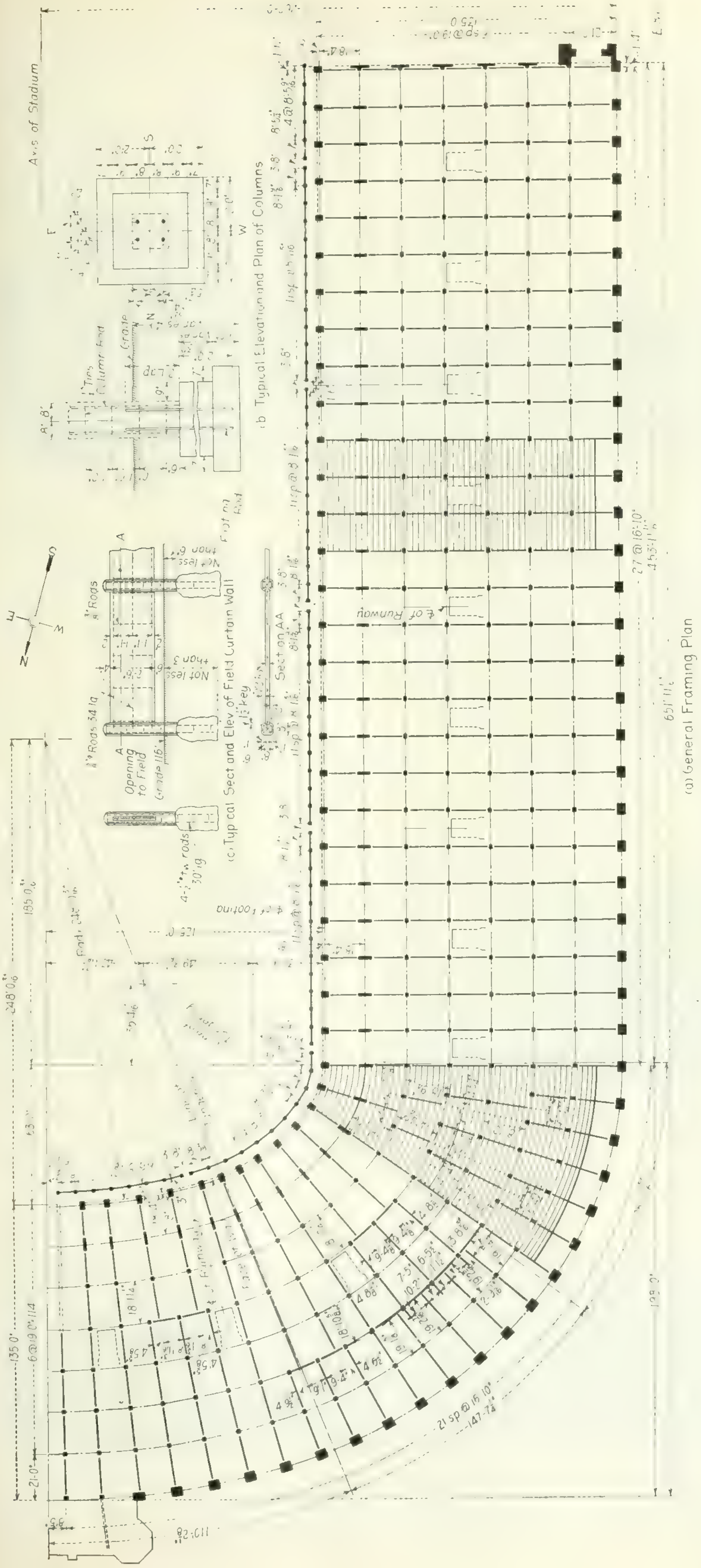

(a) Cross Section of Panels A to D
(b) Cross Section of Panels E to H
(c) Typical Section Thru Girders
(d) Typical Riser and Seat Beams
(e) Typical Step and Riser
(f) Typical Column Section
(g) Typical Section Y-Y
(h) Typical Elevation of Exterior Wall
(i) Typical Elevation of Field Wall
Grade 182'0"
Grade 143'0"
Grade 121'3"
Grade 114'6"
Field Grade 116'
Wire Cloth
Rad 9'2"
Clinton Wire Cloth 4" c to c
Runway Opening
Clinton Wire Cloth 4"x12" Mesh #10 Wires
Thoroughly Wired
Face of Wall
19'0" to ℄ of Col.
125-3" to Axis of Stadium
E&C

Fig. 2. Cross Section of Palmer Memorial Stadium Showing Typical Girder, Floor and Column Details.



(a) General Framing Plan

(b) Typical Elevation and Plan of Columns

(c) Typical Sect and Elev of Field Curtain Wall

Fig. 1. Framing Plan of West Half of Palmer Memorial Stadium, Princeton, N. J., and Some Typical Details.

DESIGN FEATURES.

The structure consists essentially of a sloping deck containing 48 tiers of seats, this deck being supported on girders and columns, the latter having spread footings. Throughout the straight portion of the stadium the columns are spaced 16 ft. 10 ins. on centers longitudinally and 19 ft. 0 in. on centers transversely, with the exception of those in the upper bent. In the curved end section the same transverse spacing of columns is maintained. The same longitudinal spacing is also maintained for the rear tier of columns in this section, but for each succeeding tier the spacing varies, the columns being spaced along radial lines, as shown in Fig. 1.

Columns.—The typical intermediate columns in rows *B*, *C*, *D*, *E* and *F* (see Fig. 1) are 16 ins. square, reinforced with four ¾-in. round longitudinal rods and with ¼-in. wire ties spaced 12 ins. on centers. The line of columns at the outside, or upper, edge of the stadium has a section 4x5 ft., to give the desired architectural effect, while the two lower lines of columns are essentially piers. At the tops of the columns heavy brackets give the desired stiffness and provide for bending stresses. The footings for the typical columns are 4 ft. square at the base and 1 ft. thick; above the footings there is a pedestal 2 ft. 10 ins. square in plan and of variable height (1 ft. 3 ins. minimum).

Figure 1 (b) shows a typical elevation and plan of the column footings, and Figs. 2 (f) and (g), which are cross sections of a typical column, show reinforcing details.

Deck.—As has been noted, the reinforced concrete deck contains 48 tiers of seats. The upper tier, at the elevation of the top landing and just inside of the railing, has a width of 1 ft. 6 ins. and a rise of 17 ins.; the next twelve tiers have a width of 2 ft. 5 ins. and a rise of 17 ins.; the succeeding fifteen tiers have a width of 2 ft. 6 ins. and a rise of 16 ins.; while for the lower twenty tiers the width is 2 ft. 7 ins. and the rise 15 ins. It is thus seen that the deck is slightly concave; the changes in rise occurring at column lines.

Figure 2 shows typical details of the reinforced concrete deck, girders and columns. As shown in Figs. 2 (a) and (b) each transverse line of columns supports an inclined girder, the top of which is cast with notches corresponding to the various tiers of seats. These girders have a uniform width of 10 ins. and a depth of 2 ft. 10 ins., from bottom of beam to bottom of riser, (except in the upper and lower panels). Figures 2 (a), (b) and (c) show the details of these girders and indicate the type of reinforcement used. As shown in Fig. 2 (a) the upper panel is cast in the form of an arch having a clear span 18 ft. 4 ins. These arches carry four tiers of seats and a 10-ft. walk, which serves as a promenade around the entire structure. The promenade is enclosed by the reinforced concrete back wall and by an interior railing, as shown in Fig. 2 (a).

Each riser beam is 4 ins. thick, and is reinforced both top and bottom with one ¾-in. square rod. The riser beams are anchored to the seat beams and to the girders with ½-in. square dowels 3 ft. long. The seat beams also have a thickness of 4 ins., these beams being poured monolithic with the risers. Both the risers and the seat beams are reinforced with "Clinton" electrically welded wire cloth having a 4x12-in. mesh and containing No. 10 gage wires in each direction. The wire mesh was sent to the work in long rolls, and was laid in continuous sheets extending from the top to the bottom of the stadium. As shown in Fig. 2 (e), the wire mesh is located 1 in. from the lower surface of the seat beam, being curved under the lower reinforcing rod and over the upper one; the wires which have a 4-in. spacing thus extend up the slope in a direction parallel to the supporting girders, and in this way serve as the principal reinforcement for the seat beams.

Runways.—In the straight portions of the stadium the 10-ft. runways are placed in every third panel; while in the curved portion there are eight runways, spaced at irregular intervals. These runways consist of inclined slabs, sloping up from the concourse, which is directly inside of the exterior colonnade, to the interior of the stadium and terminating in openings which are in line with the tops of columns *E* (see Fig. 1). As the elevation of the concourse varies, while that of all runway openings at columns *E* is constant, it was necessary to vary the slope of these runways from 1⅛ in. to 2¼ ins. per foot. For several of the runways, steps were provided in the space between columns *B* and *C* to keep the slopes within the above limits. The runway slabs are carried on transverse beams placed between the adjacent columns.

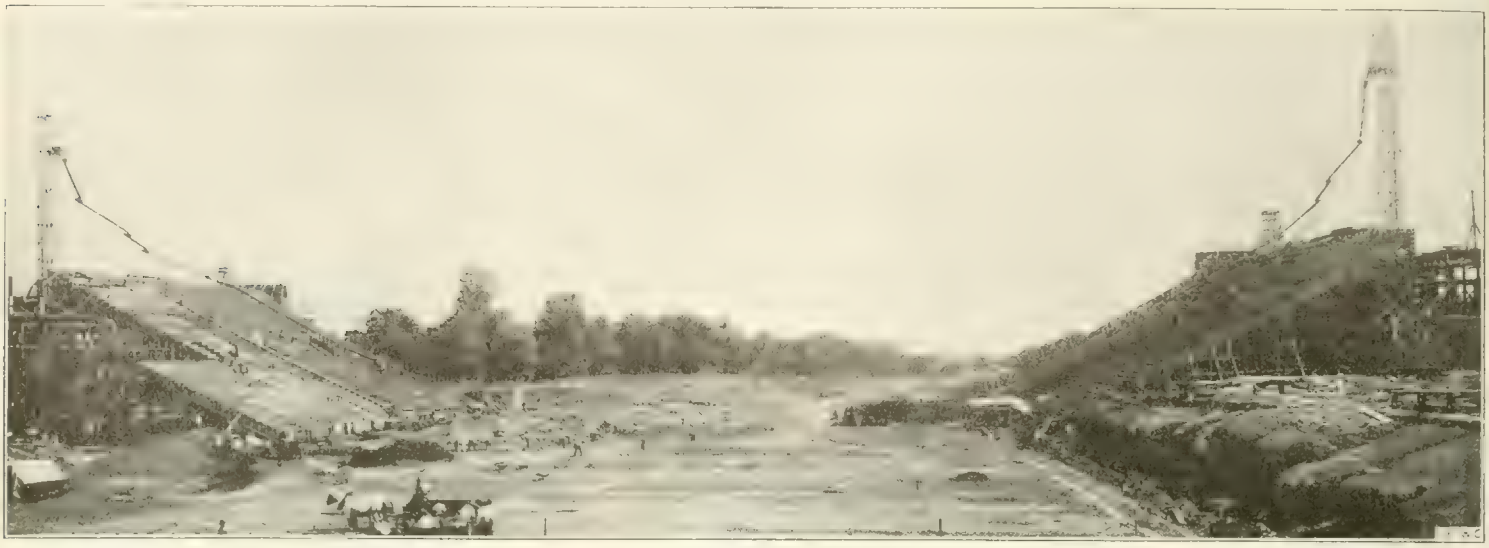


Fig. 4. View Showing Concreting of Ends of Palmer Memorial Stadium, Princeton, N. J. Note Duplication of Concreting Plant—Playing Field Is Being Brought to Grade.

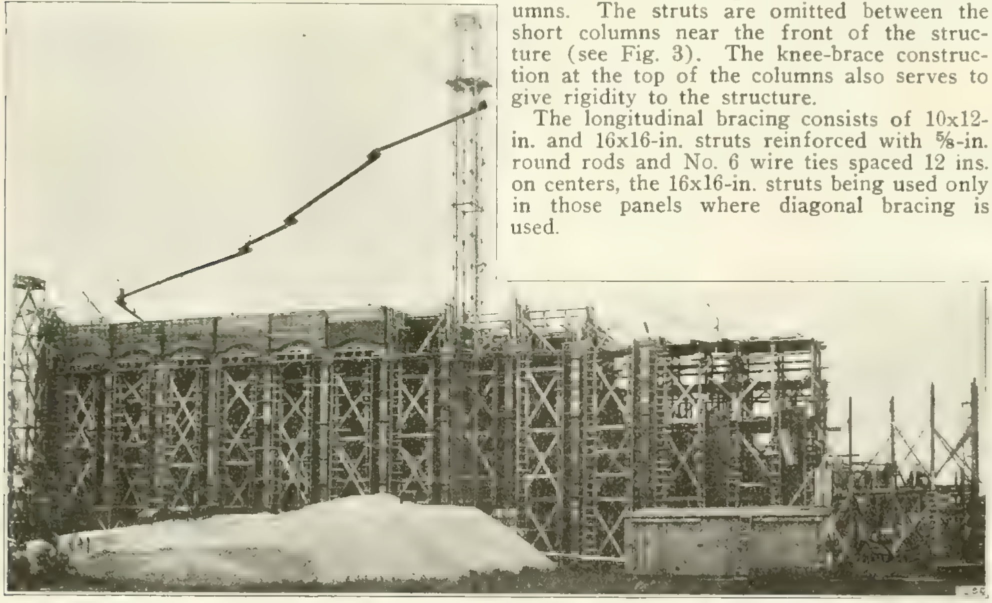


Fig. 5. Rear View at One End of Stadium Showing Location of 160-ft. Steel Tower—Note Location of Material Pile and Cement Shed.

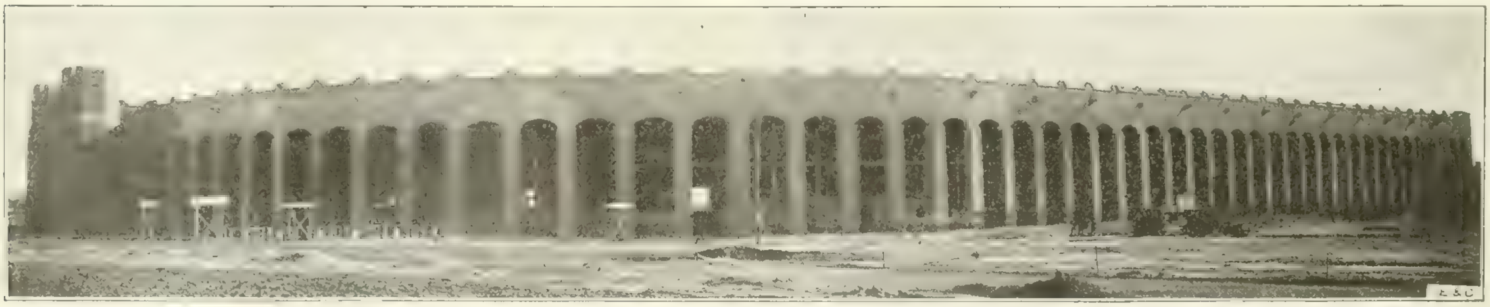


Fig. 6. Rear View of Wing of Palmer Memorial Stadium Showing Architectural Treatment—Note Ornamental Towers at Main Entrance.

Figure 3 is a typical section at a runway. At the location where this section was taken no steps were required in the runway.

Bracing Between Columns.—The transverse bracing between columns consists of 12x14-in. struts reinforced with four ⅝-in. round rods, these rods being anchored into the columns. The struts are omitted between the short columns near the front of the structure (see Fig. 3). The knee-brace construction at the top of the columns also serves to give rigidity to the structure.

The longitudinal bracing consists of 10x12-in. and 16x16-in. struts reinforced with ⅝-in. round rods and No. 6 wire ties spaced 12 ins. on centers, the 16x16-in. struts being used only in those panels where diagonal bracing is used.

Back and Field Walls and Railing.—Figure 2 (h) shows a panel of the back-wall, and Fig. 2 (a) shows a cross section of it. This wall has a thickness of 8 ins. and extends 3 ft. 9 ins. above the rear promenade. At column centers the height and thickness of this wall are increased to form pilasters.

The reinforced concrete railing along the inner face of the promenade has a height of 3 ft. 6 ins. and a thickness of 4 ins. A cross section of this wall is shown in Fig. 2 (a).

The field-wall extends 4 ft. 9 ins. above the grade of the playing field and 2 ft. above the stadium walk which extends along it. This wall has a thickness of 8 ins. and is reinforced as shown in Fig. 2 (i).

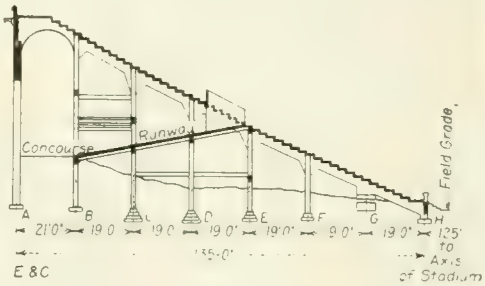


Fig. 3. Typical Cross Section of Stadium Showing Position of Runway.

CONSTRUCTION FEATURES.

In leveling the field steam shovels and carts were used, about 40,000 cu. yds. of earth being moved in this way. After the area was excavated to the proper level, the playing field was covered with a 30-in. fill consisting of successive layers of broken stone and cinders, with open-joint drain tiles along the bottom. This base was then surfaced with new turf. Figure 4 is a view of the site showing the work of bringing the field to grade in progress. The view also shows concreting work in progress at the open ends of the stadium.

The concreting work was carried on by two separate gangs, each having an organization complete in itself. The work was started at the open end of the stand, one gang operating on each wing. The keen competition which developed between the two gangs resulted in exceedingly rapid progress.

The concrete was hoisted in 160-ft. steel towers and was chuted into place through long flexible chutes suspended from a cableway. These towers were placed back of the stand, being so located that it was possible to pour about two-thirds of one straight side in these positions. They were then moved to points near the curved end, and the structure completed. Figure 5 is a view of one of the steel towers and its spouting equipment in place for pouring the straight portion of a side of the stadium. The view also shows the form work for the rear portion.

The hoisting bucket in each tower was charged from a ¾-cu. yd. motor-driven mixer, the materials being delivered to the mixer in wheelbarrows, from storage piles located near by (see Fig. 5). With the use of a double set of three-bay forms for each wing the concreting operations were made continuous, the first set of forms being moved and reerected while the concrete in the second set was being poured.

The first concrete was poured on June 29, 1914, and the two wings were joined together on Oct. 3, 1914, the best day's run being 227 cu. yds. of concrete poured by one gang in 10 hours. The entire structure was completed in 178 working days. Figure 6 is a rear view of one-half of the completed structure showing the architectural treatment.

There were used in the construction of the stadium 78,000 bags of cement, 6,000 cu. yds. of sand, 11,000 cu. yds. of stone, 450 tons of reinforcing rods, 375,000 sq. ft. of "Clinton" wire mesh, and 1,670,000 ft. B. M. of lumber.

PERSONNEL.

The architectural design was executed by H. J. Hardenbergh, New York, and the structural design by Purdy & Henderson, New York. The George A. Fuller Construction Co., of New York, built the structure.

Data Requested on the Bearing Value of Soils.

The American Society of Civil Engineers has appointed a special committee, the object of which is "To Codify Present Practice on the Bearing Value of Soils for Foundations, and to Report upon the Physical Characteristics of Soils in Their Relations to Engineering Structures." This committee, which consists of Robert A. Cummins, chairman; W. J. Douglas, Edwin Duryea, Jr., Frank M. Kerr, J. C. Meem, E. C. Shankland, and Samuel Tobias Wagner, has issued a circular requesting co-operation in its work, and asking for specific data on soils and on their bearing power. The accompanying list of questions is submitted, and it is hoped that anyone possessing data on this important subject will send in such data to the chairman of the committee, whose address is 221 Fourth Ave., Pittsburgh, Pa. The questions are numbered serially, and in submitting data it is requested that the numbers be referred to (without repeating the questions). The committee is desirous of securing as full replies as possible, especially as to practice and question No. 53. Samples of soils (in air and water-tight containers) are also desired to assist in the classification of soils. The questions are submitted under three headings: Questions 1-15 refer to tests for the bearing value of soils; questions 16-47 refer to data as to the bearing value of soils, from existing structures; and questions 48-59 to local practice as to the bearing value of soils.

TESTS FOR BEARING VALUE OF SOILS.

1. Please give name and address (if possible) of party furnishing information regarding this test.

2. Who conducted the test of the soil?

3. When was the test made?

4. Where was the test made, and what was its particular purpose?

5. State proximity to any body of water.

6. Give a short description of the character of the structure for which this test was made.

7. Give a vertical section of the soil below the ground line, and thickness of next stratum of soil below tested foundations.

8. Was the soil dry, moist, or wet? What was its color when air dried, and when in natural state?

9. Describe the physical character of the soil, and whether porous or impervious, loose or compact, laminated or homogeneous, and such other characteristics as may occur to you.

10. Describe method of testing in detail.

11. Was static or dynamic loading used in making the test?

12. Please state the rate of settlement under test, and the corresponding load.

13. Were any observations made of the influence of the test load on adjacent soil? If so, describe as fully as possible.

14. What was the actual frictional or peripheral resistance, if this was determined?

15. What were the conclusions from the test as to ultimate and safe loads for the bearing value of soil? Give frictional resistance of the sides or any other results possessing useful information.

DATA AS TO THE BEARING VALUE OF SOILS FROM EXISTING STRUCTURES.

16. Please give name and address of party furnishing information.

17. Who designed the structure?

18. Who built the structure?

19. Who made the observations and compiled the data?

20. When was the structure built? Give its history briefly.

21. Give date when observations were made.

22. Give location of structure and its purpose.

23. State proximity to any body of water and influence of vibrations.

24. Describe class of structure. Whether temporary or permanent?

25. Can you furnish drawings or sketches giving full dimensions of the structure? If not, give the following:

26. Cross-section of the structure.

27. Area of base.

28. Peripheral area of the sides in contact with the soil.

29. Depth below ground line of bed of river.

30. Depth below high and low water.

31. Were the sides of the structure in contact with the original undisturbed soil or filled ground?

32. Were the sides of the structure vertical or inclined? If the latter, how much?

33. Describe method used in building the foundation of the structure.

34. What kinds of materials were used in the structure?

35. Give vertical sections of the soil below ground line and thickness of next stratum of soil below the foundation.

36. Was the structure subjected to static or dynamic loads?

37. What was the assumed live or moving load?

38. Give maximum live or moving load per square foot on the base.

39. Give maximum dead load per square foot on the base. (Neglecting atmospheric pressure, buoyant effect, and friction.)

40. In answer to Questions 38 and 39, what consideration, if any, was given to buoyancy of water or peripheral friction?

41. Was the moving or live load assumed or actual?

42. Was the pressure uniformly distributed? If not, describe the distribution.

43. What was the relation between the total proportion of the loads borne by the bearing area and the frictional area?

44. Please state the rate and total settlement of the foundations.

45. How long was the settlement continued before reaching a state of rest? Give time records, if possible.

46. What evidences of settlement exist? If any, describe condition, nature, size, and extent of cracks. (All information furnished will be treated as confidential, if the paper is so marked; especially is information solicited regarding failures or partial failures, settlements or cracks.)

47. Does the structure indicate that the assumed safe loading per square foot was too high? If so, state your conclusion and give any additional information as to ultimate and safe load for the bearing value of soil, etc.

LOCAL PRACTICE AS TO THE BEARING VALUE OF SOILS.

48. Give name, address, and title of party furnishing the following information:

49. How long has the present practice in your locality been followed?

50. Give the locality to which the practice refers.

51. What distinction, if any, is made in allowable pressures for different classes of structures, or for dynamic or static loading?

52. Are there any peculiarities in the foundation soils in your district? If so, please describe.

53. Assuming a given bearing value for gravel or other uniform soil at the surface of the ground, what, if any, increase is made in this value as the depth increases?

54. Is it assumed that the entire live load will reach the bearing area? If not, what assumptions are made?

55. What are the allowable bearing pressures for different soils, as given in the local building code or other laws?

56. When were the building laws enacted?

57. If there are no laws, what is your local practice?

58. Please give any additional information, not covered by the foregoing, that would be of use to the committee.

59. If possible, give information as to permissible settlement for structures of various types resting on compressible soils.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

A New Machine for Making and Sharpening Rock Drill Bits.

(Contributed.)

The accompanying photographs illustrate the new drill making and sharpening machine, which is being introduced by the Sullivan Machinery Co., and which is manufactured at its Chicago works. This new machine has been designed on the lines of the Imperial Sharpener, for a number of years built by Mr. T. H. Proske, of Denver, who has granted the Sullivan Machinery Co. exclusive manufacturing and sales privileges. The Sullivan machine, however, bears only a family resemblance to its Denver prototype. The new machine is larger, more heavily built, more powerful. All its working parts are much larger and more substantial and with more generous bearing surfaces. The new machine is about double the weight of the old.

The Sullivan sharpener consists of two members, one horizontal, the other vertical, both mounted on a substantial box shaped frame. These members consist of Sullivan 2⅝-in. rock drill cylinders, with standard "Liteweight" or differential air thrown valve motion. The horizontal drill or hammer is used for upsetting the steel into the shape of the bit or shank, by means of suitable steel dollies, loosely mounted on the end of the shank or piston rod. In this hammer, the piston is a floating one, as in a hammer drill, and delivers its blows on the upset anvil block-head of the projecting piston rod.

The vertical member furnishes power for shaping the wings of the bit, etc., and for drawing out and finishing the corners. This work is done by steel dies, one acting as an anvil, and the other, attached to the piston rod above, as a swage or hammer. The vertical hammer is operated by a foot lever, which is ordinarily held up by a coil spring. This spring also serves to hold up a release pin, running through the lower valve bushing, and in turn holding the valve away from the lower seat, so that the piston is always held at the upper or rear end of the cylinder, by live air, when the hammer is idle. When the foot treadle is depressed, the pin drops, allowing the valve to seat, and the hammer to start.

The steel is held in position while being upset by steel gripping dies set in a heavy vise, which is operated by air power. This vise simply grips the steel, the forming being done altogether by the upsetting dolly and hammer. The vise consists of a heavy steel yoke, through each end of which runs a massive steel post or column. These posts are joined at the foot by a second yoke, into which fits the lower end of a substantial block or toggle link. The upper end of this link is pinned to a cross head block, running horizontally in guides in the frame. The cross head and link are actuated by a piston rod connected to a piston 12 ins. in diameter, running in an air cylinder at the rear end of the frame. (See sectional view.) When air is admitted behind this piston, the cross head is forced forward and the link forward and down, carrying the yoke with it, and closing the vise with tremendous force. Air at 100 lbs. pressure is recommended as motive power. The power provided by the air is multiplied many times just at the end of the ravel, when the cross head and link form a knuckle like lever. The pull thus exerted is estimated at not less than 100,000 lbs. per square inch.

One of the steel gripping dies is pinned into a socket in the top yoke of the vise, while the other fits a similar socket in the frame or base below.

The vise and the upsetting hammer are operated by one hand lever, the valve motion being so controlled that as the handle is depressed, the vise is closed before air is admitted to the upsetting cylinder. Further depression starts the hammer reciprocating. The vise valve rod contains a link and coil spring which holds the valve in position to keep the inlet port to the upsetting cylinder closed when the machine is idle. In stopping the machine, the lever is raised, first shutting off air from the upsetting hammer and, when this has stopped, opening the vise.

Air enters the machine at the rear by standard pipe connections. No hose is employed, except a short length for cleaning purposes. One arm of the inlet pipe enters the valve chest of the vise or clamping cylinder, while a second supplies the vertical hammer. An outside connection leads air from the side of the clamping cylinder chest to the valve chest of the upsetting hammer.

The exhaust from this cylinder is led directly into the frame. Exhaust air is led from the clamp valve chest, by a pipe and cored passages, to the vise rod guides. Whenever the vise is opened, this exhaust air escapes, effectively blowing dirt and scale out of the dies and clamp. A similar arrangement is used in the vertical member to keep the dies clean.

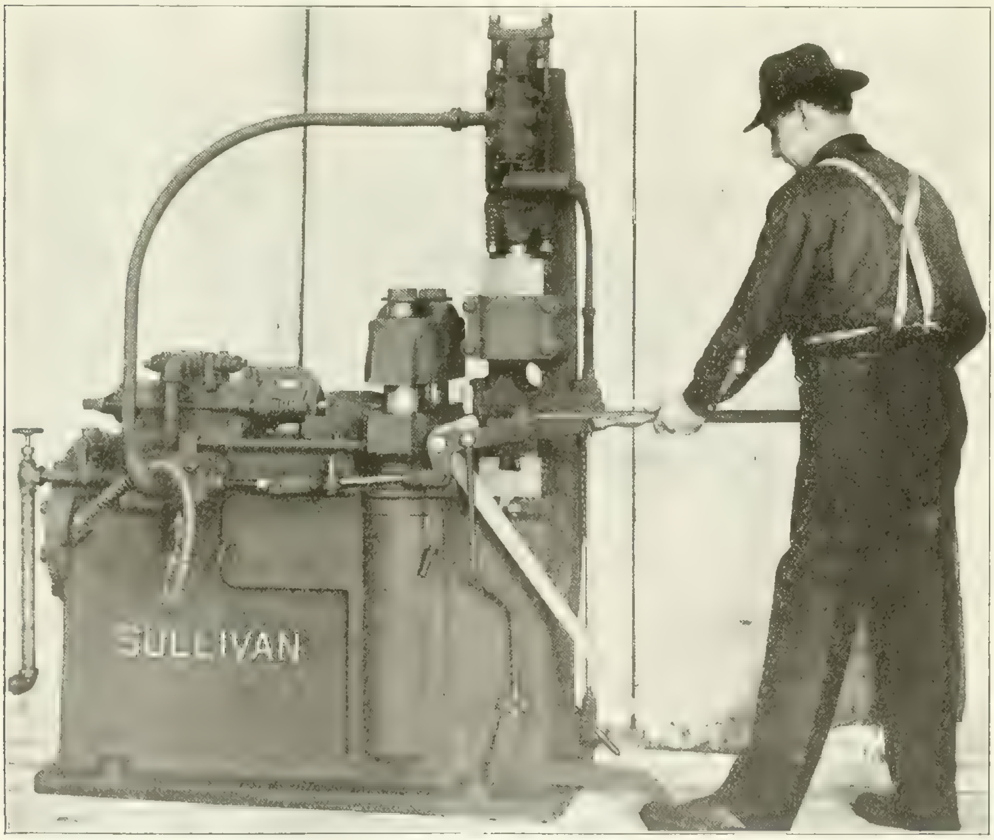


Fig. 1. Machine for Making and Sharpening Drills.

As stated above, the operator cannot start the upsetting hammer until the clamp, or vise, is in operation. A further protection consists in a pin which rises through the frame when the vise opens, and drops out of sight when the vise is closed fully. A stop is clamped to the valve reach-rod in position to strike the pin and prevent the action of the hammer cylinder, unless the pin is down completely (i. e. unless the vise is closed).

As a positive guard against operating the vertical hammer while the horizontal one is at work, (a) A loose pin is provided, which may be inserted in holes in the guide and guide weight. (b) Figure W1377 shows a rod attached to the handle or lever operating the vise and upsetting hammer, in such a way that its lower end passes through a stop and in front of an arm provided for the purpose on the foot treadle. If the operator should inadvertently step on this treadle while using the horizontal members, this rod and stop render the treadle inactive. (c) A hinged distance piece fitting over the piston rod of the upsetting hammer, prevents the dolly from following the rod back, away from its position, with consequent danger of breakage.

The operating levers are so placed that the smith uses them conveniently with his left hand and left foot, bringing his right hand at a proper point to handle the steel readily. The absence of a long carriage and tail block to hold the steel in position is a saving in floor space and in labor.

In sharpening new steel, the operator clamps the stock in the vise, upsets it slightly with a few blows from the horizontal hammer, then releases it, and begins to draw out the wings under the vertical hammer. This is so arranged that slow, heavy blows, or light rapid ones can be struck. The steel is thus alternated until sufficiently upset and proper gauge and angle given the cutting edges, when the corners are finished by the vertical dies. It is customary to make complete perfect bits from blank, raw bar steel in one heat in the Sullivan sharpener, and while daily or monthly records are dependent on other things besides the machine, a blacksmith can finish new bits, with a little practice, in 50 seconds to one minute each.

Bits of any form and gage may be made on this machine, on steel of any shape, solid or hollow; and shanks also may be formed to order, providing proper dollies and dies are furnished. The collared shanks on hollow steel for rotators or hand feed hammer drills, and the lugged shanks for mounted water jet hammer drills are two forms that are made economically and rapidly on this machine.

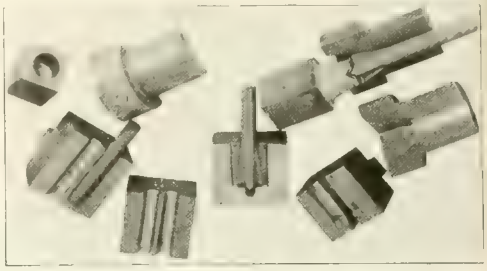


Fig. 2. Swages and Dies for Sharpening Drills.

The sharpener occupies a floor space of 5x 2½ ft. and is 6 ft. high. It weighs 4,000 lbs. Lubrication is by means of a rock drill type oiler placed in the air inlet pipe. The cross head, guides, etc., are oiled through a protected oil hole in the top of the frame. The hammer cylinders are provided with the standard Sullivan automatic differential pressure oil chambers, cast in the cylinder.

It is an accepted fact that no improvement on or even satisfactory substitute has been found for the making and sharpening of drill bits by the hand work of a skillful blacksmith, in so far as the character of the steel is concerned. The drill sharpening machine makes bits faster and more uniformly, as to shape and gage, than can the most expert hand smith. But the qualities given the steel by the constant hammering of the bit on the anvil are not secured by mechanical means such as squeezing or molding, sometimes used as a substitute. Practical drillmen know that the footage drilled by a new bit is not as great as it will be after the bit has been under the blacksmith's hammer a few times. In other words, the hammering refines, toughens and aligns the structure of the steel in the direction that gives greatest resistance to wear and shock. This is the effect secured by the Sullivan sharpener, in which all work, from first to last, is done by hammering, so that to the uniformity of gage and perfection of shape attained in other sharpeners as well, are added the qualities of increased durability, toughness and strength, which means that bits made in the Sullivan sharpener will cut faster, last longer and cost less for wear and breakage than bits sharpened by other means.

Another element in the efficiency of the "all-hammer" sharpener is that hammer sharpened bits lose heat less rapidly than steel that is squeezed or molded into shape. This is an important time factor, when many bits are to be made in a day.

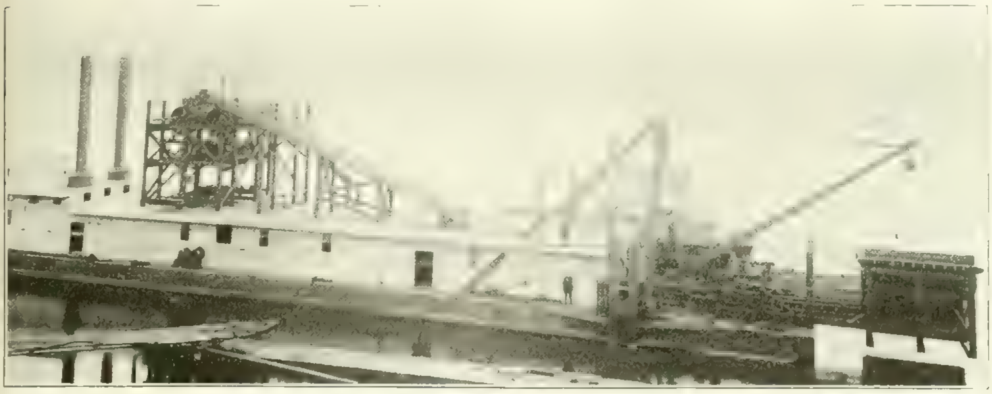
A Notable Floating Sand and Gravel Plant.

(Contributed.)

The largest floating sand and gravel plant in the country has recently been put into commission. It is owned by the E. T. Slider Co. of New Albany, Ind. The plant has a capacity of 3,000 yards per day of ten hours. The equipment is mounted on a dredge boat 225 ft. long having a beam of 36 ft. and a depth of 6½ ft. The boat draws 27 ins. of water running light and 32 ins. when coaled and loaded for service.

On the forward end of the boat is mounted an automatic swinging A-frame derrick with a 50 ft. boom. A 3-yard Hayward clam shell, manganese fitted, is operated by the derrick which delivers the material into a dewatering hopper which overhangs the bow of the boat.

This hopper is 14 ft. wide and 19 ft. long and is constructed to drain off the water which is discharged by the bucket and delivers only the material onto the conveyor belt. A trap gate is also provided at the bottom of the hopper which automatically closes when there is a small amount of material in the hopper. This seals the flow of water through the gate until a sufficient quantity of material gives sufficient weight and pressure to open the gate. As the bottom of the hopper is always filled with material the water at the top of the hopper is not allowed to discharge through the gate but flows out through louvers near top of hopper provided for that purpose. This construction overcomes difficulties which have always been exceedingly troublesome.



Floating Sand and Gravel Plant.

The clam shell is operated by a double 13x 18-in. Hayward excavator engine. This engine was especially designed for this service and has a long drum countershaft extending the full width of the boat, which locates the drums at each side of the boat and gives a direct load to the bucket operating chains from the chain idlers on the A-frame. These chains are 1 in. dredge chains. The operating levers for this engine are banked in the operator's cage in the fork of the A-frame where the operator can observe everything.

The material from the loading hopper is delivered onto a 36-in. troughed belt conveyor which goes horizontally rearward underneath the derrick, then upward to a sufficient elevation to deliver into the washing screens. The screens consist of two sets of triple jacketed hook-bolt type washing screens for gravel and two single jacketed hook bolt screens for separating the fine gravel from the sand. The single jacketed screens are mounted directly beneath the triple jacketed screens.

The loading belt conveyors running athwart ship deliver the washed material to different scows, alongside the dredge. The spouting system from the screens is novel in that it permits of several combinations of material to be loaded, together or separately as the market requires. The sand is loaded on sand scows on the opposite of the dredge.

A double 10x14-in. engine drives the screens and belt conveyors by means of a rope drive to a centralized jack shaft and the screens are driven from the jack shaft by heavy all-steel bar link roller chains 6-in. pitch.

The over-size stone is taken out by the inner jacket of the triple jacked screen and is spouted into a 36-in. Symons disc crusher. The crusher has an independent drive run by a single 10x14-in. engine. If the dredge is digging in a sand bar the crushing plant is not operated.

The fresh water is supplied by a 7-in. American Well Works centrifugal pump operated by another 10x14-in. single engine. The speed of this engine can be varied in order to meet the washing requirements of the screens.

A pair of 7x10-in. direct connected engines are geared to a long shaft athwart the boat for operating friction drums for moving barges. This enables the operators to load scows with little loss of time to the main dredge.

A complete electric lighting system is installed in the dredge operated by a single 7x 10-in. engine. The dredge is provided with four 24 x 24-in. x 40-ft. spuds with heavy steel shoes. These spuds have four sets of 6x6-in. direct connected spud engines geared to rocks on the spuds. The boiler equipment consists of two 66-in. x 16-ft. 100-H. P. boilers built to operate at 100 lbs. pressure and so arranged that each is a separate independent unit. In front of each boiler is an ash well through the bottom of the boat. The boat has complete accommodations for crew such as kitchen, dining room and bunk-rooms. The coal is unloaded from barges by the clam shell and spouted from the conveyor direct to coal bunkers in front of the boilers.

The plant was planned by Mr. Slider, the owner, and designed and equipped by The Raymond W. Dull Co. of Chicago, Ill.

A Portable Circle Swing Derrick.

Figure 1 illustrates the new "Sasgen" Steel Champion portable circle swing builder's derrick. The boom of this derrick can be removed by loosening a single nut and raising the boom about 2 ins. The bottom sills and mast fold together, the derrick thus being in two parts to facilitate shipment. The derrick has a height of 7½ ft. and the boom extends 5 ft. It weighs 200 lbs. and has a capacity of 1,000 lbs.

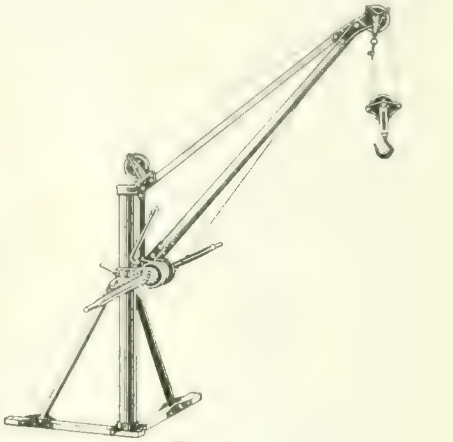


Fig. 1.

Figure 2 shows the latest improvement in "Sasgen" single shaft geared winches. This winch can be operated direct or in gear, without changing the motion of the crank. It can be changed from direct to compound by operating a lever. The winch has a capacity of 3,000 lbs., three lines, the drum being 4x8 ins.

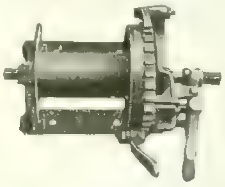


Fig. 2.

The derrick and winch shown are manufactured by the Sasgen Brothers Derrick Co., North Racine Ave., Chicago.

SEWERAGE AND SANITATION

Design and Operation of Small Municipal Refuse Incinerator at International Falls, Minn.

(Staff Abstract.)

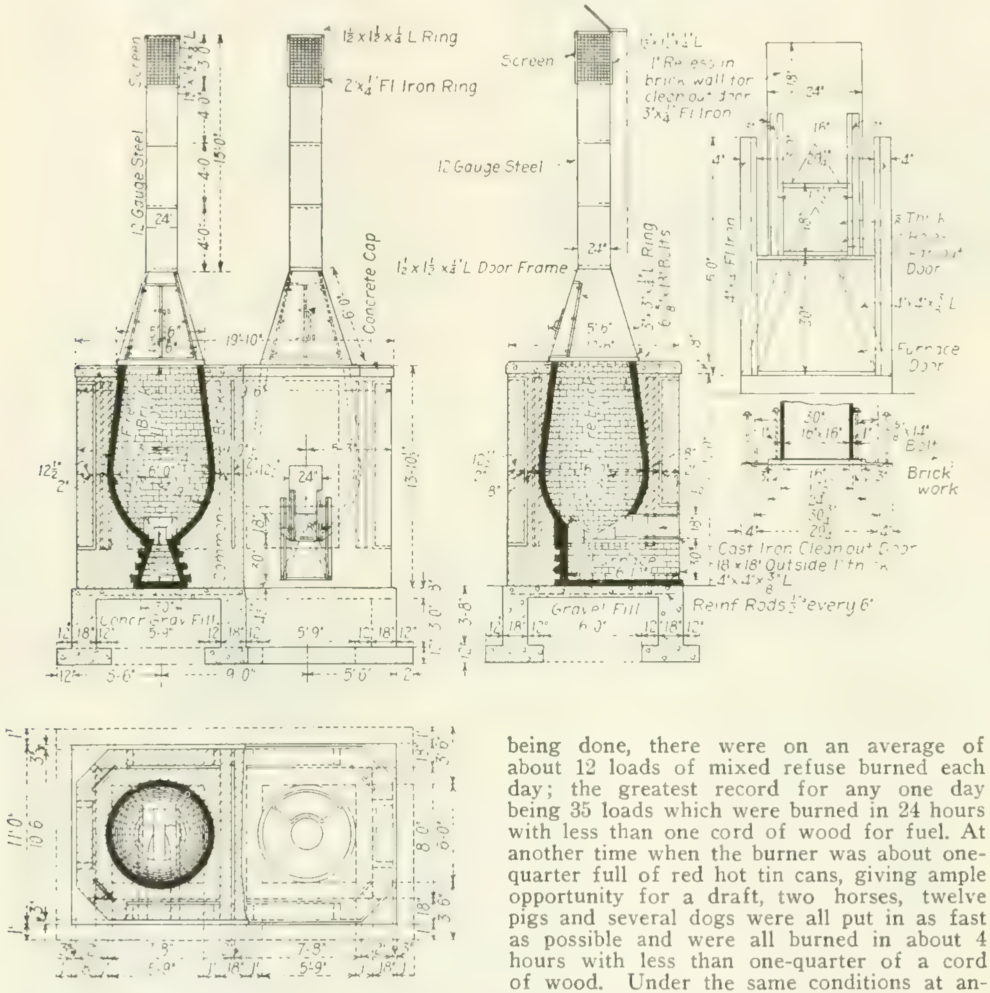
The disposal of municipal refuse in small cities and villages is usually carried on in a haphazard method which is both uneconomical and unsanitary. The village is proportionately less able to make a thorough study of conditions than is the big city. In the village a systematic plan of refuse sorting is out of the question, from an economic standpoint, for the recoverable quantity of high value is not great enough to be valuable for fuel or other purposes. The method selected should be, therefore, above all sanitary, and should permit of the disposal of mixed refuse without the necessity of sorting and at the mimimum expense. Refuse collection and hauling must be handled according to the local conditions. The present article describes the design and operation of the twin refuse incinerators at International Falls, Minn., where mixed refuse has been disposed of by burning in a sanitary and economical manner. The population served is 4,000. The same method could doubtless be employed with equal success in other small cities and villages.

OLD METHOD OF DISPOSAL.

Until about two years ago it was the custom in International Falls, during the summer months, to gather up such refuse as could easily be collected and to dispose of this refuse by dumping it into the Rainy River at a point about two miles from town. The refuse was hauled to the river bank in wagons and there dumped. In many cases the refuse was left on the shore where it created a nuisance. Objection by nearby property owners to this procedure led to a consideration, by the City Council, of better methods. Several sites were considered for the disposal of all classes of refuse, including dead animals, by burying. Again those living near these sites objected and at length the council accepted the proposition of one of their number, Mr. G. A. Oveson, to build an incinerator which he thought would dispose of all the city's mixed refuse.

The accompanying figure shows the construction and dimensions of the incinerator at International Falls. The materials employed are ordinary brick, fire brick and sheet steel.

In type it is vertical, the receiving chamber being directly above the firebox so that the refuse comes in direct contact with the fire. Owing to the peculiar egg-shape of the chamber, which is narrower at the top than at the center, all garbage has a tendency to fall towards the center without an opportunity of clinging to the walls. This gives ample opportunity for a draft around the outer edge of the mass when the burner is full. In size it is smaller than would at first seem reasonable, the inside measurements being as follows: height from top of firebox to top of brick work, 11 ft.; inside width of chamber at widest part is 6 ft., sloping to form an oval shape to a final width at top of 4½ ft. On top is placed a dome and smoke stack. It is 15 ft. from the top of the dome to the top of the hood on the smoke stack. The dome is 6 ft. high and contains two doors which make an opening 4 ft. 8 ins. by 4 ft. 8 ins. into which all refuse is dumped. The fire box is built in a triangular shape, 30 ins. wide at bottom, 30 ins. high with an opening at the top into the receiving chamber 9 ins. by 3 ft. 2 ins. This construction obviates the necessity of grates which would be almost out of the question with a fire both above and below, and which would soon become clogged with molten glass and tin cans. At the same time this construction affords a place for ashes. clinkers, etc., to fall through so that they can easily be taken out through the fire box. For all residue which can not be taken out in this way there is an opening directly above the firebox, 18 ins. square, through which the remaining material can be taken, except in the case when a large amount of glass is thrown in. Large amounts of molten glass have a tendency to so cement the tin cans together that it is sometimes necessary to break up this mass and take it out through the opening at the top. All of the residue taken out by any of the above methods must of course be hauled away and used for filling or for roads. The firebox and chamber are lined with firebrick which, in case of partial destruction, can easily be replaced with new brick. It now appears that this expense will be very small, the maintainance and depreciation charges depending entirely upon the character of workmanship and quality of material used.



Design Details of Twin Refuse Incinerators, of Oveson Type, at International Falls, Minn.

Owing to the manner in which the refuse is dumped into the receiving chamber it is best to build on a side hill or gulley in order to eliminate the construction of a timber or other approach.

No accurate record of the amount burned during one season has been kept but the city has been able to dispose of all its refuse hauled away from its streets and alleys. If care is taken in hauling and mixing a still higher efficiency could be obtained, but as in all other small cities this is not attempted at International Falls, and everything has to be taken as it comes. Fuel is seldom necessary except for starting the fire in the morning. When a good fire has once been started the garbage burns of itself; the inside of the burner is in fact so hot in the morning, after a continued use of the burner the day before, that the first load, if fairly dry, will catch and burn for the remainder of the day without additional fuel in the fire box.

During three months in the spring of 1914, when most of the cleaning up and hauling was being done, there were on an average of about 12 loads of mixed refuse burned each day; the greatest record for any one day being 35 loads which were burned in 24 hours with less than one cord of wood for fuel. At another time when the burner was about one-quarter full of red hot tin cans, giving ample opportunity for a draft, two horses, twelve pigs and several dogs were all put in as fast as possible and were all burned in about 4 hours with less than one-quarter of a cord of wood. Under the same conditions at another time eight barrels of frozen night soil were burned. These are, of course, the best records made and do not show the constant capacity of the burner. A good example can be taken from the city of Grand Forks, N. D., however, where three units of this type have been recently installed. One unit was built and a careful record was kept for 43 days during which time it consumed 311 loads of refuse, averaging more than four loads of wet and three loads of dry refuse per day. It was found that whenever the chamber was full at night, at the time the caretaker left, all that remained in the morning was a wheelbarrow or two full of tin cans and ashes.

The initial cost of the burner, as now built by Mr. G. A. Oveson, who has recently obtained a patent, is $1,600, including the necessary attached buildings and an enclosure for teams. For this first cost a population of 5,000 can be served, using the burner during the summer months and only occasionally during winter. One caretaker at about $60 per month will easily take care of all work necessary around the burner except in the case of repairs. Twenty-five cords of wood, at $4 per cord, the amount bought during the last year by the city of International Falls, was all the fuel necessary. The burner has not been in use quite long enough to obtain reliable charges for depreciation but $75 to $100 a year will easily cover this, since a new lining of fire brick can be installed for about $100.

The only nuisance arising in connection with the operation of the incinerator here described is due to the foul gases which at times escape through the smoke stack. This nuisance is slight, and occurs only when the fire is started in the morning, and at times when the burner becomes congested and the draft is so poor that considerable time is required before the fire can eat its way through the mass to burn the foul air.

From the experience with this type of incinerator at International Falls it appears that the following essential conditions have been at least partially met: (1) The first cost is within the reach of any small village or city; (2) few repairs are necessary and these are inexpensive; (3) labor charges incurred in operation are low; (4) the method is sanitary.

ACKNOWLEDGMENT.

The foregoing matter is based on a paper before the latest annual meeting of the Minnesota Surveyors and Engineers Society by Mr. E. W. Kibbey, civil engineer, International Falls, Minn.

Ninth and Final Reports of the Royal Commission on Sewage Disposal.

(Staff Abstract.)

On March 31 of this year the ninth and final reports of the Royal Commission on Sewage Disposal of Great Britain were issued. This terminates the work of the commission, which has extended over the past 16 years. The ninth report relates to two topics: the discharge of manufacturing wastes that cannot be removed through sewerage systems, and the disposal of house sewage in rural districts. The final report is a summary of the conclusions reached in all the earlier reports.

A brief review of the first eight reports of the commission is of interest at this time. They are here taken up in order: (1) Tentative conclusions pertaining to effluents from sewage treatment plants and to crude sewage. (2) The purification of house sewage ultimately discharged into streams. (3) The discharge of trade waste waters and the relations between manufacturers and city authorities. (4) Pollution of tidal waters with reference to contamination of shellfish layings. (5) Purification of domestic sewage, dealing mainly with the relative merits of the available methods for disposing of city sewage. The recommendations of this report have been put into effect in many localities. (6) Purification of distillery wastes. (7) Related to nuisance from green sea-weeds in sewage polluted estuaries. (8) Standards applied to sewage discharging into streams and determination of these standards by tests, also provisions for fixing special standards to cover special conditions. The standards aimed to keep expenditure for sewage treatment as low as possible consistent with the prevention of nuisance.

THE NINTH REPORT.

As previously stated, the ninth report deals with the disposal of trade waste waters which, for any reason, cannot be discharged into sewerage systems, and the disposal of house sewage in rural communities. The report gives a detailed account of the trade processes leading to the production of waste liquors requiring treatment, the character of these liquors and processes available for treating them. Examples of good purification plants are given, suitable for the various types of industries. Experimental data on trade waste disposal are given.

The studies indicate that for many wastes, in which the impurities are chiefly in solution, clarification will produce considerable improvement, but they cannot be thoroughly purified by present known processes at consistent cost. Efficient and economical processes of purification are available for some trade wastes, but not for all. The commission recommends that a standard of purity for trade effluents be prescribed to guide manufacturers and city officials as to the extent of their obligation. Trade wastes are so variable in character that a classification was found necessary and a standard of purity was suggested for each. The classification follows:

CLASSIFICATION OF TRADE WASTES.

(A) Waste liquors resulting from (1) coal washing, tin mining, lead and zinc mining, china-clay works, stone quarrying, stone polishing, wood pulp paper works; (2) brewing, malting, distilling, tin plating, galvanizing, wire drawing, shale oil distillation, wool scouring, tanning, leather dressing, fellmongering, dairying.

In the cases listed under (1) adequate reduction of solids in suspension may be regarded as efficient purification. In those under (2) dissolved impurities should be removed.

(B) Waste liquors resulting from (1) bleaching, waste bleaching, paper works (except where paper is made from wood pulp only), cotton dyeing, cotton printing, woolen dyeing, woolen piece and yarn scouring with dye liquor; (2) sulphite cellulose manufacture, gas and coke production.

No practicable means are known for rendering completely harmless the liquors included in Class B, but nearly all of them can be considerably improved by clarification. Briefly, the classification indicates that there are known practicable methods of efficient purification for the wastes listed under A, but not for B, under the present state of knowledge. The suggested standards of purity are as follows:

SUGGESTED STANDARDS OF PURITY.

Coal washing: Effluent should not contain more than 4 parts of suspended solids per 100,000.

Tin, lead and zinc mines, china-clay works stone quarries and stone polishing works: Provisional standard of maximum of 6 parts suspended solids per 100,000.

Wood pulp paper mills: Effluent should contain not more than 4 parts per 100,000.

Breweries and maltings: Not more than 4 parts per 100,000, and not more than 4 parts per 100,000 dissolved in oxygen taken up in five days.

Distilleries: Three parts suspended and 2 parts dissolved oxygen absorption in five days.

Tin plating, galvanizing and wire drawing: Six parts suspended solids per 100,000.

Shale oil installation: Four parts suspended solids and 4 parts dissolved oxygen absorption in five days.

Wool scouring liquor: Pending experiments under way for this type of precipitation, the report advises liquor clarification down to 6 parts of suspended solids per 100,000.

Tanning, leather dressing and fellmongering: Four parts suspended solids and 4 parts dissolved oxygen absorbed in five days.

Dairy waste: Same.

Bleaching: Suspended solids should be reduced to not more than 6 parts per 100,000.

Waste bleaching: Same.

Paper works (other than wood pulp): Same.

Cotton dyeing and cotton printing: Four parts suspended solids for the former and 6 parts for the latter.

Woolen dyeing, piece and yarn scouring: Four parts suspended solids per 100,000.

Sulphite cellulose manufacture: No standard suggested.

Gas liquor: No standard suggested.

Under no circumstances should the two last named liquors be discharged untreated into a water course. Evaporation appears to be the only practicable present method of disposal for these two wastes.

In the case of some trade wastes additional standards may have to be imposed, for example, standards of hardness and caustic akalinity or acidity, or a requirement of neutrality for the effluents from various branches of the cotton, woolen and paper trades and from metal works; a standard for arsenic or other poisonous metal for trades in which these substances are used or mined; and an oil-film standard for the wastes from oil, gas, grease or soap works.

In taking up the disposal of solid and liquid house refuse in rural districts the report advocates public sewerage and sewage disposal in towns. In sparsely settled regions these public improvements are economically impracticable and alternative methods are reviewed.

The Degree of Purification Desirable and Practicable in Sewage Treatment Plants in Iowa.

(Staff Abstract.)

Complete purification of sewage is always desirable, but for economic reasons it is rarely possible to reach this ideal condition. The present discussion has to do with the degree of purification desirable and practicable in sewage treatment plants in Iowa. It may be added that conditions as to sewage disposal in all the agricultural states are substantially the same as in Iowa. In all these states there are many small cities and villages composed largely of retired farmers and their families and trades-people. Probably the great majority of these small municipalities are situated on or near a natural watercourse which goes dry during the hot summer months. This turnishes the controlling condition with reference to sewage disposal in such localities. The extent of litigation instituted by offended property owners and the apparent readiness of the courts to enjoin the discharge of unpurified sewage may later lead to the requirement of a higher standard of purification, but until such requirement is demanded by the courts there is no better standard than that of nonputrescibility.

The natural inquiry to follow is, what is the meaning of nonputrescibility? An English requirement is that the effluent shall not contain per 1,000,000 parts more than 1.4 albuminoid ammonia, 14.3 parts oxygen absorbed in 4 hours at 60° F., 3.6 parts oxygen absorbed in 3 minutes at 60° F., and 43 parts solids in suspension, and that it shall be nonputrescible by incubator test for 3 to 5 days at 75° F.

Another requirement considers the efficiency as unsatisfactory if the albuminoid ammonia ranges between 1.5 parts and 2 p.p.m., and bad if the albuminoid ammonia is over 2 parts, and that the suspended matter shall not exceed 30 p.p.m. To the uninformed person these requirements have little interest.

The following requirement is also made:

> In the United States the usual requirement is that the effluent must be non-putrescible, or must contain only that amount of organic matter which, when the effluent is emptied into a stream, can be oxidized by the oxygen contained in the water at the time of minimum flow. In certain cases, as when the effluent is emptied into a stream in the near neighborhood of a point at which water is taken for domestic use, or is emptied into salt water in the neighborhood of shellfish layings, the effluent must be free from pathogenic bacteria.
>
> The most important points, therefore, to be determined regarding a sewage effluent is whether or not the effluent is putrescible, whether it will improve or deteriorate when emptied into a given water course, and whether or not it contains intestinal or typical sewage bacteria.
>
> As a general statement a sewage effluent is not putrescible when it contains sufficient oxygen, either as free oxygen or combined oxygen in the form of nitrates, for the complete oxidation of the nitrogenous organic matter and the sulphur compounds contained in the effluent, though a complete statement should also take into account the carbohydrates and fats.

These references indicate to the average reader that it is difficult to define the term nonputrescibility. There are several supposedly practical tests for nonputrescibility. When we talk about the number of parts per million of any substance or compound we have stated a test that requires laboratory facilities. The term "notputrescrible," physically defined, means an effluent that is inoffensive to the sense of smell, will not discolor when exposed to temperatures as high as 98° F., and therefore will undergo no offensive putrefactive decomposition.

A very simple practical test of nonputrescibility is to collect a sample of the effluent in a clean glass bottle, preferably a pint or more of such effluent, filling the bottle as nearly full as will be convenient in corking the same, then place this bottle in a convenient place in a room at ordinary temperature and watch its behavior from time to time. An effluent which is notputrescible will show no definite change, while a putrescible effluent will quickly change and will frequently pass through varying conditions for many hours, and sometimes for many days.

The scientific testing of an effluent involving the use of dissolved oxygen, or necessary oxygen furnished in any manner, furnishes the accurate determinative test. This leads us to the exact problem to be determined in any case. It does not require a scientist to determine that the effluent from a sewage treatment plant is putrescible if such effluent comes from the treatment plant in a cloudy condition, blackening rapidly within a few minutes after such discharge, and depositing along the banks of such sewage stream the black deposit so common in such cases. But if these conditions are absent the question still arises, how soon and how completely will the purification of the effluent be accomplished when such effluent issues from the treatment plant in a nonputrescible condition.

It would be impossible to state exactly what we mean chemically or bacteriologically when we state that the effluent shall be nonputrescible, except to say that such effluent will complete its purification by means of dissolved oxygen.

This statement then leads to inquiries relative to the availability of dissolved oxygen. Evidently the trickling filter or sprinkling filter gives opportunity for the maximum of included oxygen, which in obedience to bacteriological agency becomes useful dissolved oxygen, and the result reached in the trickling filter when properly operated is a satisfactory effluent, even though the actual degree of purification attained at the moment the effluent leaves the filter is far below the degree of purification obtained in slow sand filtration.

The inquiry is naturally made whether a nonputrescible effluent may not safely be discharged into the open depressions or barren watercourses where it is impossible to so locate the treatment plant that the effluent may be discharged into a running stream. It is true that such an effluent might be so discharged without creating a nuisance, and ordinarily such an effluent will not become a menace to health. Where such effluent may be discharged into a small stream, possibly of equal flow, or into a stream not many times the flow of the effluent, the purification should be satisfactorily accomplished without creating a nuisance or menace to health. The only exception that need be made to this conclusion is that pathogenic germs, or the germs of epidemic diseases which are water-borne, are not completely destroyed or eliminated by the sewage treatment. A small per cent of such germs, or a small fraction of 1 per cent of such, will survive sewage treatment, and we have in this condition of affairs what is spoken of as a resistant minority, which may perpetuate water-borne diseases. A careful oversight of the sewage treatment throughout the different seasons of the year, with the treatment plant under laboratory control where such control can be provided, will determine the necessity and extent of disinfection necessary to be employed. It is evident also that each locality presents its own peculiar conditions, and that the treatment of sewage for each locality must be studied as a local problem.

It is therefore true that we may consistently provide that the standard of purification shall be that degree of purification known as nonputrescibility, but that we must also understand that the additional work of purification that shall close the gap between nonputrescibility and complete purification is variable, thereby rendering a nonputrescible effluent in one case more difficult of complete purification than in another.

The effect of the discharge of a nonputrescible sewage effluent into the waters of a running stream has not been fully worked out by laboratory methods. A great deal of investigation has been carried on through various means for determining the effect of the discharge of untreated sewage into streams. The conclusions of these investigations are vague and indefinite. The idea prevailing in earlier years seemed to be that there could be designated some definite distance in which a stream would purify itself from the pollution of sewage discharged into it. All of the investigations indicate that distance has very little to do with the extent of the purification. The extent of the dilution of the discharged sewage by the water of the stream, the amount of dissolved oxygen contained in the water of the stream, the variable amount of the sewage through different hours of the day, and different days of the week, and different months of the year, the varying composition of such sewage, all of these items enter into the consideration of the problem of stream purification.

The effort has been made to determine the amount of water flow necessary for disposing of untreated sewage from each 1,000 persons. The best conclusion that the writer can select indicates that there should be 8 cu. ft. per second of water flow for each 1,000 persons. This conclusion is on the assumption that both the sewage and the stream are of average composition, and such a dilution would mean 0.4 part free ammonia per 1,000,000 additional in the stream water. Such dilution, however, will not prevent some nuisance near the point of discharge, and gives no indication of the distance required for the purification of the stream. Evidently such a stream of water should not be used as a source of domestic water supply unless effective methods of water filtration and sterilization be employed. It is claimed, however, that in general a nuisance may be avoided by such dilution. With proper sewage treatment it is evidently true that the nonputrescible effluent of a sewage treatment plant will contain less of active impurities than the water of the average inland stream, and where such result can be obtained there should be no objection to the discharge of such effluent into any such running stream, except that such effluent should be disinfected when necessary to do so for the destruction of pathogenic bacteria.

An additional problem enters into the discharge of the effluent from sewage treatment plants in Iowa in the fact that many of the small running streams which must be utilized for such discharge, cease their natural flow during the summer months, and the only regular flow continued through the summer is the flow from the sewage treatment plant. In such cases, if the effluent is nonputrescible there would seem to be no reason why such effluent might not be safely used for such purposes as the small running stream itself may be used, except that such effluent may contain the germs of transmissible diseases. The water of running streams should not be used by human beings as a water supply unless properly purified, neither should the effluent from the treatment plant be so used until its purification is complete.

There seems, therefore, to be common ground in the statement that an effluent from a treatment plant should be no more polluted than is the water of the stream into which it discharges, but this statement should be qualified by the provision that the water of the running stream should be at least of the average purity of such streams.

It would be indefensible to say that the effluent from a treatment plant is just as good as the water of the stream into which it discharges when such stream is grossly polluted by other means than direct sewage disposal, which condition is found in many Iowa streams.

The chemical definition of nonputrescibility given earlier in this article suggests that there shall not be more than 1.4 p.p.m. of albuminoid ammonia present in the nonputrescible effluent of a sewage treatment plant. This is practically 8 times the albuminoid ammonia supposed to be allowable in potable water. This would indicate that there should be considerable delay between the discharge of such an effluent into a watercourse and the use of such effluent as a part of a water suppy.

The most reasonable conclusion from a bacteriological standpoint is as follows:

> It seems wisest, at the present time, to avoid fixing any general standards of purity for sewage effluents. Each case should be judged intelligently on its own merits. In general, however, where bacterial purification is indicated at all, it seems fair to demand that the effluent should be of such a quality as not to increase materially the bacterial content of the body of water into which it is discharged.

This conclusion is likewise evasive in the fact that it would not require a high degree of bacterial purification, if the effluent was discharged into a stream already foul from drainage sources. Neither does this conclusion help solve the problem of the inland location where the sewage effluent must discharge into natural drainage channels which do not carry water for a considerable portion of the year.

In conclusion it must be said that we cannot adopt any better standard at the present time for the degree of purification of sewage treatment plants than that of nonputrescibility with the understanding that each local problem must be studied by itself and that any treatment plant should be under proper control and regulation. A few years of careful oversight and intelligent direction of the sewage treatment plants of Iowa will determine the essential facts of their effective operation. Such oversight would determine the extent of pollution of the streams or bodies of water into which the effluent of such treatment plants are discharged, and the extent of time or amount of dilution required for proper oxygenating of the effluent. Likewise, such oversight would determine the behavior of nonputrescible effluents discharged into barren water courses and the length of time required under varying atmospheric or seasonal conditions necessary for the completion of the purification of such nonputrescible effluents.

ACKNOWLELGMENT.

The discussion here given is from a paper by Lafayette Higgins, Sanitary Engineer of the Iowa State Board of Health, before the latest annual meeting of the Iowa Engineering Society. The quotations are from "Sewage Disposal," by Kinnicutt, Winslow and Pratt, "Sewage Disposal," by George W. Fuller and "Elements of Water Bacteriology," by Prescott and Winslow.

Pan-American Road Congress. — Col. Charles P. Light, field secretary of the American Highway Association, has been loaned by the directors of that organization to the Pan-American Road Congress until the close of the big meeting which is to be held in Oakland, California, during the week of September 13. It is expected that the Congress which is held under the auspices of the two leading road organizations of America, the American Highway Association and the American Road Builders' Association, will bring together representatives of the organized road movement throughout the entire United States and that it will have a large official representation from Canada and the Central and South American countries.

Col. Light will confer with city and county officials, commercial and road organizations and others interested in the road movement for the purpose of making known the character and scope of the annual road congress and to urge that strong delegations be named. He will also be connected with the sub-committtee on finance.

Engineering and Contracting

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Officers of Cement Products Exhibition Co.—At the annual meeting of the Cement Products Exhibition Co., held May 11, the following officers were elected: B. F. Affleck, president; A. Y. Gowen, vice-president; Robt. F. Hall, secretary; J. U. C. McDaniel, treasurer. The directors elected were the following: B. F. Affleck, J. P. Beck, W. E. Cobean, Wm. Dickinson, A. Y. Gowen, Edward M. Hagar, Robt. F. Hall, D. McCool, J. U. C. McDaniel.

Worcester Polytechnic Institute to Celebrate Fiftieth Anniversary.—The celebration of the fiftieth anniversary of the founding of Worcester Polytechnic Institute will be held June 6-10, at Worcester, Mass. President Wilson and General Goethals will probably attend. The cornerstone of the new gymnasium will be laid, and the Alumni Field dedicated during the celebration.

All-steel passenger coaches are to be introduced into South Africa, owing to increasing cost of timber. The chief mechanical engineer of the Union of South Africa Railways has been authorized to order two trains of steel coaches for trial.

CURRENT NEWS

The Doings of the Week.

Industry and Commerce, despite the uncertainty prevailing regarding the reply of Germany to President Wilson's note, showed continued improvement and progress during the past week Financial circles were more or less affected and as a result trading in stocks fell off to an average daily output of 200,000 to 300,000 shares. The unsettled foreign issue also had a tendency to hold up certain speculative projects. It is now generally believed that the German reply will lead to a peaceful settlement of the question at issue. Italy's entrance into the war brings the number of nations now engaged in the conflict up to 11, with excellent prospects of three more—Bulgaria, Greece and Roumania, soon joining the struggle. The United States is about the only shop now open for business. In the construction field an excellent showing has been made during the past week. Many big jobs were placed under contract while other large undertakings were advanced a step nearer the call for bids stage. Municipal activities were particularly well marked and a great variety and amount of work in this line was offered for bids. State and county highway improvements and city paving jobs were numerous. In the railway field, even, three small projects were advertised. More government river and harbor work is now being advertised than in any previous week of the year. In the Iron and Steel trade one prominent feature of the week was the larger buying by the railroads. With plants now working around 75 per cent capacity it needs only the entrance of the railways into the equipment and supply markets to bring many plants up to full time outputs. Mill operations of several companies were increased during the past week, and numerous inquiries are now being received. Fabricating contracts for April represented 62½ per cent of capacity as compared with 64 per cent in March. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending May 19 were as follows:

Finished Iron and Steel.	May 19.	May 12
Per lb. to large buyers	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.17½	1.17½
Iron bars, Pittsburgh.. ...	1.20	1.20
Iron bars, Chicago............	1.15	1.15
Steel bars, Pittsburgh.... ...	1.20	1.20
Steel bars, New York	1.369	1.369
Tank plates, Pittsburgh	1.15	1.15
Tank plates, New York......	1.319	1.319
Beams, etc., Pittsburgh.......	1.20	1.20
Beams, etc., New York. ..	1.369	1.369
Skelp, grooved steel, P'gh....	1.15	1.12½
Skelp, sheared steel, P'gh....	1.20	1.17½
Steel hoops, Pittsburgh......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers		
Sheets, black, No. 28, P'gh	1.80	1.80
Galv. sheets, No. 28, P'gh.	3.60	[illegible]
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh........	1.35	1.35
Barb wire, galv., P'gh........	2.10	2.10

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—An interesting development of the week is the advertising of three railway construction jobs. One of these calls for 38 miles of line for the Tucson, Cornelia & Gila Bend R. R. Co., recently incorporated with a capital stock of $3,600,000. The line probably is to be built primarily for hauling copper and may be a subsidiary of the El Paso & Southwestern System. At any rate Walter Douglas, vice-president of the latter concern, is an incorporator. The New York Connecting R. R., a subsidiary of the Pennsylvania R. R., is calling for bids for grading and masonry of a portion of Section 2, covering 4.21 miles of line in Queens Borough, New York City. The Public Service Commission of the First District, New York City, is asking bids for supply of track materials for use in constructing the dual system of rapid transit railroads in that city. The contracts let include the following: M. Cassidy, Oklahoma City, grading work in oil fields of Oklahoma for Santa Fe System; E. P. Maule, West Palm Beach, Fla., first 22 miles of Palm Beach & Everglades R. R.

Roads and Streets.—Highway construction and street paving continues to offer many construction opportunities. State aid work, as far as new calls for bids go, shows a falling off this week. New York is asking proposals on 19 contracts covering 96 miles of road, and on 10 repair contracts; Idaho is calling for bids on some state road improvements; as is Massachusetts, Illinois, and one or two other states. New York opened bids last week on repair contracts aggregating about $250,000 and on 22 construction contracts. Maine opened (bids on its first letting of the year, the work covering about 26 miles of highway. St. Mary Parish, Louisiana, awarded contracts for 50 miles of gravel or shell roads; Charleston, S. C., let a contract for 65,000 sq. yds. of paving; Rockwell City, Ia., awarded a $150,000 asphalt pavement job; Walla Walla, Wash., let paving contracts amounting to $90,000; Anderson, S. C., awarded paving jobs to cost abou $148,000; Greenville, S. C., let contracts for 70,000 sq. yds. of pavement and 20,000 sq. yds. of sidewalk.

Bridges.—Bids are asked on several fair sized bridge undertakings and also on numerous smaller structures. The County Freeholders at Atlantic City, N. J., open bids June 9 on a 742-ft. bridge. The Commissioners of Wyandotte County, Kansas, approved plans for rebuilding the Central Ave. bridge over the Kaw River at a cost of $500,000. Seattle, Wash., will ask bids at once on two steel bridges to cost about $810,000. Bridges will be of double leaf trunnion bascule type and will span Lake Washington Canal at Ballard and Fremont Sts. The Grade Crossing Commission, Buffalo, N. Y., opened bids for substructure of subway at Lord and Smith Sts., the low bid amounting to $71,989. Omaha Structural Steel Works, Omaha, Neb., was awarded contract at $29,250 for wagon bridge at North Platte, Neb

Drainage and Irrigation.—No particularly large contracts in either the drainage or irrigation fields appear to have been let last week. Drainage District No. 2 of Gibson County, Tenn., is calling for bids on 1,158,386 cu. yds. of dredge work. The U. S. Reclamation Service, Provo, Utah, opens bids June 16 on 25,000 cu. yds. of canal excavation and 2,600 cu. yds. of reinforced concrete near Payson City, Utah.

Waterworks.—No developments of particular importance in the waterworks field appear to have reached the call for bids stage last week. Lock Haven, Pa., is asking bids for continuation of construction of storage dam, the work involving excavation and 560 cu. yds. of concrete. Kenosha, Wis., opens bids June 14, for 10,000 ft. 42-in. cast-iron intake, crib and intake well.

Sewerage.—One of the larger sewerage jobs on which bids were opened last week covers the two large intercepting sewers at Milwaukee. John F. Casey Co., Cleveland, O., at $498,727 was low bidder. Palisades Park, N. J., awarded contracts for sewers and disposal works to cost $60,429. James Kennedy Construction Co., Los Angeles, Cal., at $109,000 was low bidder on a sewer job for Los Angeles; Hans C. Hanson at $80,000 was low bidder for the 21st st. sewer at Racine, Wis. Oswego, N. Y., is asking bids on a fair sized sewer contract; Beaver Falls, Pa., opens proposals June 8 on a sewage disposal plant.

Rivers and Harbors.—Work advertised for bids by U. S. Engineers includes 900,000 cu. yds. dredging at Philadelphia Harbor, Pa.; 175,000 cu. yds. of levee work in East Side Levee and Sanitary District, Ill.; furnishing 84,000 cords brush and poles for revetment work, and 660,000 cu. yds. of levee enlargement in Third Mississippi River District. The U. S. Engineer at Kansas City awarded contracts for 9,000 lin. ft. revetment work at $9 per foot, and 4,200 lin. ft standard 3-row timber dike at $14.25 per foot.

Large Industrial Developments.

Numerous contracts for the construction of large mills and factories and extensions to existing plants have been an important feature of the building field of the past few weeks. In one week contracts were let for eight important developments in the east. These included a $500,000 factory at Eddystone, Pa., for the Baldwin Locomotive Works; a $400,000 plant at Buffalo, N. Y., for the Ford Motor Co.; a 3-story, 200 ft. by 200 ft. factory at Waterbury, Conn., for the Scovill Mfg. Co.; a factory at Bridgeport, Conn., consisting of a 1-story main building 100 by 400 ft., a 2-story forge shop, 60 by 550 ft., a power plant 60 by 150 ft., and one other building 50 by 100 ft., for the Bridgeport Projectile Co.; a $250,000 factory at Camden, N. J., for the Victor Talking Machine Co.; six factory buildings at Harrisburg, Pa., to cost $200,000, for the Hickock Mfg. Co.; a 235 ft. by265 ft. manufacturing building at Long Island City, N. Y., and six manufacturing buildings at Bayonne, N. J., for the Vacuum Oil Co. One or two of these developments are probably the direct result of the demand for war munitions by the European countries. The others, however, are undoubtedly being undertaken at this time because of a present or prospective expansion of the business represented. The construction on an extended scale of new factories and mills or extensions to existing plants is a pretty good indication of improved conditions in the industrial situation.

Railway Buying.

Every now and then some well meaning gentleman rises to remark that this country is on the eve of the greatest period of prosperity that it ever has known. Everybody listens attentively and forehanded persons go out and buy large pocketbooks. But somehow this golden era is a long time in arriving. It's easy enough to prophesy, but it's the action that counts. The large equipment orders placed last week by the Pennsylvania R. R. will do more toward bringing about a revival in certain lines of business than the platitudes of a thousand prominent bankers. The expenditure of $17,000,000 for cars and locomotives and the prospective placing of additional orders amounting to $11,000,000 by this one railroad is one of the most encouraging developments of the year. The Pennsylvania R. R. not only is setting a good example in purchasing supplies and equipment, but it also is one of the few railroads undertaking any considerable amount of construction work. If other railroads would do their share as well, it would not be long before there would be some real prosperity in the railway equipment and construction fields.

Railway Contracts.

It is somewhat unusual for railways to publicly advertise for new construction undertakings. This week, however, three projects are being advertised. One of these calls for 38 miles of railroad in Arizona, another provides for a short spur for the government railway in Canada, and the third involves the building of 4½ miles of line in Queens Borough, New York City, for the New York Connecting Ry., a subsidiary of the Pennsylvania R. R. In these days of dullness in the railway construction field it is worthy of note when three jobs are advertised in one week. If contractors are as eager for work as they claim to be the railway people will get conclusive proof that it pays to advertise.

SEWERAGE DEVELOPMENTS AT PHILADELPHIA, PA.

Plan Recommended for Collection, Treatment and Disposal of Sewage.

Proposes Expenditure of $22,400,000 for Construction of Interceptors and Treatment Works.

A comprehensive plan for the collection, treatment and disposal of the sewage of Philadelphia, Pa., has been recommended by the Bureau of Surveys in a report submitted to the City Council on May 20. The scheme calls for an expenditure of $22,400,000 and provides for the interception of the sewage gathered by the various sewer systems and its conveyance by transverse collecting sewers to treatment works located in three sections of the city.

The plan recommended is only general in character, and details have been developed only sufficiently to determine the economical location of sewers, types of works, and for the purpose of estimating costs. Under the plan the city is divided into three divisions as follows: The Northeast Division comprises that part of the city northeast of a line beginning on the Delaware River at Port Richmond and extending to and along the Wissahickon Creek. The Southwest Division is that part of the city included in the watershed of the Schuylkill River and the southwest side of Wissahickon Creek. The southwest division covers the northeast side of Cobbs Creek, and that part of the Delaware River watershed between Market St. and the Philadelphia Navy Yard. The sewage of each of these divisions will be brought to a treatment works to be located within the division at a point where the effluent can be discharged into the Delaware River.

In the Northeast Division a high level collector is to be constructed along the south bank of Frankford Creek between the county line and the vicinity of O and Luzerne Sts. This will gather the sewage discharged into that creek. Another high level interceptor will have its upper terminus at 24th and Westmoreland Sts., where it would divert the sewage collected by the separate systems for that part of Germantown on the northeast watershed of Wissahicken Creek. This collector would carry the sewage along Westmoreland St. and Allegheny Ave. to 2d St., where the sewage from Gunners River main sewer would be added by a short spur and all carried in a northeasterly direction to the vicinity of N and Luzerne Sts., where it would join the Frankford Creek high level interceptor. Another high level collector would have its upper terminus at Pratt and Leiper Sts., where it would collect sewage from the Wakeling St. sewer system and other sewers above its line.

The three high level collectors will join in the vicinity of O and Luzerne Sts., and at this point will be located coarse screens, a grit chamber and an overflow to the creek for excess rain water. After the large floating matter and grit have been removed the sewage will be carried by an inverted siphon consisting of three tubes, 66, 78 and 90 ins. in diameter to the site of the northeast treatment works. It is estimated that these three sewers would collect in the year 1950 the sewage of 740,000 people amounting to 130,000,000 gals. per day, and the siphons would discharge it at a sufficient elevation so that it would flow through the treatment works without pumping.

A separate system of sewers would be constructed upon the watershed of Pennypack Creek between Frankford Ave. and the county line and an interceptor built along the creek from State Road to the county line. A separate system of sewers also would be provided for the drainage area tributary to the Delaware River between the mouth of Poquessing Creek and Princeton St. in Tacony, and connections made between the storm water conduits and the collector. The sewage and first flush of rain water from this area would be carried by the collectors to the present Pennypack Creek pumping station, which with some enlargements, will lift it into the collector from the Pennypack Creek drainage area and the combined flow carried in a low level interceptor parallel to the Delaware. This will carry the flow to the northeast works, where it will be pumped to an elevation required to carry the sewage through these works. There also would be several other low level collectors for gathering sewage from sections too low to reach the works by gravity.

The northeast treatment works would be located south of Bridesburg in the vicinity of Wheat Sheaf Lane and the Delaware River. At this site the sewage collected by the Upper Delaware low level collectors would be passed through coarse screens and grit chambers and pumped to the same elevation that the high level sewage will be delivered by siphons. The combined flow will then pass through the Emscher tanks for the sedimentation of the sewage and digestion of the resultant sludge. Adjacent to the tanks would be the sludge drying beds.

The main gravity collector for the Southwest Division would start at Front and Huntingdon Sts. and would run in a southerly direction, passing over the proposed Broad St. subway at Callowhill St. It would then follow out this street to 21st St. and thence run approximately parallel to the Schuylkill River to Reed St., where the sewage would be carried under the river in an inverted siphon. Two spurs would collect most of the sewage of West Philadelphia. The main gravity collector would be carried to the vicinity of the west end of Penrose Ferry bridge, where coarse screens and grit chambers would remove the large floating matter and the sand, after which the sewage will flow by gravity to the site of the Southwest Treatment Works. It is estimated that in 1950 this collector will deliver without pumping the sewage of 651,000 people, amounting to 159,000,000 gals. per day.

For the collection of sewage from those parts of the Southwest Division of the city at too low elevations to be gathered directly by the main gravity collector low level collectors would be constructed parallel to the Delaware River between the outlet of the Aramingo system at Dyott St. and the sewer on the north side of Market St. Then collectors would deliver to a pumping station at Front and Green Sts., where the sewage would be raised through a short force main to the main gravity collector. This low level system, it is estimated, would in 1950 serve about 189,000 people. The other feature of the system for the Southwest Division includes pumping stations on the east bank of the Schuylkill River near Callowhill St., on the east bank of the river at Reed St., at the present outlet of the existing Cobbs Creek collector, and in the vicinity of Penrose Ferry. In addition there would be various inverted siphons and low level collectors.

The southwest treatment works will be located in the lower part of the 40th Ward on the Cannon Ball farm, where the city owns 400 acres. On the eastern side of this tract there will be located 2-story sedimentation tanks of the Emscher type and sludge drying beds. The remainder of the tract will be utilized for works for the oxidation of the settled sewage, when that refinement is needed. It is estimated that the treatment works at this site will receive in 1950 the sewage of 1,663,000 persons.

For the Southeast Division low level collectors will be constructed to gather sewage from the sewers discharging into the Delaware River between Market St. and the proposed railroad freight terminal yards. They would join near Greenwich Point in the vicinity of Curtis St. and the Delaware River. At this point a pumping station and fine screening works would be constructed. After the sewage has passed through the fine screens it will be raised by a low lift pumping station so that it can be discharged through submerged outfalls to the channel of the Delaware River. It is estimated that these works will receive in 1950 the sewage of 390,000 people.

In its report the Bureau of Surveys recommended that $5,000,000 be appropriated at once for the following purposes: Purchase of land at the sites of the three proposed treatment works; construction of collecting sewers to intercept sewage tributary to Frankford and Pennypack Creeks and to the Delaware River between the treatment works to be located near Bridesburg and the mouth of Poquessing Creek; construction of sewage treatment works at the northeast site.

The Bureau recommends that subsequent appropriations be made as rapidly as possible for the construction of the collecting sewers, pumping stations, treatment works and appurtenances, generally in the following order:

Collecting sewer and treatment works for thickly populated districts of West Philadelphia	$5,700,000
Collecting sewers, pumping stations, extensicns to treatment works for sewage tributary to Schuylkill River.	4,800,000
Collecting sewers for part of sewage tributary to Delaware River	3,400,000
Low level collecting sewers along Delaware River, pumping station, southeast clarification works, and enlargements of existing treatment works	3,500,000

$2,500,000 for State Highways in Massachusetts.

State highway construction for the western sections of Massachusetts involving an expenditure of $2,500,000, has been provided for by a recent act of the legislature. The law authorizes the expenditure of this sum by the State Highway Commission on 17 routes in Berkshire, Franklin, Hampden, Hampshire and Worcester counties within the years 1915 to 1918 inclusive. The roads to be improved under the provisions of the bill are as follows:

Great Barrington, south through Sheffield and Ashley Falls to the Connecticut line.

Pittsfield to Northampton, through Hinsdale, Windsor, Cummington, Goshen and Williamsburg.

From the village of New Boston, in Sandisfield, up the Farmington River valley through Otis and West Becket to connect with the main highway known as Jacob's Ladder Road.

From Bonnyrigg Four Corners in Becket through Washington to the State highway in Hinsdale.

Huntington northerly through Worthington to Cummington, to connect with the highway between Dalton and Northampton.

Hinsdale easterly through Peru to Worthington, to connect with the road from Huntington to Cummington.

Plainfield to Cummington, to connect with highway between Pittsfield and Northampton.

Belchertown through Enfield to Ware, thence to Palmer.

Granville Corners through Southwick to Feeding Hills, the town of Agawam.

Ashfield, through Spruce Corners to Lithia in the town of Goshen, to connect with the Pittsfield-Northampton Highway.

Gill to Turners Falls, to connect with the Boston-North Adams highway.

Athol, through Petersham, Barre, Oakham, Rutland and Holden to Worcester, connecting the Boston-North Adams highway with the Boston-Springfield highway.

Worcester, through Grafton and Upton to Milford, to connect with the main highway to Cape Cod.

Warwick to Orange.

Amendments to the bill added the following highways:

South Deerfield to Ashfield.

Northampton, over Mains' Hill to Chesterfield.

A highway in Worcester county.

Rapid Transit System for Cincinnati.—The governor of Ohio has signed the bills providing for improved rapid transit facilities for the city of Cincinnati. At the November election it is probable that the citizens will vote on a $6,000,000 bond issue for developments to be carried out under the direction of the city Board of Rapid Transit Commission. The members of the commission will be appointed by the mayor. E. W. Edwards will probably be the chairman.

HARBOR DEVELOPMENTS AT TORONTO, ONT.

$1,000,000 to $2,000,000 to Be Expended This Year.

Breakwater — Dredging — Docks — Park and Boulevard Improvements.

The most extensive harbor developments now under construction on the Great Lakes are probably those at Toronto, Ont. Although work on this improvement was started only a little over two years ago contracts aggregating about $11,000,000 already have been let. Last year about $1,500,000 was expended on this work, and it is estimated that between $1,000,000 and $2,000,000 will be spent this year.

The Toronto plans provide for developments along three lines: (1) Industrial development in the Ashbridge Bay District and on a 17-acre area at the foot of Bathurst St. (2) Commercial and dock development at both these points and on the central water front. (3) Park and boulevard improvements along the 12-miles of outer waterfront from Woodbine Ave. to the Humber River, with a protected waterway from the Humber on the west to Victoria Park on the east. The preliminary estimates placed the total cost of the entire project at $19,142,000. This expenditure will be borne by the Dominion Government, the city of Toronto, and the Toronto Harbor Commission.

In carrying out the development the waterfront has been divided into three sections: The eastern section includes all the district lying east of a line drawn from Parliament St. to the eastern entrance to the harbor and extending east to the east city limit. The central section takes in the district between Parliament St. and Bathurst St. and includes the waterfront of the inner harbor and the bay shore of the Island. The western section deals with all the property from Bathurst St. to the Humber River.

The principal work in the eastern section will be the reclamation of the Ashbridge Bay District. In connection with this a breakwater will be constructed along the entire front, a distance of 4⅓ miles, at an average of distance of 700 ft. south from the present shore line. The eastern section, with the exception of the part lying east of Woodbine Ave., will be filled to an elevation of 8 ft. above mean water level. This will require 27,000,000 cu. yds. of material, all of which will be secured from the bed of the inner harbor and from the bottom of the lake outside the seawall. The industrial area proper will be north of a line drawn east and west and 1,000 ft. back from the breakwater. This line will be marked by a street 66 ft. wide, which will divide the industrial area from the park area to the south. Immediately south of this street there will be a tier of lots 100 ft. in depth and extending for over 3 miles along the north face of the park area. These lots will be reserved as locations for summer homes. In front of the cottage reservations will be a park district and a bathing beach fronting on a lagoon. This latter will be crossed by numerous foot bridges. A boulevard driveway and promenade will be constructed immediately behind the breakwater. The driveway will be 50 ft. in width, and in addition there will be a bridle path, concrete walks and boulevard areas to make up a total width of 200 ft.

In the industrial district it is planned to have 646 acres of land available for factory sites, 235 acres occupied by streets and railroad reservations and 130 acres of waterways. The 30 miles of roadways will have a minimum width of 75 ft. and a maximum width of 175 ft. The district will be served by 30 miles of railway tracks connecting with all the railroads which at present enter Toronto. A ship channel will be constructed into the district for a distance of 6,800 ft., terminating in a turning basin 1,000 ft. square. The sides of both the channel and turning basin will be so constructed as to form over 3½ miles of dockage accommodations. This channel will be 400 ft. wide and will have a depth conforming to the depth of the new Welland canal. The western or bay face of this eastern section will be developed for dock purposes as the district grows and ultimately will add two additional miles to the dock frontage.

In the central section the work consists almost entirely of commercial and park development, with one area covering 17 acres at the foot of Bathurst St., suitable for industrial development. Central dockage facilities are to be developed by the construction of docks in the area from Bay St. to York St., with an adequate equipment of freight sheds and storage warehouses. It is proposed to expend $1,785,000 on these features. The other work planned for the central section consists of the reclamation of 352 acres of additional park lands on the Island. A portion of this will serve as a location for the boulevard drive. This will be carried over the eastern harbor entrance on a double-leaf rolling lift bridge. The western harbor entrance also will be spanned with a similar structure. The lagoons will be crossed on concrete arch bridges.

In the western section from Bathurst St. west to the Humber the treatment is almost entirely shore protection and park reclamation work. A breakwater will be constructed from a point 200 ft. west of the north pier of the western channel to a point at the mouth of the Humber River, the average distance south from the existing shore line being 900 ft. The old western harbor entrance will be filled up and the boulevard driveway after crossing the new western entrance will be carried north to this newly filled land and will there divide into two branches. A recreation and passenger dock, 300 ft. long, double deck, will be constructed at the exhibition grounds.

The harbor improvements at Toronto now under contract include 17,295 lin. ft. of seawall with pile substructure and concrete superstructure; 18,000 lin. ft. of breakwater consisting of crib substructure and concrete superstructure; the ship channel and turning basin; and a retaining wall 6,894 ft. long of crib substructure and concrete superstructure.

The Toronto Harbor developments are being carried out under the direction of a commission of five members, three of which are appointed by the city council, and the remainder by the Dominion Government. E. L. Cousins is chief engineer, and Alex. C. Lewis is secretary.

Railways Return to Equipment and Supply Markets.

One of the most encouraging developments of the past few days from an industrial standpoint is the activity of the railways in the purchase of equipment, materials and supplies. Many large orders have been given out in the past two weeks and numerous inquiries are now being figured on. The Pennsylvania R. R. announced early this spring that it would expend $28,000,000 for new equipment and materials. Last week it placed orders amounting to $17,000,000. These called for 3,500 box cars, 324 refrigerator cars, 3,000 gondola cars, 7,219 hopper cars and 50 locomotives. This is the first big buying by this company for more than a year. The total steel rail requirements for the Pennsylvania for 1915 will be in the neighbrhood of 170,000 tons. Orders for 12,000 tons have been placed, and 138,000 tons will be let in the near future. The remaining 20,000 tons probably will be held over until later in the year. The Chicago & Northwestern Ry. has placed an order for 2,000 steel box cars, 50 steel under-frame caboose cars and 50 steel passenger cars.

The giving out of such large orders by the Pennsylvania R. R. at this particular time is of especial interest. Only a short time ago it was reported that because of the uncertainty in financial conditions that it was felt might arise from the Lusitania disaster the company had canceled its entire equipment program for this year. The placing of the $17,000,000 worth of contracts last week, is an effective rebuttal of this report.

Highway Repair Lettings in New York.

Bids were opened May 18 by the New York State Highway Commission on 28 contracts for the repair of highways by state aid. There was good competition for the larger resurfacing jobs and on some of the contracts the figuring was quite close. Repair Contract 746, providing for the resurfacing of 7.96 miles of road in Cayuga county was the most attractive offering, there being 12 bidders on this work. On three contracts there was only one bidder. The Dale Engineering Co., Utica, N. Y., was low bidder on four contracts; The Kennedy Construction Co. of Albany, was low on three; Harry W. Roberts Co., Utica, N. Y., was low on three, and Thos. Huckwell & Co., Albion, N. Y., also was low bidder on three contracts. The following tabulation shows the high and low bids and the number of bidders on each contract:

Contract No.	Miles.	High bid.	Low bid.	Number bidders.
690........	11.30	$10,043	$ 8,950	4
767........	4.00	12,699	11,268	3
746........	7.96	49,194	38,322	12
743........	8.58	4,070	3,465	5
754........	2.07	9,938	9,938	1
762........	19.86	9,307	7,482	7
757........	41.10	7,608	6,670	9
732........	14.49	6,935	5,152	9
745........	15.69	4,358	4,055	3
752........	17.75	3,870	3,551	5
734........	29.71	13,615	10,871	8
729........	25.27	11,247	8,771	8
763........	32.44	15,406	12,280	4
731........	131.91	13,878	10,947	7
730........	30.30	14,506	12,008	8
765........	3.74	15,102	13,395	4
755........	2.20	11,978	11,483	2
759........	6.83	6,845	5,343	4
641........	23.63	6,022	4,694	9
751........	7.00	2,813	2,251	6
747........	10.75	4,720	3,767	6
721........	.41	3,231	2,821	5
713........	7.05	2,890	2,890	1
758........	3.94	25,975	22,000	4
541........	3.04	20,417	15,081	8
753........	1.85	13,326	11,332	6
723........	13.42	4,355	4,355	1
748........	2.00	1,618	1,410	6

The next letting of repair contracts will be held on June 4. This covers 10 contracts, four of which are for resurfacing with 3 ins. of bituminous macadam, two for resurfacing with waterbound macadam and one for reconstructing with bituminous macadam top. The State Highway Commission also will hold a road construction letting at the same time. This letting includes 19 contracts covering over 95 miles of highway.

Large Public Building Contracts to be Let Soon.

Several notably large public and educational buildings are now being advertised for bids. These include buildings for the University of Illinois at Urbana, Ill., a municipal court building at Detroit, Mich., and the office building for the Department of the Interior at Washington, D. C.

This latter structure will occupy a site approximately 400 by 400 ft., will have seven stories and basement and will have a face brick and limestone facing. Drawings and specifications will be ready June 1, and bids will be received until 3 p. m., July 13, by Jas. A. Wetmore, acting supervising architect, Treasury Department, Washington, D. C. Contractors may estimate on the construction including the mechanical equipment (except elevators), on the construction except the mechanical equipment and elevators, on the mechanical equipment only (except elevators), or on the elevators alone.

The structures at the University of Illinois will include a building for the School of Education and the ceramics and vivarium buildings. Bids for their construction will be received at the office of James B. Dibelka, state architect, 130 N. 5th Ave., Chicago, Ill., until 2 p. m., June 1.

The municipal court building at Detroit will be a 6-story and basement structure, 100 by 200 ft. in size and will cost about $600,000. Smith, Hinchman & Grylls, Detroit, are the architects. The bids will be received until 10 a. m., June 9, by Geo. H. Fenkell, Commissioner of Public Works.

CONSTRUCTION PROJECTS AT PHILADELPHIA, PA.

Large Expenditures to be Made for Public Improvements.

Subways, Bridges, Sewers, Grade Crossing Elimination.

Philadelphia, Pa., will be one of the greatest construction centers in the country during the next three or four years. A great variety and amount of work will be started in the near future by this city. Rapid transit developments, including the building of subways and elevated lines and improvements to sewerage facilities will require the expenditure of many millions of dollars. Bridge building, paving, grade crossing elimination and the continuation of the development of harbor facilities will provide many construction opportunities. In addition large developments are to be undertaken by the Pennsylvania and other railroads.

The Bureau of Surveys, as noted elsewhere in this section, has just submitted its report on a plan for the collection, treatment and disposal of sewage. The recommended scheme calls for appropriations aggregating $22,400,000 extended over a period of 5 years. For the commencement of work on the rapid transit improvements a loan of $6,000,000 was authorized by the citizens at an election last month. The bill providing for the appropriation of this sum was reported to the city council on May 20 and if the expected favorable action is taken it is probable funds will be available so that actual work can be started within two or three months.

The $6,000,000 will be expended for the construction of the Broad St. subway, and the remainder of the rapid transit project will be financed by other loans. At the general election next November the citizens of Pennsylvania will vote on several amendments to the State Constitution. One of these provides for increasing the borrowing capacity of Philadelphia from 7 to 10 per centum of the assessed property valuation. It is expected that about $60,000,000 will be provided for the development of transit and harbor conditions in this city.

Action was taken last week by the City Councils that will result in the immediate undertaking of a considerable amount of construction work. The ordinance appropriating the councilmanic loan of $4,325,000 for permanent improvement was passed and plans of the Bureau of Surveys for the following bridges were approved and their construction authorized:

Bensalom Pike	$200,000
54th St. over P. B. & W. R. R.	25,000
Front St.	12,000
Orthodox St. over Frankford Circle	25,000
13th St. over Reading Ry.	13,000
Torresdale Ave. over Frankford Ave.	45,000

An allotment of $2,000 was made for the preparation of plans for a bridge on Henry St. to span the Wissahicken. This probably will be one of the longest bridges in the city. The Council's committee last week also reported bills for the construction of extensions of 12 main sewers. These include the extension of the Rock Run sewer to drain Oak Lane; completion of Gunner's Run relief sewers from 3d St. to 12th St, $70,000, and the extension of Cobb's Creek intercepting sewer, $70,000. These sewer and bridge improvements will be financed from the $4,325,000 loan.

Other construction undertakings now before the Councils include an ordinance for a loan of $5,000,000 to pay the city's share of eliminating grade crossings on the Pennsylvania R. R. in the northeastern and central parts of the city. The expense of this improvement will be divided equally between the city and the railroad and if the bill is passed an early start will be made on the work. Ordinances also were before the Councils authorizing a contract between the city and the Philadelphia & Reading Ry. for abolishing the grade crossing at Green Lane, the opening of Godfrey Ave. and the construction of a bridge under the tracks of the North Penn R. R. Another ordinance authorizes the execution of a contract between the city and the Pennsylvania R. R. for the abolishment of grade crossings at Highland, Seminole, Hartwell and Chilten Aves., on the line of the connecting railroad.

A bill is before the Steam Railway Committee of the Councils, and favorable report is expected soon, for the establishment of the classification and distributing yard between 54th St. and Malvern Ave., Overbrook, by the Pennsylvania R. R. This bill practically requires the entire electrification of the new yard and also of the tunnel proposed to be built on the line of Malvern Ave. for a new branch line.

A. Merritt Taylor is Director of Transit; Morris L. Cooke is Director of Public Works. and George S. Webster is Chief of Bureau of Surveys.

Dredging in Delaware River at Philadelphia, Pa.

A good sized government dredging contract is now being advertised. The area to be dredged is located near the upper end of Philadelphia Harbor, opposite the Point Richmond coal piers of the Philadelphia & Reading Ry. It covers a distance of 2,000 ft., as measured along the center line of the channel of the Delaware River.

The area to be dredged has a present depth of from 21 to 30 ft. at mean low water. The mean range of tide at this locality is about 5.5 ft., and the maximum velocity of the normal tidal current is about 2.3 miles per hour. The usual working season extends from March 15 to Dec. 31. The work to be done consists in the excavation of a channel having a bottom width of 1,000 ft. (except immediately in front of the piers) a least depth of 35 ft. at mean low water and a length of 2,000 ft. No dredging will be done within 50 ft. of any pier.

The estimated quantity of material to be removed is 800,000 cu. yds., scow measurement. The over depth allowance between the planes of 35 ft. and 36.5 ft. is estimated at 120,000 cu. yds., scow measurement. The material to be removed is believed to be firm mud, with an admixture of sand, clay, gravel and cobbles and, possibly, boulders. It is understood that the city of Philadelphia, when dredging in this locality, found the material to be very hard and difficult of excavation and disposition. The material excavated must be transported and deposited above high water, or in inclosed basins, at places provided by the contractor and approved by the contracting officers. The method which has generally been used for disposing of material dredged from the Delaware River is to dump the material from scows into rehandling basins, from which it is pumped ashore above high tide by hydraulic pipe line dredges.

Bids for dredging in the Delaware River, in Philadelphia Harbor, will be received until noon, June 21, by Col. Geo. A. Zinn, U. S. Engineer, 815 Witherspoon Bldg., Philadelphia, Pa.

Current Constructional Activities in Cincinnati.

The following notes pertain to the contemplated constructional activities in Cincinnati:

Water Department—All water mains are laid by contract in Cincinnati. There will be considerable work this year on the new high pressure fire system. The installation of this system was begun in 1914 and will be finished in 1916. This year the 36-in. low pressure loop around the high pressure district will be finished. This will involve the laying of about five miles of 36-in. pipe, part of which is yet to be placed under contract.

At Kennedy, a recently annexed subdivision, a group of five water storage tanks, aggregating a cost of $100,000, will be placed under contract this summer. These tanks will be constructed of a steel shell lining surrounded by 6 ins. of concrete. The design has not yet been adopted but is rapidly taking form to combine utility and good appearance. Mr. J. A. Hiller is General Superintendent of Water Works, and Mr. Philip Fosdick is Director of Public Service.

City Engineer's Department.—The Duck and Mill Creek interceptors, of the new sewage collection works, are partially under contract. The city is now asking bids for $1,000,000 worth of sewer bonds to provide funds for the work on the Mill Creek interceptor. This money will be used to close an 18,000-ft. gap between the portion now under contract and the Ohio River. Nothing new is immediately contemplated on the Duck Creek interceptor.

Awards of contracts for relief sewers are being let daily, at this time, in amounts ranging from $5,000 to $40,000. Street work is being held up on account of a shortage of funds.

Bids will be received until noon of June 1 for constructing the proposed Park Avenue bridge. This is to be a reinforced-concrete structure. The estimated cost is $165,000. Mr. F. S. Krug is city engineer.

Highway Construction in Illinois.

Larger expenditures will be made this year in Illinois for highway construction than ever before. The state aid bills now before the legislature carry an appropriation of $2,750,000 for road purposes. This legislation has received the approval of the governor and legislative committee chairmen and is practically assured of passage. The funds made available by the previous legislature amounted to $1,100,000, so that the present appropriation will be an increase of $1,650,000. This fund becomes available July 1 and will provide for the work for the ensuing two years. The counties pay one-half the cost of the state aid roads.

In addition to the work to be done by the state large construction programs will be carried out by counties, townships and road districts under bond issues. Two counties alone, Cook and Vermillion, have voted $3,500,000 of bonds for highway improvements, and this work will be started in the near future. Vermillion county, in fact, began advertising for bids for the construction of 174 miles of hard surfaced roads, but the letting was postponed because of a suit brought against the county. The preliminary work, however, is being proceeded with and everything made ready for the new letting which will be held in the near future. The work in Vermillion county, on which the bids were asked, provided for the construction of concrete and brick surface roads, or part concrete and part brick roads with gravel or broken stone shoulders. The system was divided into 18 sections. In Cook county, a $2,000,000 bond issue is available and preliminary work looking to the beginning of actual construction in the near future is now well advanced.

PERSONALS

Mr. Le Roy Greenalch is city engineer of Rensselaer, N. Y. It has been erroneously stated in several papers that Mr. Greenalch had succeeded Alfred Kaufman, who recently resigned as city engineer of Albany, N. Y.

Mr. W. S. Moore has been appointed city engineer of Grand Rapids, Mich. Mr. Moore was assistant city engineer of South Bend, Ind., from 1898 to 1904. For six years following he was city engineer of Mishawaka, Ind., and for the past five years he has been city engineer of South Bend. Mr. Moore has also been retained as consulting engineer on numerous works, and has designed several large concrete bridges for St. Joseph and Elkhart counties.

Mr. E. F. Ayres has been appointed resident engineer of the Oregon State Highway Commission, at Sherwood, Ore. He is in charge of the Rex-Tigardville section of the Capitol Highway, Washington County, Oregon, which comprises six miles of water bound macadam. Mr. Ayres was in general engineering practice from 1895 to 1903. Since that time he has specialized in highway engineering, and has been employed on such work in Massachusetts, New York, Texas, Oklahoma, Washington and Oregon. He is the author of

"Earth Roads and Culverts," published as a bulletin by the Oregon Agricultural College in 1912.

Dr. George A. Soper, ex-president of the Metropolitan Sanitary Commission of New York, and chairman of the Board of Experts, invited by the Real Estate Board of Chicago, to report upon the sanitary problem of Chicago, will address the Ways and Means Committee of the Chicago Association of Commerce, Hotel La Salle, Wednesday, May 26th, 12 o'clock noon. Subdivision 63—engineers, will have a special table at this luncheon and invites all the engineers of Chicago to be present to hear Dr. Soper's address on the future sanitary policy of Chicago, the most important engineering and health question that confronts this city.

Mr. F. O. Eichelberger has been appointed city engineer of Dayton, Ohio, succeeding G. C. Cummin, who resigned to become city manager of Jackson, Mich. Mr. Eichelberger was with F. J. Cellarius, civil engineer, in 1901-1903, engaged on an atlas of the city of Dayton. The year following, he was bridge inspector for the San Pedro, Los Angeles & Salt Lake Railroad, and in 1904-05, engaged in macadam road building in Montgomery County, Ohio. In 1905 Mr. Eichelberger entered the service of the city of Dayton, as second assistant engineer. From 1907 to 1911 he was special engineer in charge of sewers. Since 1911 he has been first assistant city engineer.

Mr. William J. Orchard has resigned as assistant sanitary engineer of the New Jersey State Board of Health, to become associated with Wallace & Tiernan & Co., Inc., 136 Liberty street, New York City, engaged in the construction and installation of chlorine control apparatus for water and sewage disinfection. Mr. Orchard is a graduate from the Massachusetts Institute of Technology, in sanitary engineering. In 1908 he was employed by the Charles River Basin Commission and in 1909 by the engineering department of the Massachusetts State Board of Health. During 1910 and 1911 he was in the engineering department of the Metropolitan Water & Sewage Board, and in 1912 was again a member of the engineering department of the Massachusetts State Board of Health. He has been assistant sanitary engineer for the New Jersey State Board of Health.

Mr. J. X. Cohen has been appointed designing engineer for the Sewage Disposal Works of Syracuse, N. Y. This work will involve the design of a 50,000,000-gal. sewage pumping station, a force main about 22,000 ft. long and a sewage treatment plant, of 50,000,000 gals. daily capacity. Mr. Cohen has been in the sanitary engineering field for the past eight years. He has been with Hering & Fuller, later with Hering & Gregory since 1907. During this time he has assisted in the preparation of reports, plans and specifications for 10 refuse disposal projects, over 30 water supply and purification works and more than 60 sewerage systems or disposal works. He has also been in active charge of the construction of a number of sewage disposal plants for small municipalities and institutions. Mr. Cohen is a graduate of Cooper Union, attaining his C. E. degree in 1914. He is a Junior in the American Society of Civil Engineers.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examination:

Marine engine draftsman for submarines; $4.00 to $5.04 per diem. June 23-24.

$50,000,000 Road Loan for Pennsylvania.

Both branches of the Pennsylvania Legislature have passed the resolution proposing a constitutional amendment to permit the state to issue $50,000,000 of bonds for highway improvements. This resolution must be passed by the next Legislature to enable it to be submitted to the voters. In the event of passage by the General Assembly of 1917 it could be submitted to popular vote in November, 1918.

New President of American Waterworks Association.

Nicholas S. Hill, Jr., consulting hydraulic and sanitary engineer, was elected president of the American Waterworks Association for the coming year, on a letter ballot by the members. His election was announced at the annual convention held at Cincinnati, May 10-14.

Mr. Hill graduated from the Stevens Institute of Technology in 1892. His first engineering work was done for the South Side Elevated Railroad Co. of Chicago, whose service he entered as a mechanical engineer and rose to the position of chief mechanical engineer. In 1893 he was appointed engineer-secretary of the Sewerage Commission of Baltimore. The following year he was appointed engineer to electrical commission of that city, and in 1897-98 he was chief engineer of the Baltimore Water Department. In 1903 he was appointed chief engineer of the New York City water department. His work for both cities is well known, and upon his entering private practice in 1904, his services as consulting engineer were in demand by a number of cities and water companies in various parts of the country, on matters relating to construction, operation and improvement of water supplies. He has been retained on valuation of a number of water works properties and in connection with sewers and sewage disposal projects.

Nicholas S Hill Jr

In 1913 Mr. Hill was chairman of the Advisory Commission of Engineers on the Jerome Park Filters. He was a member of the Board of Appraisers appointed by the New Jersey State Water Supply Commission, to appraise the properties of the East Jersey Water Co. He was also a member of the committee appointed by the State of New York to report upon the pollution of harbors along the Atlantic Seaboard in connection with litigation between the State of New York and the State of New Jersey in re the Passaic Valley Trunk Sewer Project. He was expert in charge for Jersey City in the now celebrated case of the Mayor and Alderman of Jersey City vs. the Jersey City Water Supply Co.

At the present time Mr. Hill is President of the Water Board of East Orange, N. J.

Mr. Hill is a member of the firm of Hill & Ferguson, consulting engineers, 100 William street, New York. The firm specializes in water supply, hydraulic power developments and sewage disposal. He is a member of a number of other technical and scientific societies, including the American Institute of Consulting Engineers, the American Society of Mechanical Engineers, the New England Water Works Association and the American Society for Testing Materials.

CONTRACTORS.

The Marsch-Cleary-White Construction Co., which was recently awarded the contract for 500,000 cu. yds. of grading and 55,000 cu. yds. of concrete in connection with flood protection work along the White River at Indianapolis, is composed of John Marsch, and the Cleary-White Construction Co., both well known Chicago contractors. The Chicago office of the combined company is at Room 1307, 105 W. Monroe St., in charge of Mr. G. H. Hailey.

The Schaw-Batcher Company Pipe Works, 211-219 J. Street, Sacramento, Cal., has taken the contract for the extension of the water main system of the city of Sacramento, aggregating approximately $600,000. The type of pipe to be supplied will be partially of riveted steel, which will be manufactured by the company at their South San Francisco works, and the balance of cast iron, which will be supplied by the United States Pipe and Foundry Co. The Schaw-Batcher Company has successfully handled in the past many large contracts, the most notable ones in recent years having been the duplication of the Bull Run pipe line, supplying water to the city of Portland, at a cost of $1,250,000, and the fabrication of the riveted pipe used in the power plant of the Pacific Gas & Electric Co. at the Lake Spaulding project in California. The officers of the company are: William Schaw, president; J. H. Batcher, vice-president; A. H. Heilbron, secretary; F. H. Kiefer, treasurer. The company has an extended experience, running over many years in contracts of this nature and are fully equipped for handling contingencies that may arise on the Sacramento work.

The Eureka Paving Co. of Houston, Texas, recently awarded large contracts on street work in that city, last year laid 70,000 yds. of pavement in San Antonio, 98,000 yds. asphaltic concrete, 15,000 yds. wood block, and 10,000 yds. of brick paving in Houston. In 1913 the company laid 60,000 yds. of sheet asphalt in Houston and in Port Arthur. The present contracts call for 59,911 sq. yds. of asphaltic concrete, 48,680 cu. yds. excavation; 23,083 lin. ft. of standard 18-in. curb; 24,340 ft. concrete curb and gutter; 59,911 sq. yds. of 4-in. concrete base. The total bid was $143,726.40. The company also has a contract for one concrete bridge, $11,574. Mr. H. J. Cullinan, formerly in charge of the Paving & Roads Division of the Texas Company, is president of the Eureka Paving Co. Mr. J. A. Handy, formerly with the Barber Asphalt Co., and later superintendent of the municipal plant at New Orleans, is vice-president and manager. Mr. E. E. Clancy, secretary and treasurer, was connected with large railroad contractors for 12 years.

OBITUARIES

Edmund K. Turner, formerly chief engineer of the old Fitchburg Railroad, died in Brookline, Mass., May 6, aged 67.

In 1891 he resigned and the next year established himself as a consulting engineer.

Philip Mirtz, assistant chief engineer of the New York Central Railroad, died in New York City May 11, aged 31.

Mr. Turner graduated from the Massachusetts Institute of Technology in 1870 with high honors, and two years later became chief engineer of the old Nashua, Acton & Boston Railroad. Within two years he accepted a similar position on the Fitchburg, making a splendid record for efficient service. After 10 years he was made assistant superintendent of the road, acting in the dual capacity for seven years. At various times during this period he acted as chief engineer of other New England roads.

NEW CATALOGUES

Couplings.—Paper, 3½x6 ins.; 6 pp. The Chapman Valve Manufacturing Co., Indian Orchard, Mass.

Describes Anderson patented couplings and gives price lists, with sizes and weights. Illustrated.

Railway Standpipes.—Paper, 6x9 ins.; 8 pp. American Valve & Meter Co., Cincinnati, Ohio.

Describes the Poage Automatic Water Column, its flexible, non-freezable drop-spout, special valve mechanism, and gravity turning device. Illustrated.

Meter Statistics.—Paper, 3½x6 ins.; 12 pp. Pittsburgh Meter Co., East Pittsburgh, Pa.

A little pamphlet containing data on water consumption and the use of meters in over three hundred representative cities and towns in the United States.

Drills.—Paper, 6x9 ins.; 12 pp. Sullivan Machinery Co., 122 S. Michigan ave., Chicago.

Bulletin No. 66 G, describing Sullivan airfeed stoping drills, "DF-21," "DA-21," and "DG-21." As in all Sullivan publications, the machines are described in detail, with instructions for operation and illustrations showing typical work.

Permutit.—Paper, 6x9 ins.; 20 pp. The Permutit Co., 30 East 42nd street, New York City.

Describes Permutit, the Permutit process of softening water and the Permutit apparatus. Illustrated with half-tones and diagrams and gives data as to application in various industries and costs.

Meter Testing Machine.—Paper, 6x9 ins.; 16 pp. The Ford Meter Box Co., Wabash, Ind.

Describes the Ford Meter testing machine, a practical and comparatively inexpensive device for rapidly and accurately testing water meters. Explains the methods used in testing and gives tables.

Water Meters.—Paper, 6x9 ins.; 8 pp. National Meter Co., 224 E. Fourth street, Cincinnati, Ohio.

Describes Type K Nash meters, giving details of design, specifications and illustrations. These are disc-type meters with bronze casing, and breakable flange washer, made in ⅝, ¾ and 1-in. sizes.

Enameled Tanks.—Paper, 6x9 ins.; 14 pp. The Dover Boiler Works, 50 Church street, New York City.

Dover rust-proof enamaled tanks, and bitumastic enamel and its application to steel tanks and other structures are described in this book. Shows some of the structures and gives data on durability, maintenance costs, etc.

Air Compressors.—Paper, 5½x3¼ ins.; 32 pp. Sullivan Machinery Co., 122 S. Michigan ave., Chicago.

"Blue Booklet" No. 115, showing styles and capacities of Sullivan air compressors. The descriptive matter is confined to comprehensive captions, and tables of dimensions and power requirements. Arranged for easy reference.

Meters.—Paper, 6x9 ins.; 48 pp. Henry R. Worthington, 115 Broadway, New York City.

Illustrates and describes Worthington meters of the piston, disc and turbine types. Gives tables of sizes and capacities, diagrams showing construction and parts, and ten pages of useful general information and tables relating to meterage.

Concrete Mixers.—Paper, 6x9 ins.; 40 pp. The Standard Scale and Supply Co., 1345 Wabash ave., Chicago.

Catalogue Y-125, describing the "Standard" low-charging concrete mixer. Shows improved features of the 1915 type and views of typical operations. The "Standard" special street paving mixer with skip-loader, sectional delivery spout and forward and reverse traction is particularly described.

CATALOGUE REVIEWS

Steam Shovels.—Paper, 6x8½ ins.; 48 pp. Marion Steam Shovel Co., Marion, Ohio.

"Marion Reliability and Your Profits," is the suggestive title of the latest catalogue (No. 93) of the Marion Steam Shovel Co. It is an attractive little booklet, written in an entertaining style and illustrated with numerous half-tone reproductions of actual photographs of Marion shovels on the job. Various kinds of work are shown, in widely separated places and differing conditions. The efficiency and economy of the shovels are argued from the facts shown in these cuts. Construction and operation are described, and specifications for several models are included.

Trenching Machines.—Paper, 9x12 ins.; 32 pp. F. C. Austin Drainage Excavator Co., Railway Exchange Bldg., Chicago.

Catalogue 109A, describing Austin trenching machines, is a well illustrated publication containing considerable data on the design, construction and operation of these machines. The photographs showing the possibilities of the trench excavator are gathered from many sources, and illustrate some unique operations. Abbreviated specifications are given for several types and upkeep costs are given.

INDUSTRIAL NOTES

The Burd High Compression Ring Co., Rockford, Ill., has secured the contract from the Packard Motor Car Co. of Detroit, Mich., to supply the entire 1916 requirements of the Packard Co., with the patented Burd high compression rings.

MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York, recently has been awarded the following: Two contracts for pedestal concrete piles at the Eagle Works of the Standard Oil Company, Claremont, N. J.; foundation of the new Boston National League Baseball Co. grandstand; foundations of the new fountain in Grant Park, Chicago; foundation for addition to Malleable Iron Fittings Co., Branford, Conn.

The Raymond Concrete Pile Co., New York and Chicago, recently has been awarded a contract by the Crucible Steel Co. of America, Pittsburgh, Pa., for the design and construction of the foundations, tunnels, etc., for the new ordnance department buildings at their Atha plant, Harrison, N. J. The contract includes several thousand concrete and wooden piles as well as a large amount of excavation and reinforced concrete construction. The Raymond Concrete Pile Co. also has been awarded contract for placing concrete piles in foundations for the following buildings: Church of St. George, Brooklyn, N. Y.; New Syria Temple, Pittsburgh; new reinforced concrete warehouse for P. H. Butler Co., Pittsburgh; Connelly Bldg., Atlanta, Ga.; warehouse, Baltimore, Md.; warehouse for Eagle Pencil Co., New York City; Christy paint works of National Tube Co. at McKeesport.

FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409 U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should be made to the file numbers.

Technical Supplies and Machinery.—Association in Russia wishes to get in communication with American manufacturers and exporters who may desire to build up a trade in that country, especially in technical supplies and machinery No. 16811. [For address see first paragraph.]

Hoists.—American consular officer reports a possible market for sale of hoists in Italy. No. 16808. [For address see first paragraph.]

Pumps.—Commission merchant in Russia desires to establish commercial relations with American manufacturers and exporters of centrifugal and elastic pumps. No. 16821. [For address see first paragraph.]

Steam Cranes.—Foreign chamber of commerce wishes offers for 2-ton capacity steam cranes with reach of 29.37 ft. No. 16828. [For address see first paragraph.]

Pipe.—An American consular officer in South America reports an opportunity for the sale of 3, 4 and 5-inch pipe for use at pumping stations in his district. No. 16831. [For address see first paragraph.]

Hoists—An American consular officer in South America transmits a detailed report relative to a possible opportunity for the sale of steel hoists in his district. No. 16832. [For address see first paragraph.]

Railway Material.—A consular officer in one of the neutral European countries transmits a number of blue prints, specifications, etc., relative to an opportunity for the sale of railway material. Cable quotations are desired. No. 16829. [For address see first paragraph.]

Construction Material.—Business man in France wishes to enter into commercial relations with American manufacturers and exporters of dressed and rough lumber for building contractors, structural iron and steel for buildings and railroads, wood-working machinery, metal and wooden bridges, hoisting machinery such as cranes, mining and excavating machinery, stone crushers, cement mixers, and transportation devices, such as cars, portable railway lines, locomotives, automobiles, wheelbarrows, etc. No. 16862. [For address see first paragraph.]

Water Turbines.—A firm in Honduras wishes to secure prices and descriptive catalogues for small water turbines for electric plants. Prices and weights should be stated f. o. b. New York and New Orleans. No. 16893. [For address see first paragraph.]

Road Rollers.—Firm in Russia wishes to receive quotations and full information on 12-ton road rollers, to be run by gasoline or kerosene. No. 16870. [For address see first paragraph.]

Pipe.—Firm in Honduras wishes catalogues and prices on riveted steel and iron pipe for turbine conduits. No. 16877. [For address see first paragraph.]

Ties.—An American consular officer in Europe transmits specifications, etc., relative to an opportunity for the sale of railroad ties. The specifications, etc., may be examined at the Bureau of Foreign and Domestic Commerce or its branch offices. No. 16885.

Pipe, Nails, Etc.—Business man in Canada desires to receive prices and full information relative to pipe, wire nails, etc., f. o. b. American ports, including freight rates to Madras and Bombay, India. No. 16,817. [For address see first paragraph.]

Wire and Cables.—English firm desires to secure an agency for the sale of American wire and cables. No. 16,816. [For address see first paragraph.]

Ice Plant Machinery.—Company in Honduras wishes to secure catalogues and price lists and full information relative to the cost of installation, cost of production of ice, approimate shipping weight, crated for export, and prices f. o. b. New York or New Orleans for ice plant machinery. Plans of 1-ton capacity and less, for gasoline engine or electric power, are in demand. No. 16,889. [For address see first paragraph.]

Steel Plates for Boilers.—A firm of coppersmiths and plumbers in England desires quotations from American manufacturers of steel plates for boiler making 3/16 to 5/16 ins. in thickness. No. 16,852. [For address see first paragraph.]

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Can Anything New Be Said About Depreciation?

To one at all acquainted with the scores of articles on depreciation it might seem that "the last word" must have been said some time ago. The reading of an article by H. P. Gillette in the water works section of this issue will tend, we believe, to shake belief in the finished state of our knowledge, even as to the fundamental principles of estimating depreciation.

In our issue of Oct. 30, 1912, the same author published an extended discussion of depreciation, but in that article minor attention was given to accrued depreciation and major attention was focused on depreciation annuities and maintenance expense. Depreciation annuities and current repairs are so interrelated that neither can properly and fully be considered without consideration of the other, yet this important fact has scarcely received more than mention in the numberless discussions on the subject of "upkeep."

Mr. Gillette, in the article in this issue, calls attention to a matter that has not been discussed hitherto. We refer to the "identical plant theory of reproduction cost," the advocates of which assert that they do not attempt to "re-engineer" the plant that they appraise. Mr. Gillette says that although this is their avowed position they fail to adhere to it, for they deduct functional depreciation, and in so doing they set up as their standard of value the most economic plant that can be designed.

We suggest the advisability of reading the article to which reference is made, even if the reader is not particularly concerned in appraisals. The logic involved in an analysis of depreciation causes and formulas is beset with many concealed pitfalls. A study of the fallacies that have been associated with the treatment of depreciation is itself no mean training in the art of correct reasoning.

Computing Run-Off in Draining Irrigated Lands.

The irrigated land drainage problem differs in two important particulars from the problem of draining ordinary wet lands; the water does not come directly from precipitation and riddance of the soil from injurious salts (alkali) as well as from excess water is essential. Both of these factors influence design and capacity of irrigation land drainage systems, but capacity is chiefly determined by conditions of source and movement of water much more complicated than exist in wet land drainage. Precipitation records and run-off formulas and factors do not enter into irrigated land drainage or at least they are not direct influences on design. There is no direct precipitation; run-off in the ordinary sense of the term does not exist.

The water to be removed in draining irrigated land is usually percolating irrigation water. It may come from excess application of irrigation water to the tract itself or from seepage from ditches traversing the tract; in both cases the movement of the water is downward. In another case over watering of, or seepage from canals on, an adjacent tract will be the source; then the movement of the water to the injured tract is laterally through porous strata from the tract being overwatered or having leaky canals. It may be also that the water necessitating removal by drainage comes from distant higher reservoirs, canals, etc., by passage through deep porous strata; in such case the movement of the water is upward into the injured tract. Counting possible combinations of sources it is evident that estimating the quantity of water that a drainage system must handle is a somewhat intricate task.

> *The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.*

As might be expected practice is neither standard nor consistent. For small areas of a few hundred acres it is common to determine the irrigation supply and provide drain capacity for a certain fraction of this supply. The assumed fraction ranges from one-fifth when the subsoil is clay to one-third when average subsoil exists to one-half when the subsoil is sand. If the subsoil underlying the tract is gravel the irrigated area assumed is not the injured area but the area directly contributing and the fraction taken is one-third or one-half the amount of water supplied to this contributing area. These are rule of thumb methods and stand scrutiny only because they have in most cases proved reliable.

When one regards the extensive and intensive study given in wet land drainage to all the factors that enter into the determination of capacity of ditch and canal systems the rough approximations used in irrigated land drainage appear odd. It is true doubtless that analysis of percolation and ground water movement is a comparatively intricate task. Also drainage of irrigated lands until recently has been a problem infrequently presented for solution. Nevertheless the fact that an empirical guess is the basis on which most irrigated land drainage systems are designed is not creditable. This journal would be pleased to have discussion of the subject.

For Better Methods of Making Sand Analyses.

In this issue we publish an article which calls attention to the desirability of standardizing apparatus and methods for making analyses of sand and gravel. The article emphasizes the importance of this subject to the water works interests and we are, therefore, publishing it in our water works section. The subject is of general interest, however, and the betterments in procedure advocated are of direct interest to all engaged in street paving work and in general concrete construction.

The subject is one of economic importance in connection with water filtration, particularly. As Mr. Burgess points out the terms "effective size" and "uniformity coefficient," now used in specifying filter sands, have little or no significance to an ordinary contractor or to the dealer who is in the business of screening and sizing sands. The attempt to specify the size of sand grains, rather than the sizes of the openings in screens, is confusing to men of the classes named. The problem of obtaining satisfactory filter sand would doubtless be greatly simplified if specifications were drawn to stipulate that the sand, to be satisfactory, must contain certain definite quantities as separated by certain standard sieves. Such standard sieves would of course be readily available to contractor and engineer alike.

The practical importance of this matter to water works interests was forcefully brought out by Mr. F. C. Leopold, general manager of the Pittsburgh Filter Co., in his discussion of Mr. Burgess' paper. Mr. Leopold stated that beyond question the present unsatisfactory method of specifying filter sand sizes is unnecessarily adding to the expense of obtaining such sand in many localities. At present there are a great many localities where perfectly acceptable sand can be secured for filtration purposes and where fairly satisfactory screening plants are established. The only necessary addition to such existing screening plants would be inexpensive screens to secure the grade of sand necessary for filtration plants. Often when the present sand analysis requirements are put up to the local dealer he is literally scared away from the job and refuses to name a figure for furnishing the sand. Consequently many cities have paid anywhere from $2 to $10 a ton for freight on sand when equally acceptable filter sand could have been obtained elsewhere at $1.50 a ton, or less, for freight. Mr. Leopold has had charge of the installation of many water filtration plants throughout the country, in small cities as well as in large ones, and certaintly is thoroughly in touch with conditions as they exist today. He feels that there is no justification for the use of methods and terms of sand analysis which add nothing to the final efficiency of the filtration plant, but which prevent a local dealer who could do so from furnishing material that would adequately fulfill the requirements.

In a word, the mechanical analysis of sand, which ought to be a very simple process, has been rendered somewhat mysterious by the methods now in vogue in specifying filter sands. This element of mystery is also a considerable element of needless expense for the reasons stated. A committee of the American Water Works Association has been appointed to consider the revision of present methods of making sand analyses, and will report at the next annual convention.

A Comprehensive Investigation of Engineering Education.

Many engineers have written their views on the subject of engineering education, some have orally expressed their ideas, while others who have not been able to obtain a hearing have felt that proper attention to their views, on the part of those in charge of our engineering schools, would speedily have resulted in a happy solution of the problem. That the subject is one of vital concern to engineers is evident, and it is just as evident to those who have given the subject study that our engineering schools are at variance as to what constitute proper courses of study. Some schools have given undue attention to the demand that its graduates be immediately capable of doing efficient work along certain lines, while others have taken the position that a thorough grounding in the fundamentals of engineering is of greatest value. It is undoubtedly true that a broad study of the subject should result in the formulation of principles which may serve as a guide to those who have in charge the laying out and administering of engineering courses. It is of interest to note that the Carnegie Foundation for the Advancement of Teaching, in conjunction with seven engineering societies and the General Education Board, has undertaken a comprehensive study of engineering education in this country. A list of questions has been sent to members in an effort to secure a wide and representative expression of opinions and ideas. As there are many practicing engineers who are not members of these societies we are here reprinting the list of questions submitted. It is requested that the answer to each question shall not exceed 75 words. Replies should be sent direct to The Carnegie Foundation for the Advancement of Teaching, 576 Fifth Ave., New York.

1. What are the particular points at which the work of the engineering schools is effective and successful?

2. What are the particular points at which the work of the engineering schools is least effective and successful?

3. What specific experiences illustrate the conclusions expressed in your answers to questions 1 and 2?

4. What are the most important factors in determining probable success or failure in engineering?

5. When examining a candidate for a prospective job, what sort of information is best calculated to assist in judging his fitness and probable success? Give samples.

6. What sort of work, what specific jobs, what kind of experiences are most effective in testing a man for fitness and probable success in engineering? Give samples.

7. Have you ever found a knowledge of either French, German or Spanish essential to your professional career?

8. Should a reading knowledge of one of the modern languages be required of every engineer? Why?

9. Make specific suggestions for the improvement and strengthening of engineering schools.

In addition to requesting information from engineers in active practice the Foundation is submitting another list of questions to teachers in engineering schools, and is making a direct study of the methods used in various engineering schools and of results secured. It is hoped, as a result of this comprehensive investigation, that definite conclusions can be drawn which will aid engineering schools in giving more efficient training under the conditions with which each must contend.

Mathematics and Logic.

Mathematicians have frequently contended that deductive logic finds its highest and best exemplification in the science of mathematics. Engineers have often gone a step farther, urging that applied mathematics gives the most useful training in the art of deductive reasoning. Without belittling the merits of either pure or applied mathematics as disciplinary in logic, we wish to urge the necessity of other sorts of training in reasoning from premises to conclusions.

One of the grave defects of mathematics as a training in logic is the very fixity of its symbols. Its fundamental terms are carefully defined and universally accepted. A circle is a circle the world over. But with the ordinary symbols of ideas—the common words of every day usage—there is no such fixity or universality of acceptance. Consequently deductive reasoning that is not mathematical is subject to errors of a kind that rarely occur either in pure or applied mathematics.

To take a simple illustration, there are words "cost" and "value," often used as if they were perfectly interchangeable, yet they are perfectly interchangeable only at the instant that a purchase in a free market is made and then only as related to one party to the transaction. At that instant of exchange the "cost" to the purchaser is the market "value" for the thing exchanged. Yet even at that instant the market "value" is not the "cost" to the seller.

Recently a public service commission refused to recognize "brokerage" on bonds as a part of the "cost of reproducing" a plant. Upon examination of the reasoning leading to this conclusion, we find that the commission made its mistaken inference because it used the terms "value" and "cost" interchangeably. Briefly the reasoning was as follows:

If A builds a house with his own money, and B builds the same sort of house with borrowed money on which he pays a brokerage, B's house will command no greater price or rental than A's. Therefore brokerage adds nothing to the value of a house, and, by parity of reasoning, adds nothing to the rate-making value of a public utility plant.

The subtle sophistry here lies in the fact that "cost of reproduction" was the assumed "rate-making value," and the two things—one a "cost" and the other a "value"—were regarded as identical! Of course "brokerage" adds nothing to commercial "value," but it certainly does add to "cost."

Commercially the value of a plant is greater the less it costs, so long as its product sells at a fixed price.

By the same reasoning used to reject brokerage as a part of cost of reproduction, other items of actual cost could be rejected.

The decisions of courts, as well as of public service commissions, again and again furnish us examples of false reasoning due to lack of clear and full understanding of the two common words "cost" and "value." Unfortunately, also, the testimony and writings of engineers often give examples of similar sophistry, indicating that mathematical training alone does not afford sufficient protection against this sort of false deduction.

A careful study of language is absolutely essential to correct deductive reasoning, save where mathematical symbols and terms are involved. Since most reasoning is not quantitative, and therefore not mathematical, it follows that no man can hope to become a thoroughly good logician until he has acquired the habit of using words with extreme precision. In this respect the average lawyer is likely to excell the average engineer.

A study of language has often been urged upon engineers as a means of gaining the respect of well educated men, as well as a means of conveying ideas clearly and forcefully. But we recall no reference to language study as a means of training engineers to be better logicians. Of course when this is the end in view, language must be studied primarily as a reasoning tool. The ordinary rhetoric has nothing to say about words as symbols of ratiocination. It deals with them only as devices to convey ideas lucidly and with elegance.

It may be helpful to other engineers, as it was to the writer, to regard words as symbols that indicate a force or group of forces—kinetic or static. A single word may indicate a force-group, or it may require a full sentence or even several sentences, to symbolize a given force-group. All reasoning relates to force-groups that have recorded themselves upon the mind, much as sound waves have produced a phonographic record. And the rise of ideas in the brain is much like the reproduction of a phonographic record.

Reasoning is the combination of ideas—the reproduction of parts of sense-records in sequence. Words are the symbols of these sense-records, and, where the sense-record is at all complex, words are as essential in general reasoning as are symbols in mathematical analysis. Once let this conception of the reasoning process be clearly formed and there will inevitably arise a great respect for language as a reasoning instrument. Instead of being regarded, as it now is, merely as a device for conveying thought—or for concealing thought, as a satirical Frenchman had it—language will be held worthy of most careful study because it is part of the essential mechanism of all profound, and of nearly all ordinary, thinking.

"Men are such stuff as dreams are made on," but language gives the dreamers power to apprehend reality.

Word study is as essential to the logician as study of the properties of materials is to the engineer.

The Growing Tendency in Concrete Road Construction Toward Refinement in Quality of Materials.

The successful future of concrete roads depends upon firm adherence to superior quality concrete. Subgrading and drainage may be good and, of course, must be good for any road that is to endure, but the final criterion of a concrete road as distinguished from other constructions is the integrity and durability of the material itself—the quality of the concrete. The service to be given by concrete in no other structure calls for such perfect quality of material as is demanded in a road. This truth is not a new discovery. It has long been known to the few best students of concrete roads. The new feature is that whereas formerly the few observed the truth and the many neglected it, now the many observe the truth and only the few neglect it. One is very strongly impressed with this change who reviews the last season's reports of municipalities that have been building concrete roads for a few years.

The quality of concrete is determined by the quality of the raw materials, by the proportioning and incorporation of these materials, and by the curing of the deposited mixtures. To the perfection of all of these things experienced concrete road builders are paying now much more strict attention than a year ago was considered at all essential and are urging even stricter attention in future work. Practice has reached a point where demand exists for refinement in materials for and processes of concrete production for roads. This stage of attainment in the development of the concrete road is to our mind the finest promise that we have that the concrete road has arrived.

First, in the attention being given to insure better concrete materials, is cement. Very few communities having much experience in concrete road building fail to provide for the thorough testing of all cement. This is essential. Few materials as widely manufactured as is Portland cement rank more uniformly of high average quality, but all cement is not test proof any more than are every brick and every steel bar. No road job of size fails to receive an occasional shipment of cement that has to be rejected. The safeguard is testing. To make testing practicable and to provide direct control, commissions having concrete road work in charge are adopting the plan of furnishing all cement. Besides securing control of the testing, the road authorities by this plan avoid any tendency of the contractor to reduce the cement content of his concrete. Excessive use is prevented by holding the contractor responsible for any over run of cement and for loss of cement bags.

Aggregates for concrete for road work need and are receiving increased scrutiny as to quality. Pit run gravel is not accepted by many. Stone and screened gravel are required to be graded and to be kept within narrow size limits. In some work the coarse aggregate is required to conform to a set co-efficient of wear. Inspection of sand is rigid. The dirt content and the proportion of flat flakes are being strictly limited and demand is usual that the grading of particles be fairly perfect. Altogether concrete road practice in the requirements for quality of concrete aggregates is superior to that in almost all other kinds of concrete construction.

The best road construction sets a high standard of perfection in the proportioning and mixing of concrete. Set proportions are commonly abjured. The aggregate is studied to determine proportion of voids, sizes, form and gradation of particles and the concrete content is varied to conform, and as frequently as need be, with the purpose of securing density of mixture. Duration and speed of mixing are strictly governed. One road commissioner has conducted careful tests to determine the quality of mixture produced by different numbers of revolutions and different speeds of rotation of the mixer used and on the results has set rigid requirements for mixing time and mixer speed. Here it may be noted that individual tests are positively necessary on each work where different mixers are used; for the speed of rotation and number of turns which give the best concrete with one mixer are no criterion of what another mixer will do.

Methods of curing are numerous and the difference in efficiency between the better methods is not great. The advance in curing methods indicated by recent practice is shown rather in the care with which all methods are carried out than in devising unique methods. The curing period is lengthened wherever possible; water is supplied liberally and the road slab is kept continuously wet; protection from wind and sun is sought.

The preceding summary of increased refinement in conducting concrete road work can be materially lengthened by adding minor details. The fact that concrete road building is becoming a very particular task of concrete construction has, however, been clearly indicated and that is all that it was proposed to do. The contractor, all of whose experience has been in general concrete construction, must be prepared to accept new standards of refinement in concrete production when he enters the field of road work. It is more important to emphasize this fact than most of the other changed conditions that concrete road construction brings, because it is less obvious than most of the others. Coincidentally it should be noted that the tendency for increased refinement is bringing an increase in concrete pavement costs. The old "dollar a yard" slogan of the concrete road enthusiast is ceasing to have much of the truth that it once had. Dollar a yard concrete roads will be built in occasional places but the concrete road of the future will most certainly exceed materially the cost of most of the concrete roads of the past and it should do so, for unless all indications fail it will be a much better road.

WATER WORKS

The Use, Design, Construction, Cost and Durability of Wooden Stave Pipe.

V.

Construction Organization and Methods.

Contributed by Andrew Swickard, Hydraulic Engineer, Palo Alto, Calif.

ORGANIZATION OF FORCES.

The number of men required in constructing wooden stave pipe lines, and their organization into working crews, will depend entirely on the magnitude of the work. The simplest case would be that of a proposition requiring only one crew to carry the work to completion within a reasonable time; the work being so located that a camp is unnecessary. If the proposition is a large one, and the time limit comparatively short, work might be carried on at a number of points, so widely separated that more than one camp would be necessary to provide accommodations for the workmen. In the first case the work would be done under the direction of a skilled foreman working under directions from the home office, and using such labor as the immediate locality could furnish. In the second case, the work would be under the direction of a general superintendent working through the camp superintendents. Each camp superintendent would direct the affairs of the camp and the construction, through the store-keeper and foremen of each construction crew.

The number of the general superintendent's assistants would be governed by the amount of work necessary to keep the material arriving in proper proportions, and in quantities necessary to keep the construction camps supplied, to make the analysis of reports and cost data, and to keep the entire project in proper working order.

The Camp Superintendent.—The camp superintendent would keep the general office informed of his needs in material and supplies, receive and check them at his camp, redistribute to the working crews, see that the trench or bed for the pipe is properly provided, and make and render reports covering all features of the work. His number of assistants outside of the construction crews will depend entirely on circumstances, as will also the number of construction crews.

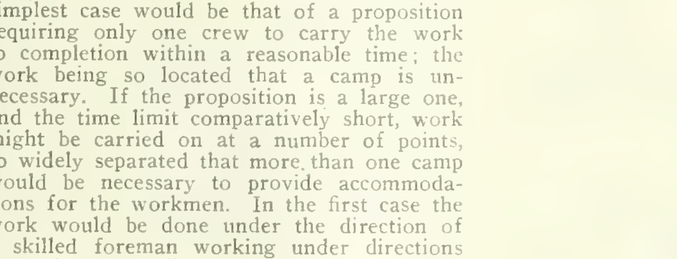


Fig. 1. Form and Centering Used in Laying Wooden Stave Pipe.

(Shows outside form with detachable braces to hold the form in place until a sufficient number of the lower staves are in place to hold the form in an upright position. Also shows wooden centering in position.)

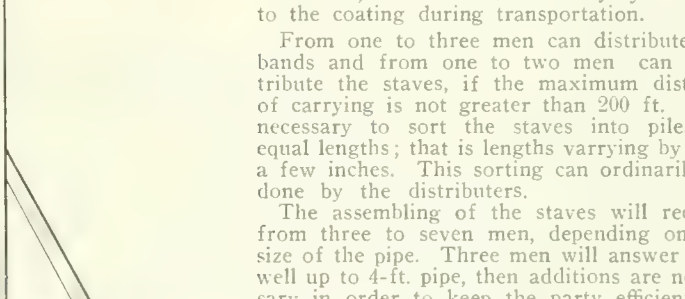


Fig. 3. Sketch Showing Inside Form Made of Gas Pipe—Suitable for Smaller Sizes of Wooden Stave Pipe.

The Construction Crew.—A construction crew will consist of the men distributing material from the points where it has been left by the teams, usually in quantities at points as near 300 ft. apart as circumstances will permit, the band benders, the band painters, those assembling the staves, those assembling and spacing the bands, and those back-cinching bands. It is usual to repaint the bands after they have been hammered during the process of back-cinching. Where the pipe is laid on sills, these are usually set by the agency that is preparing the trench or bed for the pipe.

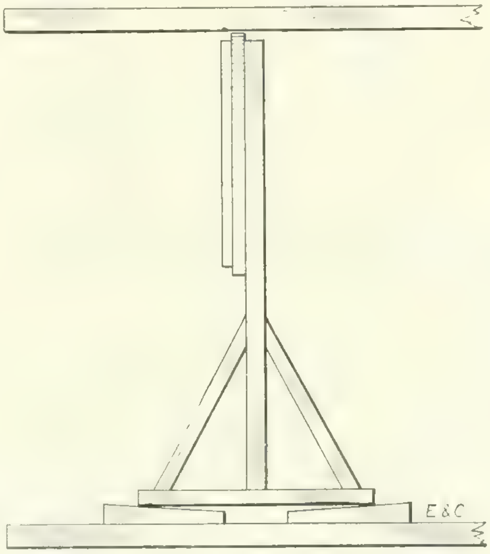


Fig. 2. Sketch of Wooden Centering in Position—Removal of Wedges Releases Form.

The number of men bending bands per crew will depend on how closely the bands are spaced on the pipe, and also on the conditions that affect the rate at which the staves are assembled; usually there will not be more than one band bender. One man can dip the bands in paint as fast as one man can bend them, provided they are placed so conveniently at the dipping vat that not more than a step or two is necessary to reach them; it requires another man to so place the bands and to remove them from the dripping board. The bending and painting of the bands is sometimes done at a stationary plant and they are then hauled to the pipe line. This is necessary if the coating is to be an application of hot asphaltum or other substance; but more or less injury is done to the coating during transportation.

From one to three men can distribute the bands and from one to two men can distribute the staves, if the maximum distance of carrying is not greater than 200 ft. It is necessary to sort the staves into piles of equal lengths; that is lengths varrying by only a few inches. This sorting can ordinarily be done by the distributers.

The assembling of the staves will require from three to seven men, depending on the size of the pipe. Three men will answer very well up to 4-ft. pipe, then additions are necessary in order to keep the party efficient.

Putting on bands and spacing them requires two men or some multiple of two, depending on the space between bands, and also on the size of the pipe. Where the spacing is wide, it will not take all of the time of two men to put on bands, and they would also assist in the distributing of the bands and possibly of the lumber. One man can put on bands on very small pipe say up to 20 ins. in diameter, or on the sizes that he can stand astride of and work.

The back cinching is best done by men working in pairs, except for the smaller sizes of pipe. The number of pairs of men will depend on the spacing of the bands and also on the size of the pipe.

The general forces on large projects would be so varied in make-up by conditions and circumstances that an illustration would not be apt. The construction crews would not vary much in make-up, be the project large or small, only in the number of crews. As illustrations of the make-up of a crew we will use one on a 30-in. pipe and one on a 60-in. pipe.

30-in. pipe, with four bands per foot:

	Per day.	Men.
Bending bands	600	1
Painting bands	600	1
Distributing bands	600	3
Putting on pipe	600	2
Back-cinching	600	8
Assembling staves, ft	150	3
Distributing staves, ft	150	1

The total number of men in a crew building 150 ft. of 30-in. pipe per day is 19. Allowing one man $3.00 per day and the others $2.50 the total cost is $48 or 32 cts. per foot of pipe. If only two bands per foot were being used the crew would consist of only 12 men at a total cost of $30.50 per day or 20⅓ cts. per foot of pipe.

60-in. pipe, with 4 bands per foot:

	Per day.	Men.
Bending bands	250	1
Painting bands	250	2
Distributing bands	250	3
Putting on pipe	250	2
Back-cinching	250	6
Assembling staves, ft	62½	4
Distributing staves, ft	62½	2

The total number of men in a crew building 62½ ft. of 60-in. pipe per day is thus seen to be 20, at a total cost of $50.50 per day or 81 cts. per foot of pipe. If only one-half as many bands per foot were being used then only 13 men would be needed at a total cost of $33 per day or approximately 53 cts. per foot.

In these illustrations conditions were assumed that would allow the banding of the pipe to keep pace with the assembling of the staves. In actual practice, the bending, painting, and distributing of the bands would be carried ahead of the distribution and assembling of the staves. Assembling the bands on the pipe would follow behind the assembling of the staves a varying distance due to the change in band spacing. The back cinching would follow in an erratic manner due to the sudden impulse of individuals to travel to greener fields. The back-cinching crew would be frequently drawn upon to fill vacancies at the front, and would thus become an unreliable quantity as far as numbers are concerned.

METHODS OF CONSTRUCTION.

Points of Beginning and Closure.—If the project is small and only one crew is used, the work would be started at one end and carried on continuously until completed, but if two crews are necessary then one of two methods can be followed: commencing at a point near the middle and working in opposite directions toward the ends, or starting a crew at each end and working toward the middle point. The completion of the pipe by joining the two ends, where two crews are building toward each other, would be accomplished by cutting staves to fit the remaining gap, then bending them until the slots in the ends of the staves would engage the metal tongues, then allowing them to or forcing them to straighten out; this forces the stave onto the tongue and into the proper position. The only difficulty in connection with this method is "rounding out" the pipe, and this is easy if the pipe is large enough so that a man can be left inside to assist in bringing the staves to a position that will make a smooth surface. Otherwise the "rounding out" is more difficult but practicable. If a man is left inside, the size of the pipe and the distance to the end must be such that he can crawl out conveniently; if this is not practicable a man-hole must be cut into the pipe to be covered with a metal plate. Where a number of crews are employed from one camp two crews would be started from selected points building in opposite directions toward approaching crews. The work can often be expedited by engendering a rivalry between approaching crews; a flag at the half-way point being the goal.

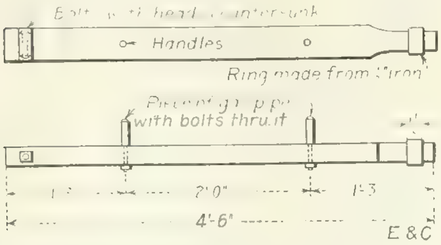

Bolt with head countersunk
Handles
Ring made from iron
Piece of gas pipe with bolts thru it
2"
2'0"
1'3
4'-6"
E&C

Fig. 4. Details of Long Driving Bar for Use in Constructing Continuous Stave Wooden Pipe Lines.

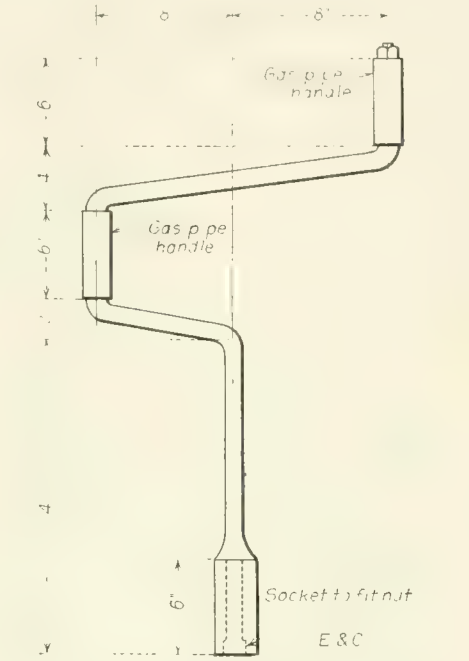


Fig. 5. Detail of Brace Wrench for Rapidly Turning Down the Nuts on Bands of Wooden Stave Pipe.

Band Bending.—The bending of the bands can be done by running them through a machine containing three driven rollers, but the fact that each rod would have heads or nuts at the ends, would interfer with the efficiency of this sort of a device. A table built of any lumber that might be available with a raised circle or half circle built on top works very nicely. The table should be of a height equivalent to that of a man's waist band, and should be heavy enough so that the force applied to bend the band will not move the table. The circle on the top of the table should have a radius less than that of the pipe for which the bands are intended; the exact radius can be determined only by trial for a given case.

Band Dipping.—The dipping vat need not be more than an ordinary wooden trough 1 ft. deep and 1 ft. wide and of a length such that a band bent to the proper form will, when standing vertically, rest on the ends of the vat but not quite reach the bottom. The band can then be rolled around sliding on the ends of the vat until the band is covered, and then out onto the drain board at either end. A contrivance of this sort is efficient and is easily and quickly moved to any desired place. The bands, for a small pipe, which are light in weight and can be handled very readily are more economically coated by dipping them bodily into a vat, of paint, of a form that will permit this.

Assembling the Staves.—The assembling of the staves of a pipe requires comparatively few and only simple tools. The first and very essential appliances are the forms, for both the outside and inside. The outside form is necessary for only the lower half of the pipe, and therefore need be only a half circle, and is best when made from gas pipe; a stiff form with a minimum of weight is thus obtained. The inside form for the smaller sizes of pipe is best made from gas pipe, and for the larger sizes of wood. See Figs. 1, 2 and 3.

After a pipe is started a crew requires one inside and one outside form, but in order to set up the first section two of each is necessary, unless the pipe is started from a cast-iron or riveted steel special, then only one outside form is necessary.

In starting a section in a case where it is intended to extend the pipe in both directions the two outside forms are set up, the staves are laid in position against the forms, keeping the two sides balanced to prevent the tendency to roll until the lower half of the staves are placed. The inside forms are then placed and the upper half of the staves are put in position. A few bands are then put on the section; enough to hold the staves rigid, say 2½ or 3 ft. apart. The forms are then removed and the outside one is set for the new sections. While the forms are being removed and set up ahead, two men, usually the head man of the crew and an assistant, put in the metal tongues in the slots in the ends of the shorter staves of the section already set up, those in the longer staves being driven in while the new section is being assembled. The tongues being longer than the slots it is necessary to pry the longer staves apart sufficiently to allow the tongue to be started then a blow or two from a light hammer seats it properly in the slot. Before allowing the staves that have been pried apart to be released it should be noticed whether or not they will assume a position that will make a smooth inside or outside surface. If an uneven surface is formed the staves at that point cannot be hammered out into place because the projecting tongue will hold them.

With the tongues inserted in the shorter staves of the section already in place and the outside form, for the new section, in place, a bottom stave of the new section is put in, one that will form the continuation of one of the shorter staves of the old section, one having a metal tongue already in place. This stave should be driven lightly with a hammer until it covers the metal tongue. Then the two adjoining staves are slid into place, butting against their corresponding staves in the old section; the metal tongue is then driven endwise into the slot formed by the two abutting ends, or is inserted in the end of the stave in the old section, before the new stave is slid in, and is driven into the slot and then downward slightly into the stave previously put into place. Then the new stave is put in place and tapped home. Then a stave on each side corresponding to a shorter stave in the old section is placed.

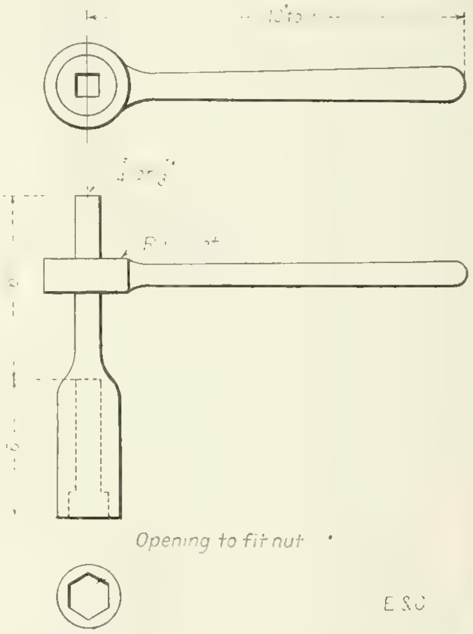


Fig. 6. Detail of Ratchet Wrench and Socket Attachment for Turning Down Nuts on Bands of Wooden Stave Pipe Lines Over 48 ins. in Diameter.

This process is carried on until half the circle is complete and then the inside form is set up and the staves are carried up until the circle is complete.

Placing Temporary Bands. A number of bands must be put on, enough to hold the section rigid, and over the dove-tailed joint enough bands must be put and cinched tight enough to prevent the joints from opening subsequently, and tight enough to prevent the staves from rebounding when being driven snugly home with an 8 or 10-lb. sledge.

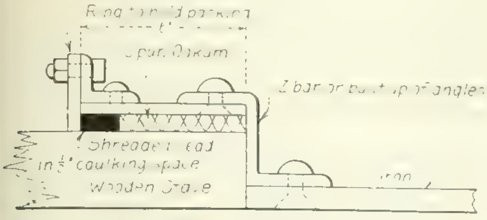


Fig. 7. Detail of Connection Between Wooden Pipe and Steel Pipe.

Driving the Staves.—If the assembled section is on a tangent, the next stage of the process is to drive the staves endwise so as to secure actual contact between the ends of the staves and a proper seating of the tongues in the bottom of the slots. This is done by holding a driving bar against the end of a stave and striking the bar with about a 10-lb. sledge. If the staves rebound when driven hard it will be necessary to cinch the bands over the joint tighter or put on more bands. A driving bar consists of a piece of oak timber about 2 ins. thick and of a width a little less than the width of the staves. The details of such a bar are shown in Fig. 4. Two bars are necessary, a long one and a short one; the long one for the short staves in the section and the short one for the projecting staves. On a tangent the driving of the staves is an easy matter, but on curves it becomes more laborious, because the bend thrown into the staves makes them drive harder, and as the bending of the pipe opens the joints on the convex side it is necessary to drive the staves two or three times.

Making Curves in Alignment.—On curves, horizontal or vertical, the next step in the process after the temporary bands have been put on a new section and the staves driven snug, is to put the necessary bend in the section. The method of doing this dpends on the size of pipe and conditions along the pipe. For small pipe the bend can be made with a lever, but for large pipe a jack-screw or a chain-block is necessary. If there is a bank against which the jack-screw can work it is the most convenient. On vertical curves the weight of the pipe with the added weight of three or four men will usually make the desired bend unless it is a very large pipe, and then a number of men jumping in unison will usually make the bend.

During the process of making a bend in the pipe the driving of the staves can be continued. Care should be taken that the bending is not carried so far that the joints on the convex side pull so far apart that the tongue comes from the slots. It would be a difficult matter to get them back without injuring the end of the stave.

On sharp curves stave joints three or four sections back are sometimes pulled apart to some extent. Three or four lengths of staves cannot be driven with a sledge hammer. A ram, consisting of a heavy timber to which are nailed cross pieces for the men to handle it with, has been used by the writer, to drive as much as 60 ft. of staves. Guides must be provided for the ram to slide on otherwise it would be difficult to hit the end of the driving bar. By being careful to put on enough extra bands over the joints on curves, the use of a ram can usually be avoided.

The assembling of the staves is but a continual repetition of the process that has been described, unless some special form of construction becomes necessary to meet some special need. This might likely occur in the reduction or increase in the size of the pipe. The staves in the larger pipe that are in excess of the number in the smaller pipe must be tapered to a point, and if the width of the staves for the two sizes is not the same the widest must be trimmed down enough, starting 2 or 3 ft. back, to make the ends correspond. Occasionally the intake end of a pipe is required to be enlarged. This is done by the introduction of tapered staves.

Assembling and Spacing Bands.—Assembling and spacing the bands on the pipe is best done by men working in pairs. If the pipe is small enough so that a man can stand astride it and work, only one man is necessary. In cases where the band is in one piece, it has been bent into a circle with the ends meeting or lapping over a little, and is put on the pipe by pulling the ends apart sufficiently to let them pass over the pipe. The band will spring back only part way, to the original shape, but the ends are easily sprung together and coupled with the shoe. A few turns of the nut renders the coupling secure. The shoes or couplings are placed along the sides of the pipe and are made to alternate, so that the shoes of adjacent bands are always on opposite sides of the pipe, and along the sides of the pipe they are arranged uniformly in rows as shown in the illustration in Article I of this series. The purpose of putting the shoes along the side of the pipe is to take advantage of the fact that the initial tension in the band is greater at the coupling than in other parts of the band, and that the consequent pressure against the pipe is greater under the shoe, than at other points under the band, and tends to prevent the pipe assuming an oval form due to the weight of the material. Bands should always be put on so that the threaded ends point upward, otherwise the nut would be below the shoe and inconvenient to tighten. Where the bands are in two parts and are bent so as to fit the pipe accurately they are easily assembled. The piece headed at both ends is placed over the top of the pipe and the shoes are hung on the heads, then the threaded piece is passed under the pipe and the ends are slipped into the shoes. For tightening nuts a brace wrench, see Fig. 5, is the most efficient form to use. It is rapid and can even be used for final cinching on pipe up to 24 ins. in diameter. The brace wrench, however, cannot be used on sizes of pipe that raises the handles so high that they cannot be worked conveniently. The limit is about a 48-in. pipe. For sizes greater than this a ratchet-wrench is the most convenient, and efficient. The ratchet is a standard tool carried by most large dealers, but for pipe work it is used on a socket made to fit the nut, see Fig. 6.

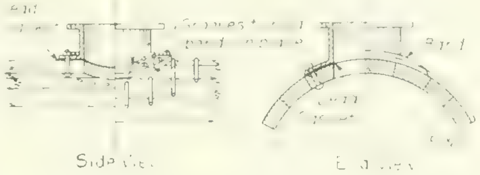


Fig. 8. Detail of Flanged Cast Iron Saddle for Connecting Air Valves, Standpipes, Blow-off Valves and Branch Pipes to Wooden Stave Pipe.

Pipe that is intended to lie on the ground and be backfilled must be kept a couple of inches above the ground by means of blocks until the bands are put on. The blocks can be removed by raising the smaller sizes of pipe slightly with two levers, and larger sizes of pipe with two short jack-screws, one on each side of the pipe.

The spacing of the bands is accomplished either by marking the position of each band on the pipe by means of a pair of dividers properly set, or by means of a gage to set each succeeding band with, in reference to the preceding one.

The back-cinching is best done with a straight wrench that connects directly with the nut. The nuts are turned on until the bands fit snugly, by those assembling and spacing bands. In the process of cinching the nuts are not moved any great distance, so that speed in turning is no object, and the straight wrench thus answers, and stands the strain best.

In cinching it is desirable to seat the bands in the wood so that the width of the indentation is not greater than the radius of the rod, or the depth of the indentation is approximately ¼ of the diameter of the rod. This cannot be accomplished by cinching alone, so it is necessary to hammer the band, using about a 2 or 3-lb. hammer for the purpose.

In cinching it is not desirable to compress the staves to greater than 200 lbs. per square inch. This can be done approximately only by judging the pull, in pounds, an average man applies to the wrench, and then making the length of the wrench in accordance with this rule. For a wrench, in length, 16 times the diameter of the bolt, the strain produced in the bolt is 45 times the pull exerted. This rule is applicable only to pressed nuts turning on rolled threads, such as are generally used on pipe, and means that a 30-lb. pull with a 12-inch. wrench will strain a ¾-in. rod up to 1,350 lbs. In order to get a leverage of 12 ins. a 14-in. wrench would be necessary.

SPECIAL CONNECTIONS.

We have covered all the essentials of construction in considerable detail. There remains the matter of special connections, such as connecting wooden pipe with iron pipe, connecting branch lines to the main, putting gate-valves in a line of pipe, and connecting air valves, stand pipes, and blow-off valves to the main line.

The connection between wood and iron pipe can be made by means of a special cast-iron or riveted steel bell. The cast-iron special bell should be made in general as in the case of standard cast-iron pipe excepting that the depth should be greater. A riveted steel bell is shown in Fig. 7.

If the branch from a wooden pipe is large, say equal to ½ the diameter of the main or larger, a special cast-iron or riveted steel "Y" set in the main is necessary. If the branch is small a cast-iron saddle bolted to the pipe to make a watertight junction, and securely held in place by the pipe bands, can be used. A saddle of this sort is shown in Fig. 8. This type of connection is suitable for blow-off valves, air-valves, stand pipes, or any other connection desired.

Figure 9 shows a number of iron specials used in a wooden pipe line, in a very small space. Besides the specials that have been mentioned is shown the method of making sharp bends; in this case by a cast-iron elbow.

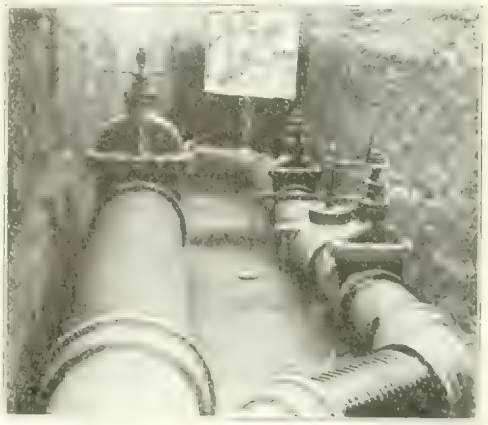


Fig. 9. View of a By-Pass in a Wooden Pipe Line Showing a Number of Special Connections.

(Shown by courtesy of the Pacific Tank and Pipe Co., of San Francisco.)

MINIMUM RADIUS OF CURVATURE.

The minimum radius of curvature allowable in wooden pipe depends on the character of the lumber, diameter of the pipe, width of staves, and to some extent on the thickness of the staves. It is practical to make a curve so sharp that staves in either the top or bottom of the pipe are liable to be broken. On a very sharp curve a stave is liable to break after the curve has been finished. The removal of a stave and putting in another on a curve is a difficult task, but can be done. The minimum radius of curvature varies directly as the diameter of the pipe and also as the width of the staves, the thickness being neglected. An approximate rule would therefore read as follows:

$R = k\,W\,D$, where
R = Radius of curvature in feet,
D = Diameter of pipe in inches,
W = Width of staves in inches, and
k = A constant, varying with the character of the wood used.

For redwood a safe value of k is 1.00 and for Douglas fir 0.80.

For example a redwood pipe 24 ins. in diameter, with staves 5¾ ins. wide can be bent to a radius of 1×5¾×24=138 ft.; with staves 3¾ ins. wide can be bent to a radius of 1×3¾×24=90 ft. A pipe 72 ins. in diameter with staves 5¾ ins. wide, 1×5¾×72=414 ft.; with staves 7¾ ins. wide 1×7¾×72=558 ft.

LIST OF TOOLS FOR ONE CONSTRUCTION CREW.

The following is a list of the necessary tools required by one construction crew:

1 bending table.
1 dipping vat.
1 outside form.
1 inside form.
2 driving bars.
1 10-lb. sledge.
1 cross-cut saw.
1 rip saw.
1 keyhole saw.
1 carpenter's hammer.
1 adze.
1 brace and bits.
2 wood chisels, 1½-in.
1 jack plane.
12 straight wrenches.
6 brace or ratchet wrenches.
12 3-lb. hammers.
2 wooden mallets with rounded faces.
1 metallic tape, 50 ft.
1 tri-square.
1 2-ft. rule.
1 pick.
1 shovel.
2 jack screws.
1 chain block.
1 crowbar.

This article concludes the series on Wooden Stave Pipe.

The Valuation of Water Works Properties.

II. Estimating Accrued Depreciation; Inspection and Tests vs. Life Formulas.

BY HALBERT P. GILLETTE.

The United States Supreme Court has repeatedly held that accrued depreciation must be deducted from the "new value" of property in arriving at an appraisal either for rate making or condemnation. In this article I will not attempt to show that rates properly made are entirely independent of the accrued depreciation, nor will I discuss the fact that accrued depreciation increases the "development cost" of a property. These are matters to be treated in subsequent articles of this series.

Accrued Depreciation is the loss in value that has accrued in a plant by virtue of the action of natural and social forces. Depreciation, then, may be classed, according to its two great causes, as (1) Natural, and (2) Functional, that is Social. The term "Commercial" is sometimes used instead of "Functional."

The forces that commonly cause Natural Depreciation are: (1) Chemical action, (2) electrical action, (3) mechanical action, and (4) vital action. Rust is an example of chemical action; electrolysis is an example of electrical action; abrasion or wear is an example of mechanical action; rotting of wood is an example of vital action, as is also the progress of senility of animals resulting finally in death.

The forces that commonly cause Functional Depreciation are: (1) Invention, (2) growth of business that renders a plant unit inadequate economically, (3) public enactment that causes either loss of part or all of the economic use of a plant unit, (4) competition that results in a reduction in unit prices.

It needs but to make these classifications of the causes of depreciation to give us pause when we undertake to say that any single simple method of estimating accrued depreciation can be applicable to all these sorts of depreciation. *Inspection*, for example, may disclose approximately the amount of wear that has occurred in the piston and cylinder of an old pump, but mere inspection may not disclose whether an old pump is as economic in the use of fuel as a new one. *Testing* alone will demonstrate the fuel efficiency of pumps. Testing alone, however, will not show the depreciated value of a pump or of any other apparatus that is to be compared with some apparatus of standard value. To make such a comparison accurately we must apply mathematics, even though it be of a very simple sort, as will be shown later.

Prospective Depreciation is the prospective cost of replacing plant units when their natural or functional lives come to an end. It is very important to distinguish between "accrued depreciation" and "prospective depreciation." Accrued depreciation can usually be estimated with considerable accuracy, even in individual cases; but prospective depreciation is more problematical and often can not be estimated at all accurately for individual plant units, even when it can be estimated with considerable accuracy for a large group of similar plant units.

Average Lives.—There are many published tables of the *average* prospective lives of different kinds of plant units. Engineers have almost universally misused these tables, for they have considered that an *average prospective* life could be used in calculating the *individual accrued loss of value* of a given plant unit. Under but one condition, or rather set of conditions, is it correct to use "life tables" in estimating accrued depreciation, namely: (1) The life of the *particular* plant unit under investigation must correspond to the life of the *average* life given in the table. This is never true, save by chance, where functional depreciation is involved. (2) There must be no appreciable difference in the lives of the *parts* that go to make up the whole of each plant unit. This is seldom true save where there are no parts that are renewed before the renewal of the whole plant unit.

To put these statements in concrete form, it may be approximately correct to say that a given wooden pole, or a railway tie, or a horse will have a life the same as that given in a table of average lives of such things. But it may be, and usually is, wholly erroneous to assume that a given pump or a given water main will have a life the same as that given in an average prospective life table. The natural life of a wooden pole, or cross-tie, or horse, ordinarily does not differ very materially even in different parts of the country; whereas the functional life of an individual pump or a given water pipe may, and usually does, depart greatly from the averages given in life tables.

In this connection attention should be called to the fact that the lives of water works units, as given in published life tables, are nearly all functional lives. Thus, reservoirs are assigned a life of 50 to 100 years. What does this mean? That a reservoir will be rusted, decayed or abraded to such an extent at the end of 50 to 100 years that it will be no longer serviceable? Not at all. It means that some engineer has come to the conclusion that the *average* reservoir has been outgrown and abandoned at the end of 50 to 100 years, and that he infers that the *average* existing reservoirs will, in the future, be replaced in 50 to 100 years. Now he may be entirely right, and, if so, the owner of every reservoir may wisely provide enough out of earnings to amortize the investment in his reservoir within 50 to 100 years. But this is not tantamount to saying that a given 25-year old reservoir has lost one-half to one-quarter its life, as many engineers have erroneously inferred.

In logic one of the fundamental principles is this: *Conclusions of fact respecting averages of many individual cases are correctly applicable only where many cases of the same sort are involved.*

Thus, it may be a fact that the average child has an expectancy of 35 years life at birth. It may also be a fact that the average man 35 years old has an expectancy of 25 years remaining life. But neither of these facts may be at all applicable in a given individual case, unless that individual is to be treated as one of a large group of similar individuals, as is done by insurance companies.

There are reservoirs hundreds of years old and in service. The same is true of aqueducts, pipes, buildings, etc. The *natural* life of such things is often so great as to be beyond determination. Even machinery of the heavier sorts often has a natural life much greater than is given in life tables relating to machinery. Thus, pumps are commonly assigned a life of 20 to 30 years, but that this is assumed to be an average functional life and not a natural life is evidenced by such facts as the existence of pumps 50 years old and still in active service. I have frequently referred to Stevenson's second locomotive, still in use in an English colliery after a century of service.

In the recent case of the Denver Union Water Co. versus City of Denver, an eminent engineer testified that the pumps in use by the company have an average age of 27 years, and he assigned a total probable life of 41 years to the pumps in spite of the fact that no published life table gives more than 30 years life for pumps. In the same case he assigned a probable life of 41 to 47 years to the wooden pipe in Denver, although the actual age of some of the pipe was nearly as old as the 30 years extreme life given in published life tables. To this I may add my own observation in two water works appraisal cases where much of the wooden stave pipe was nearly a quarter of a century old. Some of it, in fact, had been originally laid under my own eyes. Practically all of it was still in perfect condition as to the wood, and the bands were but slightly rusted.

In the Denver case a life of 23 years was assigned to boilers by an engineer representing the company, and it was stated that many of the boilers were more than 16 years old, doing good service and approved by boiler insurance companies.

The same engineer in the Denver case assigned to cast iron pipe the following lives:

16-in. and larger	94 years
10 to 15-in.	72 years
6 to 8-in.	56 years
3 to 4-in.	41 years

In this connection it is of interest to cite the fact that 6-in. cast iron pipe laid on Locust from 7th to 8th streets, Philadelphia, was recently removed after having been in service 88 years. The pipe had been cast on its side, for it varied from ½ to 5-16 in. thick. Its interior was tuberculated, but the iron showed no deterioration. The pipe might have remained in use indefinitely had it not been necessary to make way for a sewer. This and other examples show that the *natural* life of cast iron pipe is so great as never to have been recorded.

I have said enough to caution the reader against being persuaded to use published "average lives" or "extreme lives" of waterworks plant units in calculating accrued depreciation. Very few of such lives are either averages or extremes to begin with. So-called "average lives" are mostly estimates based on data insufficient to be properly called averages.

Since most of such lives depend upon the rate of growth of the towns or cities, it follows that an average life for England would not be an average life for America. An average for Maine would not be an average for California. An average for villages would not be an average for cities. And so on indefinitely. A halt should be called on the indiscriminate use of "average lives," gathered nobody says how and often by whom nobody says, nor where nor when. Such data have been passed from author to author, until frequently their age seems to entitle them to the veneration that naturally associates itself with antiquity. But, when we question most of these ancient data on their reason for existence, their only answer is: "We are."

For calculating depreciation annuities, I repeat that average functional lives, even though rough guesses in some cases, may often suffice until we can secure something more reliable. But for calculating accrued depreciation no average functional life can be used rationally in a "straight line" or "sinking fund" formula.

There are very few classes of plant units in a water works to which can be assigned a definite average *natural* life, to say nothing of the much greater difficulty as to *functional* life estimates. Steel and wrought iron (unless almost pure iron) pipes undoubtedly rust out, and thus have a more or less definite natural life. The same is true of the bands of wooden pipe but to a less degree, and, under certain adverse conditions, the wood in a water pipe may decay. Ten years ago most water works engineers assigned a prospective life of about 20 years to wooden stave pipe, but, as above stated, the tendency now is to double that estimate. Personally, I think we know so little about the natural life of wooden stave pipe that we are quite as well qualified to guess at 60 as at 40 years. This being so, accrued depreciation of wooden pipe can only be determined after inspection.

In this connection I would suggest that every water works company will do well to begin the practice of keeping samples of all kinds and sizes of pipe removed in the process of tapping. Also it would be wise to have some local civil engineer, not connected with the company, inspect the pipe that is uncovered at different points, in the course of the company's routine work of tapping, stopping leaks, etc. The engineer's testimony will be available in a rate making or condemnation case, and should prove valuable. This same advice holds as to any other classes of plant units that are buried and only occasionally uncovered. Incidentally, note may be made of the character of the excavation encountered in making temporary openings.

Recovery Value, or "recoverable value," is the net value remaining in a plant unit upon the expiration of its natural or functional life. Of course, it is understood that we are now speaking of its life in its particular place in the plant under consideration. Recovery value is salvage value minus cost of removal.

Wearing Value, or "service value" is the difference between the cost new and the recovery value of a plant unit. Therefore "wearing value" is the only part of the value that depreciates.

Scrap Value is the selling price of an old plant unit that has so depreciated as to be worthless for further service in any part of any plant until it has been re-manufactured. The term applies to many metals that can be used again after re-melting, re-rolling, and the like.

Salvage Value is the selling price of an old plant unit after its removal. It can never be less than its scrap value, and may be considerably more if the plant unit can be used again in a plant without being entirely re-manufactured.

Recovery value may be less than salvage value or even less than scrap value, as happens when the cost of removing a plant unit is greater than the price for which it will sell as scrap. This is illustrated in the case of a small pipe, the cost of excavating which may exceed its scrap value. In paved streets, even fairly large pipes may at times have little or no recovery value, because the cost of taking up and relaying the pavement alone exceeds the salvage value. Of course where a trench for a new pipe is to be dug at the time of the abandonment of the old pipe, the same trench may serve to rescue the old pipe and then its recovery value and salvage value may be almost identical. This is particularly true where trenches are in rock, for it then is usually wise to re-use the old trench for the new pipe.

In this connection attention should be called to the advisability of pricing out the pipe and pipe laying separately from the trench digging and back filling. Otherwise it may be difficult to estimate the accrued depreciation of the pipe. Thus, if the pipe is laid in a rock trench priced at $3 per cubic yard in excess of earth excavation, it is evident that the rock trench may not have depreciated at all, although the pipe in it may have depreciated.

Another point to remember is this: A good many owners and managers of water companies make a practice of using wrought iron mains, particularly in outlying sections of the town. They estimate that within a few years —long before any sort of pipe will have reached the end of its natural life—it will be necessary to lay a larger pipe, because of the growth of the town. When a larger pipe becomes necessary, they dig up the small wrought iron pipe, scrape and "tar" it again by dipping, as described in *Engineering and Contracting* of Dec. 13, 1911. Since the natural life of such pipe is largely dependent on the life of its "tar" coat, it is apparent that this method results in a very long life for the pipe—a fact often overlooked by appraisers who put their entire faith in published tables of average lives.

A RATIONAL DEPRECIATION FORMULA.

We come now to a part of this subject that is even yet little understood by many persons. Some there are who stoutly assert that estimating accrued depreciation is entirely a matter of inspection and the application of judgment. Others there are who put little faith in what they are pleased to term "the hunch method of guessing at depreciated value," and they insist upon using either the "straight line formula" or the "sinking fund formula" in determining accrued depreciation. Each of these extremists sees the weak points in his opponent's method, but is almost blind to the weak points in his own method. My belief is that there should be a combination of inspection and test with mathematical calculation in arriving at depreciated value.

Were there a general market for water pipes in all stages of depreciation, as there is for second-hand furniture, it might be possible for an experienced dealer in second-hand pipe to look at a given pipe and guess its depreciated value quite closely. But no such condition exists. The engineer called upon to estimate the accrued depreciation of plant units *must* apply mathematical and economic principles if he is to arrive at results that are rational and reliable. When it is said that values are independent of mathematics, the statement is really meaningless. Value itself is a numerical expression, and the instant the idea of number becomes involved in any problem, that instant mathematics enters the problem.

There is a great class of valuation problems that involve the conception of "capitalizing" an income to arrive at commercial value. Thus, if the prospective net ground rental of a city lot is $600 a year, and if money invested in such property commonly commands 6 per cent, the value of the lot is $600 divided by 0.06, or $10,000. This process of dividing a prospective annual net income (or expense) by a rate of interest is called *capitalizing*. I need not here go into the complexities of such problems, as illustrated in cases where incomes are rising or falling, or where operating expenses fluctuate, or where functional depreciation is not provided for in the operating expenses, etc. But I will presently indicate, in a very general way, how the rate used in "capitalizing" should be determined.

In considering the value of a given thing, some other thing of known value must be used as a standard for comparison. In estimating the depreciated value of an old thing, of course the value of a new thing of the same general class is the standard of value. Now the value of a new plant unit can be ascertained by securing quotations from manufacturers and contractors, or from the records of a company's recent costs. Hence the "cost of re-production" becomes a standard of value for plant units. But this standard should not necessarily be a new thing precisely like the old thing, for there may be a new thing that is more economic than the old thing. Therefore we reach this conclusion:

If annual output and gross earnings are not affected by substituting a new plant unit for an old plant unit, the total average annual cost of production with a new plant unit of most economic design for the given service is the standard of value by which the old plant unit is determinable.

For "plant unit" in the above statement there may be substituted "group of plant units." For "total average annual cost" there may be substituted "total capitalized cost."

If R is the rate of normal return on the investment, say 10 per cent; and if C is the first cost of a new plant unit of most economic design, say $10,000; and if E is the average (equated) annual operating expense inclusive of depreciation and taxes, say $2,000; then the total annual cost is $R\,C + E$, or (10% × $10,000) + $2,000, which is $3,000.

Let v be the unknown depreciated value of the old plant unit, which is to be measured by the standard of value furnished by the new plant unit. Let e be the average annual operating expense with the old plant unit, say $2,500.

Then the value, v, of the old plant unit must be such that when multiplied by the rate of fair return (10 per cent assumed for illustration) and added to its $2,500 operating expense, the total will be the same as the total with the new plant unit, or $3,000. At once it is seen that the depreciated value of the old plant unit is $5,000, for 10 per cent of $5,000 added to $2,500 makes $3,000. Expressed as a formula, we have:

$$Rv + e = RC + E$$

whence

$$v = C - \frac{e - E}{R}.$$

This rational depreciation formula, when expressed in words, state precisely what the common sense of every business man will indicate to him as a fact, namely:

The depreciated value of an old plant unit is equal to the cost of a new plant unit of most economic design minus the capitalized difference in their respective average annual operating expenses. The proviso being, of course, that the output and the gross earnings shall be the same with the new as with the old plant unit.

Put concretely, let it be shown that a new pump costing $10,000 will save $200 a year in fuel and repairs, as an average, compared with the existing old pump; then let it be shown that all the other operating expenses remain unchanged, and that a fair return rate on money invested in the given business is 10 per cent. Then $200 capitalized at 10 per cent is $2,000. Hence the old pump is worth $2,000 less than the new pump, or $8,000.

Observe, now, the very important conclusion that this rational method of estimating depreciation leads to:

If it cannot be shown that the substitution of a new plant unit (or group of plant units) will decrease average operating expenses, then the value of the old plant unit is as great as the value of a new plant unit.

Recently I had occasion to apply this generalization in the case of a water works reservoir that was 30 years old. It had suffered no natural depreciation except a small leak which could be repaired for about $100. The reservoir was of permanent construction, and it was adequate in capacity not only for present but for future needs. No larger reservoir would be built if a new one were built today.

A stand pipe could not be economically substituted for it, and no other suitable reservoir site existed nearer to the city or more desirable because of greater pressure. I held that its age of 30 years had not the slightest bearing upon its depreciated value. My judgment as to its value would be unaffected were it 300 years old or 3 years old. My criterion of its value was entirely independent of its age. The criterion was the total annual cost of the most economical substitute for it, and by this test the 30-year-old reservoir, instead of being worth less than a new alternative reservoir was worth more. This added value I regarded as the value of the reservoir—a matter that will be discussed in the next article of this series.

Identical Plant Theory.—Most engineers seem to think that "cost of reproduction" implies the reproduction of an *identical* plant, but then when they come to consideration of depreciated value they "cross their wires," for they deduct therefrom estimated accrued depreciation due to "inadequacy," "obsolescence resulting from invention," etc. When they do that they fail to see that no longer are they sticking to their "identical plant" theory, but are actually setting up as a criterion another plant—the most economic substitute plant. Personally I see no method of rationally estimating accrued depreciation of all kinds save by comparison with the most economic substitute. But I also see that in appraising an entire property this method carries us logically into a consideration of the cost of building up the attached business *in the face of competition with the existing plant,* and not upon the hypothesis that the existing plant does not exist. This is a phase of the subject of appraisal that I will discuss at length in the fifth article of this series.

The identical plant theory of estimating "reproduction cost" absolutely excludes all consideration of functional depreciation, if logic is to be applied. At most only natural depreciation can be associated with the identical plant theory.

Normal Return Rate.—Obviously the normal return rate used in estimating reasonable annual return on invested capital, or in capitalizing annual expenses or incomes, is deserving of careful consideration. This subject, too, is reserved for a separate article so it will be barely touched upon now.

A normal return on capital is the sum of normal interest and normal profit. Normal interest rate may be designated as a bond or mortgage interest rate on property similar to that in question, where there is a substantial equity above the bond.

Normal profit covers both a normal return for proprietary supervision and for insurance against all risks not provided for in the operating expenses. Among these risks are loss of income arising from general or local business depressions, loss of income from public enactments, and loss of income from direct and indirect competition. Functional depreciation may also be regarded as one of the forms of risk, and should be provided for in the profit rate if not already provided for as an operating expense. Totaling up we may have some such statement as this:

	Per cent.
Normal interest rate	5
Normal profit rate—	
Proprietary supervision	2
Functional depreciation	2
Insurance on permanency of income	1
Total normal return rate	10

These percentages are here given merely for illustration. At a later time I will show to what extent and why they vary, and I will also show that an interest rate, such as 5 per cent, contains elements of proprietary supervision and insurance.

Mistakes in the use of rates for capitalizing expenses or incomes are so common as to be almost universal. Let two things be remembered and many of these mistakes will cease: First, that the normal return rate and not a bare interest rate must be used in capitalizing. Second, that the normal return rate depends in part upon what exists in the operating expenses in the form of proprietary supervision, and functional depreciation.

A normal return rate is what public service commissions usually aim to allow a company to earn, and they commonly call it a "fair return rate." But, as I view it, a fair return should be permitted to exceed a normal return. If not, there is lack of sufficient inducement to effect economies in construction and operation.

Age—Life Depreciation Formulas.—There are two depreciation formulas in common use, each of which involves two factors: (1) Age of the plant unit and (2) its probable total life. These formulas are commonly known as the "straight line formula," and the "sinking fund formula." My "rational depreciation formula," above given, does not contain the age factor directly, although it is involved where natural depreciation occurs. I have written an elaborate discussion of this "rational depreciation formula," and expect to see it published soon. The formula above given is a simplification of a more complex, general rational depreciation formula, but it will serve all ordinary purposes.

I have proved that the "sinking fund depreciation formula" is a special case of the "rational depreciation formula," and applies only where *natural* depreciation is involved and where average annual repairs are no greater starting with new plant unit than with an old one.

The "straight line formula" is defensible only as a rough approximation of the "sinking fund formula."

There are several books—such as my "Handbook of Cost Data," Fish's "Engineering Economics" and various books on appraisals—in which the "sinking fund" and the "straight line" depreciation formulas are explained. But in none of these books will be found a full exposition of the logical limitations of those formulas as aids in estimating accrued depreciation.

Inspections and Tests.—In order to apply the "rational depreciation formula" above given, it is usually necessary to inspect the plant units and it is often necessary to test some classes of them. These steps are taken in order to estimate the prospective operating expenses.

Studies of the accounting records may be of considerable aid in determining what the prospective costs of repairs will be by showing the amount, character, expense and dates of past repairs. Thus, a boiler whose flues have been recently renewed will obviously cause less prospective operating expense than one whose flues are old; therefore it will have a higher depreciated value.

Tests of the efficiency of a pump will indicate its fuel consumption as contrasted with a new pump. Inspection of the pump will disclose what parts are worn, and what the probable date of their renewal will be. With these factors known, and with a knowledge of efficiency and maintenance costs of modern pumps, the "rational depreciation formula" can be applied with considerable accuracy. Whereas merely to guess at the depreciated value after an inspection is likely to yield results far from the truth. To apply an "age-life formula" is likely to result in even greater error. This is notably so in the case of buildings, reservoirs and other structures that are practically everlasting if properly maintained.

CONCLUSION.

In no other part of an appraisal of physical property can so much value be thrown away as in the appraisal of accrued depreciation. Here it is that logic has usually been cast to the winds. Water pipe and reservoirs in perfectly good condition, and economically adequate, have, time upon time, been assigned 15 or more per cent accrued depreciation. Buildings that likewise were adequate have been written down in value to a degree many fold the cost of repairing every defect.

As aids in estimating accrued depreciation, published life tables for water works are practically worthless. For the most part the lives of plant units given in such tables are functional and not natural. And, almost without exception, such lives are determined by the *growth* of the towns and cities; that is, the depreciation is functional depreciation due to economic inadequacy, in estimating which the curve of growth of the *given* community is a much better criterion than any record of average growth of communities. Carrying the reasoning farther, the growth of each section of a city is a better criterion to use in estimating functional depreciation than the growth of the city as a whole.

Desirability of Standardizing Apparatus and Methods for Making Analyses of Sand and Gravel.

(Staff Abstract.)

Early investigation by the Massachusetts State Board of Health indicated that the efficiency of a sand filter depends much upon the size, or range of sizes, of the sand grains composing the filtering material. Consequently, it was necessary to devise some efficient method of analyzing the filter sands for comparative purposes, and the method described by Mr. Allen Hazen in the report of the Massachusetts Board for the year 1892 was developed to meet the requirements which existed at that time. This method proved so satisfactory that it has been generally used by the sanitary engineering and chemical professions up to the present time.

Within recent years, however, the engineering field requiring accurate analyses of sands and gravels, has broadened very greatly. A comparatively new type of filter, called the American or rapid sand filter, has been developed and has been found to meet the average requirements in the United States, outside of the eastern states, more efficiently than does the English, or slow sand filters. Experience indicates that the size of the sand required for a rapid sand filter differs materially from that generally used in the construction of a slow sand filter. While the methods of analysis employed for sand used in the slow sand filter may readily be adapted to the analysis of sand required in the rapid sand filter, the usual method of expressing results in terms of effective size is not entirely satisfactory, because the range of size of sand permitted in rapid sand filters frequently is very much less than is commonly used in the filtering material of slow sand filters.

Another important use for mechanical analysis of sands and gravels arises in the selection of materials required for concrete mixtures. It is recognized that arbitrary standards or proportions for mixing the aggregates required to form waterproof or dense concrete are no longer satisfactory nor are they to be recommended because of local differences, especially in the size and ranges of sizes of grains or particles composing the large and small aggregates.

A still further use of mechanical analyses of sands is in the preparation of asphalt mixtures such as are required for certain types of street pavements.

The matter of standardizing methods of making analyses of sands is of importance to all water works men who have to do with water purification problems. If contractors and water works superintendents understood more about the matter, it would frequently be possible to construct and maintain filtration plants at much less expense than is now required. The matter of obtaining satisfactory filtering material frequently is extremely simple, but has been made difficult by the methods of analysis commonly employed, and by the requirements as to size described in engineering specifications. There is no probability that the engineering profession as a whole will adopt the terms now used in the mechanical analyses of filter sands for the analyses of sands and gravels used for other purposes, such as proportioning concrete, paving mixtures, etc., so that uniformity and standardization of the results of such analyses can be obtained only by a revision of present methods.

On account of the lack of suitable standards it is not surprising to note that specifications covering the use of such materials frequently are extremely weak and ambiguous. Such weaknesses, of course, tend to increase the cost of work and frequently result in a very unsatisfactory quality of material.

Manufacturers of apparatus required to separate materials into specified sizes, or range of sizes, now find it extremely difficult to satisfy the specifications and requirements of engineers in this respect. This is particularly true in regard to the preparation of sands required for filtering material. It is seldom that a local community does not have available, within reasonable distances, satisfactory material as required for the preparation of a filter sand, but, on account of lack of knowledge on the part of the local contractors or on the part of the engineers in charge of a particular piece of work, such local sands seldom are used and filter sand is nearly always imported, perhaps from considerable distances and at large expense.

It is believed that some of the confusion which has resulted in the matter has been from the adoption in specifications of such terms as "Effective Size" and "Uniformity Co-efficient," which are applied to sands used for filtering material. These terms, of course, have little or no signficanuce to an ordinary contractor or to the dealer who is in the business of screening and sizing sands and gravels.

A further confusion has arisen from the endeavor to use the actual size of the sand grains rather than the sizes of the openings in the screens. Because few engineers have available the equipment required to standardize sieves, the results of analyses have often been reported in terms of numbers of meshes, or wires, per inch. This method of expressing results, of course, is indefinite and inaccurate, because wire cloth used in the manufacture of sieves frequently varies both as regards sizes of wires and the number of meshes per inch.

Within recent years this difficulty has been appreciated by manufacturers who in some instances have endeavored to clear up the matter by producing standard testing sieves made in accordance with recent standard specifications and with certain arbitrary intervals of spacings between the individual units. By such means it is hoped to fix definitely the diameter of the openings in testing sieves. Recently, moreover, the Bureau of Standards of the Department of Labor and Commerce at Washington has adopted standard specifications covering the manufacture of certain testing sieves; also, when solicited, this department stands ready to rate and standardize testing sieves at a nominal cost with a view of determining the actual average diameters of the openings.

Possibly that feature which would tend most to clear up the situation would be to change the standard of measurement from the size of the sand grains to the size of opening in a sieve. In view of the fact that the coarser testing sieves such as are required for sand analyses can now be obtained with wires of very nearly uniform sizes and accurate spacings, in both directions, it follows that such sieves will, within reasonable and sufficient accuracy, contain openings of certain definite sizes. Testing sieves which do not come within such requirements as are contained in the specifications of the Bureau of Standards should he rejected.

Table I shows ratings of different nests of sieves with which the speaker has from time to time been familiar.

TABLE I.—SIZES OF SEPARATION OF REPRESENTATIVE TESTING SIEVES FOR SAND ANALYSIS.

Meshes per in.	Sizes of separations in millimeters					
	A-1.	A-2.	B.	C.	D.	E.
4	.....	.....	.....	5.6	.....	5.77
10	2.00	2.00	2.19	2.15	.....	2.09
14	.....	.....	.....	1.45	1.45	.....
18	1.04	1.05	1.07	.....	.....	.....
24	0.79	0.81	0.81	.....	0.86	0.78
30	0.58	0.60	0.61	0.57	0.58	0.57
40	0.45	0.46	0.48	0.46	0.40	0.45
50	0.31	0.33	0.34	0.37	0.30	0.34
60	0.24	0.30	0.30	0.23	0.27	0.39
80	0.187	0.197	0.190	0.195	0.195	0.193
100	0.153	0.161	0.168	0.160	0.150	0.156
140	0.121	0.117	0.126	0.115	0.120	.....
200	0.085	0.087	0.104	.....	.....	.....

The sieves indicated in column "A-1" and "A-2" were used in the office of Hering & Fuller of New York. The ratings in column "A-1" were obtained by counting and weighing the sand grains. The ratings in column "A-2" are of the same set of sieves and were made subsequently by the speaker by measuring the diameters of the openings in the screens and applying the factor 1.10 to the sieves Nos. (10-100) and 1.18 to the sieves Nos. 140 and 200. The ratings in column "B" were made by Mr. A. E. Kimberly at the Sewage Testing Station of the city of Columbus, Ohio. The sieves of columns "A" and "B" were made by the same manufacturer at the same time, under the same specifications. The ratings in columns "C" and "D" were obtained by the speaker for two nests of sieves used at Philadelphia. The ratings in column "E" were determined by Mr. J. W. Ellms for the sieves used in testing the sand required for the Cincinnati Water Purification Plant. Mr. Ellms rated these sieves by measuring the diameters of the openings and applying the above mentioned factors to determine the sizes of separations.

Table I serves to illustrate some of the reasons why it is believed that the subject of standard apparatus and standard methods for analysis of sands and gravels is of great importance to the engineering profession at this time.

Attention is drawn also to the marked differences in engineering specifications and requirements for the preparation of sands used for filtration purposes. Frequently such specifications are limited to an expression of the maximum and minimum effective size and maximum and minimum uniformity coefficient. These terms mean nothing to the ordinary contractor who must furnish the material. It is obvious that the whole question of obtaining satisfactory material would be very much simplified if the specifications would read that a satisfactory sand would be one which contains not more or not less than certain specified quantities as separated by certain standard sieves. Such standard sieves would be available for the contractor, or manufacturer of the material, as well as for the engineer in charge of the work who, under present circumstances and conditions, has the matter almost entirely in his own hands. This is true in regard to specifications for sand required not only for filtering material, but also for any other purpose.

It is believed that the adoption of a standard nest of sieves by the engineering profession would help very materially in securing uniformity in the expression of results of mechanical analysis of sands.

It is also believed that there would be a great advantage in simplicity of expression of results of analysis or in the form of specifications covering the preparation of filter sands to the effect that 10 per cent of the sand passes, or shall pass, say, a standard sieve No. 35, or a standard sieve having an opening of 0.417 millimeter diameter, as compared with the usual statement that a sand has, or shall have, an "Effective Size" of 0.46 millimeter. Moreover, the term "Effective Size" has no significance whatever outside of its application to a filter sand, and, of itself alone, the term is of doubtful value as applied to sands such as are frequently used for rapid sand filters. The range of sizes is believed to be much more significant.

ACKNOWLEDGMENT.

The foregoing matter is from the paper on this subject as read by Mr. Philip Burgess, Hydraulic Engineer, Columbus, O., before the American Water Works Association.

DRAINAGE AND IRRIGATION

Methods and Cost of Lining an Irrigation Canal With Concrete.

(Staff Abstract.)

The canal lined was a used canal of the Burbank Power & Water Co., Burbank, Wash. Construction methods were carefully planned in advance and followed without variation. The canal bed was settled with water for two weeks, the canal being divided into short compartments, and water permitted to run from the upper compartments to the lower for filling.

After canal settlement, line and grade stakes were set every five feet, each stake being a hub with center marked and its top set to the final concrete grade. The pre-determined width of the strips was 5 ft. The pre-determined thickness of concrete of lining was 0.2 ft., the base 6 ft., depth of canal 3 ft. and side slopes 1½ to 1—the carrying capacity being 60 sec. ft.

With the line and grade set once and for all, templates were constructed having the exact thickness of the proposed lining and the exact shape of the finished canals. With the line and grade stakes and a carpenter's level, it was possible for the workmen to trim the sub-grade precisely as it should be. This work was carried on a few hundred feet in advance of the canal lining. Accurate work at this point was very essential to secure uniform thickness of lining.

Sand and gravel, after being run through a 1½-in. rotary screen, was found in natural proportions about one mile from the center of the work. This was hauled by contract at $1.75 per cubic yard measured in the finished lining and placed in piles above the canal 150 ft. apart and 15 ft. back from the slope of the canal, the slope of the ground above the canal not being very great. Experience subsequently proved that the piles of gravel might better have been 200 ft. apart.

Two steam driven concrete batch mixers mounted on trucks and equipped with side loaders were started at the center of the canal to be lined (8,250 ft.) each working away from the other and endeavoring to obtain its end of the lining first. The mixers were moved from pile to pile on plank runways and pushed by the men—the mixers being on the upper side of the canal at all times and passing between the canal and the line of piles of gravel. For each mixer outfit, a movable trough or chute was provided for taking the discharge of the mixer and depositing it in the concrete carts in the bottom of the canal. The lining was laid at two points for each mixer, starting 75 ft. on each side and working toward the mixer. Plank runways in the canal bed were provided and one concrete cart for each laying gang was employed.

The mixture was made on the basis of 1 bbl. of cement to 1 cu. yd. of finished concrete, or about 1 to 7, and made as wet as the side slopes would permit. Two men in each laying gang placed the concrete roughly with square pointed shovels, one man helped dump the concrete carts in the bottom of the five-foot strip being lined, and between times made ready the next strip and dampened the subgrade, while a fourth man in each laying gang trowelled the rough concrete into the finished shape.

Three men were required for each mixer to supply the raw materials to the machine, one man for fireman and engineer, one man to dump the mixer, and one man to hoe the concrete down the chute. An additional man covered the finished lining with wet burlap strips and kept moving them forward.

The water was hauled 1½ miles on the average by three four-horse teams hauling 400-gal. tanks on wagon trucks. The exact amount of coal required at each setting was pre-determined and left there in advance in sacks. The laying of this 8,250 ft. of concrete lining was completed in 14 working days. As much as 900 ft. in one day were accomplished. The men became very skillful in moving the machines and were able to lose not over 15 minutes time at each moving The cost of the actual concrete was as follows:

	Per cu. yd.
Sand and gravel	$1.75
Cement delivered	2.65
Water	.25
Coal	.10
Labor mixing concrete	.65
Labor laying concrete	.88
Superintendence	.31
Total per cubic yard	$6.59

In addition to the above, the cost of equipment less its salvage value, was 32 cts. per cubic yard, the cost of trimming the canal bed was 72 cts. per cubic yard and the engineering was 32 cts. per cubic yard. This made a grand total of $7.95 per cubic yard or $1.10 per linear foot of canal.

The cost of cement was $2.25 per barrel f. o. b. Burbank, common labor was paid 25 cts. per hour with a bonus of 2½ cts. for staying until the job was finished, and the finishers and firemen were paid 27½ cts. per hour with a bonus of 2½ cts. under the same conditions. With but few exceptions, we were required to pay the bonus, and it was a good investment, as it overcame the great demoralizer of day labor work of this kind—constant changing of personnel. The incentive to do fast work was created by the two mixer gangs racing for the finish.

The preceding account is extracted from a paper by E. M. Chandler, Burbank, Wash., before the Washington Irrigation Institute.

Plans for a Typical Condition of Mississippi Bottom Land Drainage.

(Staff Abstract.)

The plans presented indicate the manner of handling the overflow and the interior drainage for an area of some 466 square miles in the Arkansas bottoms bordering the Arkansas and the Mississippi rivers. This example is selected because it is typical of the problem encountered in many places in the southern states bordering the Mississippi and its large tributaries. Briefly the land along the main streams is higher and the slope is descending from these streams toward the inland hills. Also the interior creeks and bayous, which divide the bottoms into irregular plots, have banks higher than the main areas of these plots. Roughly then the topography of a "bottom" is a basin bordered by inland hills and high land along the main boundary rivers and this basin bottom is composed of many saucer-like depressions formed by highlands along dividing creeks and bayous. These conditions are obviously admirable for ponding flood waters and preventing ready run off after outside flood conditions have ceased to exist and when combined with another condition almost universal they constitute the characteristic drainage problem of the Mississippi bottom. This other condition is this: While the levees along the main rivers prevent broad overflowing of the bottom, they do not prevent backwater flooding due to water from the rivers entering the streams which cut the levees to discharge into the rivers. The precise conditions can be comprehended more exactly by detailed description of the specific example illustrated.

PRESENT DRAINAGE CONDITIONS.

Referring to the map, Fig. 1, it is seen that a levee along the Arkansas River and another along the Mississippi bound the basin on the north and east. The two levees do not join; there is a necessary gap where Cypress Creek passes through into the Mississippi. This gap is about two miles wide. While the levees are full protection where they exist, the gap at Cypress Creek permits back water to flood the basin. Here then is one of the typical conditions cited above. The others are described as follows:

The small degree of interior drainage now existing is secured through the numerous bayous and creeks which meander through the district.

The bayous are of the usual type encountered in the Delta section, being tortuous, frequently ill defined, and of irregular width. They often widen out into lake-like bodies of practically dead water and again contract into narrow channels. They are usually encumbered with drift and debris of all sorts, and particularly in their wider portions often contain growths of standing timber and various forms of water-loving vegetation. As these bayous approach the Mississippi River they usually undergo a marked contraction in cross section. This peculiarity is probably due to the backing up of river water in these bayous before the levees were constructed, the resulting obstruction to the current causing the deposition of suspended matter brought down from above. The land immediately adjoining the bayous is usually higher than that a short distance back from the streams. This condition, characteristic of Mississippi Delta bayous, as of the river itself, is especially marked along Amos and Macon Bayous (see Fig. 1), whose banks are frequently as much as 6 to 10 ft. above the general elevation of the surrounding area.

The existing outlets are not sufficient to care for the run-off tributary to them. A moderate winter rain, even when the Mississippi is at normal stage, causes the flooding of large areas. The high banks of the bayous prevent a quick return of this water to the channels, and thus the lowlands remain covered with water for long periods after the streams themselves have returned to a normal stage. A similar condition occurs when the land is flooded by backwater coming through the levee gap from the river. The land being lower than the banks of the streams, a large area is left covered with water, which disappears very slowly.

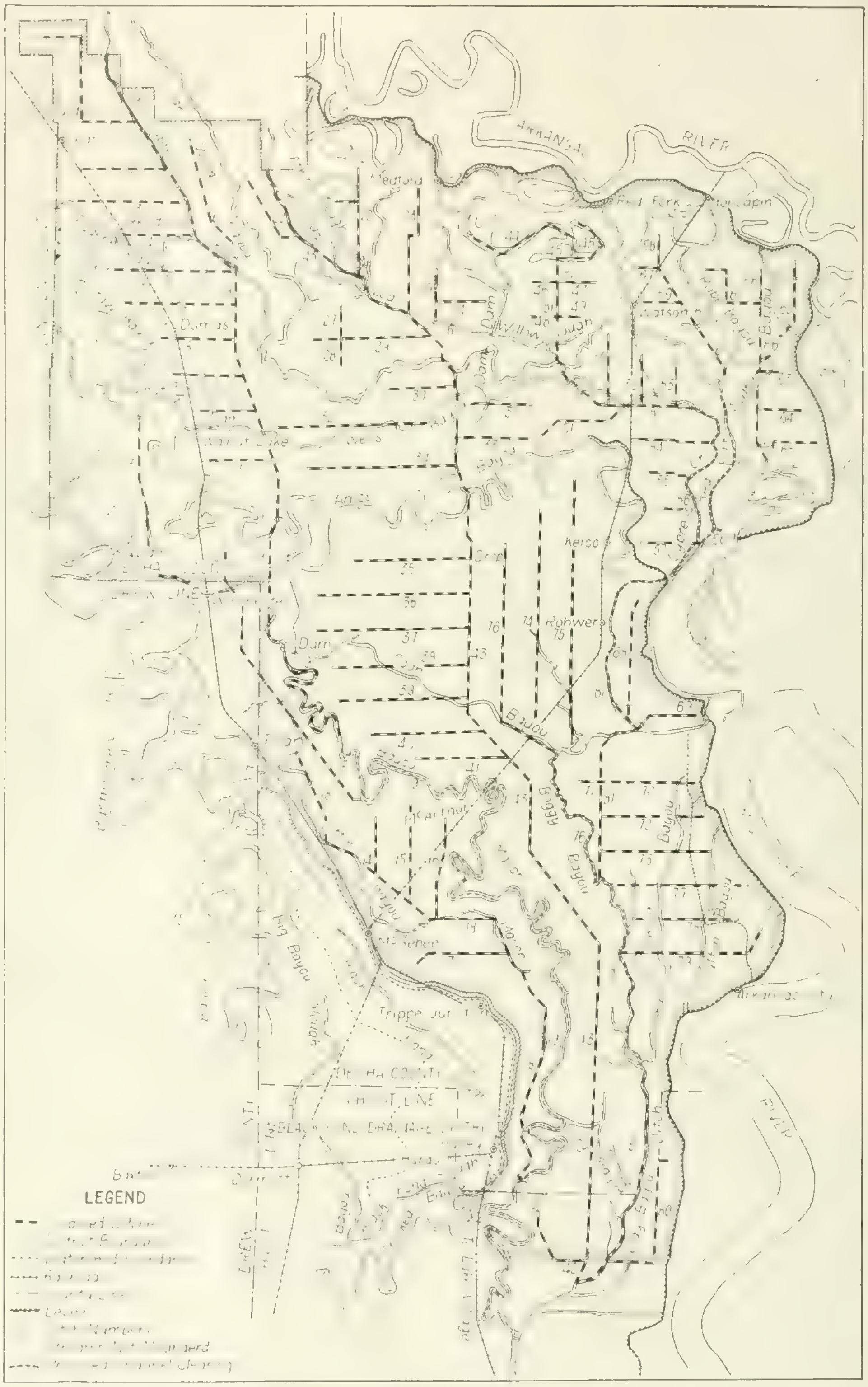


Fig. 1. Drainage Plan for Cypress Creek District, Desha County, Arkansas.

DRAINAGE PROBLEM.

The water from which the district must be protected comes from two sources: First, direct precipitation upon the watershed in which the district lies, and, second, overflow from the Mississippi River whose backwater enters the district through the gap in the levees at the mouth of Cypress Creek, damaging not only the district itself, but a large area in Chicot County, Arkansas, and northern Louisiana, since such water, once behind the Mississippi River levee, must flow south to the Red River. The drainage problem, then, is not only to provide the necessary outlets and laterals to care for the run-off from the 658 square miles tributary to the district, but so to design and locate these outlets that the drainage water now entering the Mississippi River through the levee gap will be diverted, thus making it possible to close this gap. With the construction of these outlets and the closing of the levee gap the reclamation of the district will be assured.

The plan provides for closing the levee gap by constructing main ditches Nos. 13, 18, 19, 43 and 81 as shown on Fig. 1. These main ditches aggregate nearly 185 miles and are estimated to cost $1,603,102. The laterals shown can be constructed at an addition of some 38 per cent to the cost if constructed with the main ditches and this will bring the total cost of drainage to $7.49 per acre.

DETERMINATION OF RUN-OFF COEFFICIENTS.

Of the technical questions discussed in connection with the report on this work the most important is that of determination of run-off coefficients and this discussion follows:

In deciding upon the run-off coefficients to be used for the Cypress Creek drainage district the following method was pursued: A trial coefficient was selected for a small area, one for a medium area, and one for a large area, and an algebraic expression was then sought whose curve would approximately fit these platted coefficients. The run-offs for intermediate areas were then calculated and plotted and the curve thus obtained was compared with all the data derived from the gagings. The formula was changed and the investigations continued until a satisfactory curve was obtained.

After an examination of the results of the gagings, taking into consideration the probable effect that the reclamation of the district will have on the rate of run-off, and after a study of some of the larger drainage districts in the immediate vicinity of the Cypress Creek drainage district, the following tentative assumptions were made as to run-off:

From 5 square miles, 1 in. in 24 hours (26.88 sec. ft. per square mile); from 25 square miles, ¾ in. in 24 hours (20.20 sec. ft. per square mile); from 400 square miles, ½ in. in 24 hours (13.44 sec. ft. per square mile).

It was found that Fanning's formula could be converted into an expression whose curve fulfilled these assumptions. The conversion of this formula is as follows:

Fanning's formula is $Q = 200\ M^{5/6}$.

Where Q = run-off from whole area, in second-feet, and M = area of watershed, in square miles.

Substituting K for 200, and RM for Q (where R = the run-off in second-feet per square mile), we have:

$$RM = KM^{5/6} \text{ or } R = \frac{KM^{5/6}}{M} = \frac{K}{\sqrt[6]{M}} \qquad (1)$$

$$\text{whence } K = R\sqrt[6]{M}$$

Substituting the three assumed values of R and M, we have:

For $R = 26.88$, $K = 35$
For $R = 20.2$, $K = 34.5$
For $R = 13.44$, $K = 36.4$

Replacing the constant, K, by 35 in formula (1), we have:

$$R = \frac{35}{\sqrt[6]{M}}$$

This expression, which has been used for calculating run-off in this project, is represented by the curve in Fig. 2. It was found to agree fairly closely with what gagings have been made, giving in most cases values somewhat greater than the gagings showed. As has been pointed out, however, overflow and backwater affected some of the gagings and tended to give discharges less than the actual ones. Allowance has also been made for increased run-off to be expected after drainage.

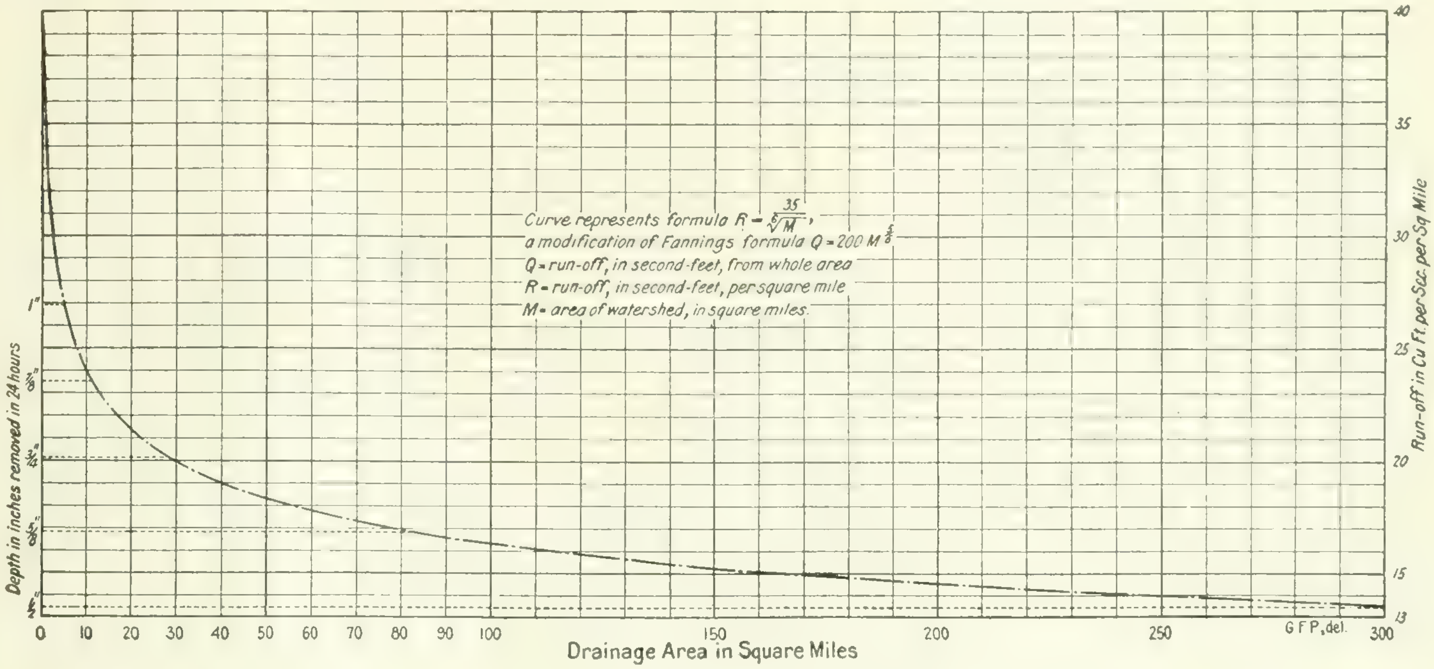


Fig. 2. Curve Showing Run-off to Be Provided for by Proposed Drainage Ditches.

The preceding information is partly rewritten and partly quoted from the report by S. H. McCrory, O. G. Baxter, D. L. Yarnell, L. A. Jones and W. J. Schlick, drainage engineers, Department of Agriculture.

Exploitation of Borneo's Timber. — The Government of British North Borneo is taking steps for a general survey of the timber possibilities of the country, estimating the amount available and classifying it into the various kinds suitable for export. Mr. D. M. Matthews, an American forestry expert, formerly in the Forestry Service of the Philippines, has been employed for this work. It has been found that valuable hardwoods can be obtained there, the more important of which is billian or ironwood, an extremely hard and antproof timber.

First Cost and Cost of Operation of Irrigation Pumping Plants.

(Staff Abstract.)

PLANT COSTS.

As a basis for the figures, the representative of a well-known manufacturer was asked to give prices, efficiency and other data on both centrifugal and triplex power pumps, ranging in capacity by the hundred gallons, from 100 to 500, inclusive, a minute, and for heads of 25, 50, 100 and 200 ft. Taking these prices as a basis, and adding the cost of motor, fittings, erection and building, we have the following schedule of plant costs:

DIRECT CONNECTED CENTRIFUGAL PUMPS.

Capacity G. P. M.	Head.	Size.	Cost of plant.
100	25	2½-in.	$ 407.00
100	50	2-in.	369.00
100	100	2-in.	479.00
100	200	2-in. 2 S	715.00
200	25	3-in.	550.00
200	50	3-in.	550.00
200	100	2½-in.	600.00
200	200	2½-in. 2 S	875.00
300	25	4-in.	644.00
300	50	3-in.	644.00
300	100	3-in.	715.00
300	200	3-in. 2 S	1,034.00
400	25	5-in.	732.00
400	50	4-in.	698.00
400	100	3-in.	748.00
400	200	4-in. 2 S	1,249.00
500	25	5-in.	787.00
500	50	4-in.	765.00
500	100	4-in.	831.00
500	200	5-in. 2 S	1,724.00

BELT DRIVEN TRIPLEX PUMPS.

Capacity G. P. M.	Head.	Size.	Cost of plant.
100	50	5½x 8-in.	$ 741.00
100	100	5½x 8-in.	764.00
100	200	5½x 8-in.	821.00
200	50	7½x 8-in.	1,216.00
200	100	7½x 8-in.	1,261.00
200	200	7½x 8-in.	1,319.00
300	50	8½x10-in.	1,437.00
300	100	8½x10-in.	1,517.00
300	200	8½x10-in.	1,600.00
400	50	10x10-in.	1,877.00
400	100	10x10-in.	1,979.00
400	200	10x10-in.	2,065.00
500	50	10x12-in.	2,463.00
500	100	10x12-in.	2,510.00
500	200	10x12-in.	2,792.00

In comparing the schedule note that in a number of instances the cost of plant for a given head is less than that of the preceding lower head, and that smaller sizes are used,—these are not errors. In centrifugal pumps, the capacity within a certain range is governed by the design of the impeller and the speed, and not by the diameter of the discharge nozzle. Also in the triplex pumps, exactly the same pump is offered for more than one head. The total plant costs are also affected by the cost of motor used, which varies according to the speed, the slow speed motors costing considerably more than those of high speed. The sizes and types of pumps and motor speeds are those selected by a man of large experience in irrigation work; and while better selections might be made in some cases, the list represents probable average practice, and as used here, is a fair basis.

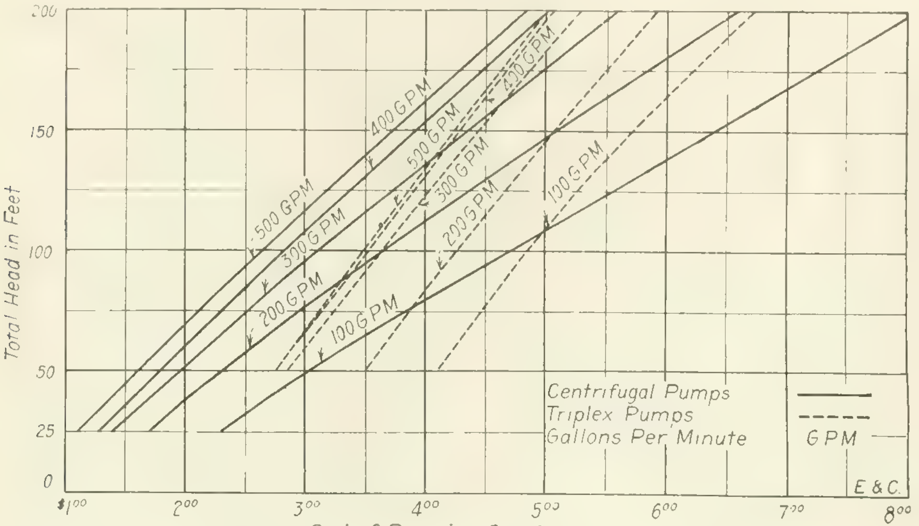


Fig. 1. Cost Per Acre Foot of Pumping for Irrigation.

OPERATING COSTS.

In arriving at a basis of operating costs for each year, the following assumptions were made:

(1) That the irrigation season covers the period from May 1st to September 30th, inclusive.

(2) That the pumps would operate 24 hours a day for 26 days each month, or a total of 130 days.

(3) That the pumps would operate 624 hours each month.

(4) That the capacity of the several sizes of pumps operating on the above schedule would be as follows for the season:

Size.	Acre ft.
100 gallons per minute	57.5
200 gallons per minute	115.0
300 gallons per minute	172.0
400 gallons per minute	230.0
500 gallons per minute	287.5

(5) That power would be paid for on the meter basis, and on the schedule in use in the Yakima Valley.

(6) That interest on investment in plant be figured at 7 per cent.

(7) That depreciation and renewals be figured at 7 per cent.

(8) That cost of supplies be taken at 1 per cent of cost of plant.

(9) That insurance be figured at 1 per cent.

The total for the last four items is 16 per cent.

In determining final costs for any particular location, it will be necessary to add the charges upon whatever pipe line is required to deliver the water to the desired point, also the yearly cost of water right, if water is purchased from a ditch. Estimated costs of pumping follow:

DIRECT CONNECTED CENTRIFUGAL PUMPS.

Capacity, in gals. per min.	Head, in ft.	Cost per acre-foot pumped.
100	25	$2.24
100	50	3.00
100	100	4.93
100	200	8.17
200	25	1.68
200	50	2.24
200	100	3.68
200	200	6.59
300	25	1.37
300	50	1.93
300	100	3.16
300	200	5.57
100	25	1.25
400	50	1.74
400	100	2.90
400	200	4.99
500	25	1.11
500	50	1.59
500	100	2.65
500	200	4.82

BELT-DRIVEN TRIPLEX PUMPS.

Capacity, in gals. per min.	Head, in. ft.	Cost per acre-foot pumped.
100	50	$4.08
100	100	4.80
100	200	6.65
200	50	3.47
200	100	4.25
200	200	5.89
300	50	2.83
300	100	3.64
300	200	5.23
400	50	2.76
100	100	3.54
100	200	5.02
500	50	2.77
500	100	3.46
500	200	5.00

By platting these figures on paper, we have, Fig. 1, a diagram from which it is possible to ascertain the approximate cost per acre foot for pumping to any head between 25 ft. and 200 ft. for the centrifugal pumps of the respective capacities, and for heads between 50 ft. and 200 ft. for the triplex pumps. On the accompanying diagram, Fig. 1, the centrifugal pumps are represented by full lines, and the triplex pumps by dotted lines. The point at which the full and dotted lines of the same capacity cross, indicates the approximate head at which the types will operate with equal economy. This is 110 ft. for the pumps of 100 G. P. M. capacity, 150 ft. for the 200 G. P. M., and 165 ft. for the 300 G. P. M. Above these heads, the diagram indicates that the triplex pumps will be the more economical. It also shows that for the 400 G. P. M. cajacity the types balance at 200 ft. head; and that for the 500 G. P. M., the centrifugal is the more economical pump within the range of head considered.

The figures and diagram clearly show the lower cost per acre foot as the size and capacity are increased. This leads to the suggestion that where conditions are favorable for serving two or more tracts from one point, that it will be economy for the owners to join in building one plant that will give the best results, rather than to construct two or more plants of lower efficiency and higher cost and maintenance.

The preceding data are condensed from a paper by H. D. Hanford, Seattle, Wash., in the proceedings of the Washington Irrigation Institute.

GENERAL

The New Austin Dam and Power Plant.

Contributed by Frank S. Taylor, Resident and Directing Engineer, Austin, Texas.

II.

DAM.

The total length of dam and corewall is 1,535 ft., of which 1,091 ft. are spillway, 124 ft. bulkheads, and 300 ft. corewall.

A typical section of the new portion of the dam is shown in Fig. 1. As indicated, it is a reinforced concrete structure, having an inclined upstream wall, making an angle of 42° to the horizontal. At a point about 2½ ft. above low water level, this slope of the wall ends, intersecting a narrow horizontal bench and from the upstream edge of this horizontal bench a vertical wall goes straight down into the rock. This vertical wall forms both the lower portion of the deck and the cutoff wall, and in the designation used on the work is termed the "cutoff wall."

The object of the bench is to allow flow of water through any completed section of the dam during construction, the flat horizontal slab, which runs the entire length of the dam, and covers the upper part of the bench, being omitted until the completion of the work. This top slab covers a space 4 ft. wide, measured horizontally from the upper edge of the cutoff wall to the lower edge of the inclined deck slab. Since the upper edge of the cutoff wall is only about 2 ft. above mean low water, a rise of 2 ft. will pass water over the cutoff wall through the opening and through the dam and a rise of 4 ft. would give a thickness of water of 2 ft. over the edge of the cutoff wall, which means that as much water would be passed through and under the dam as would flow over the crest of an ordinary weir, the entire length of the dam, and 2 ft. in depth over it. Normally, the total flow of the river was taken through the sluice gates in the bottom of the dam, later to be described, but, in the case of floods, the openings through the horizontal bench, together with the area afforded by the sluice gates, would usually take care of the whole river flow at such times, without an elevation in the water level of more than 4 to 6 ft.

The supporting walls are both longitudinal and transverse. The transverse walls are set parallel to the flow of the stream and are 20 ft. apart, measured from center to center. The longitudinal walls are also spaced 20 ft. apart, measured from center to center in a direction at right angles to them. These latter walls are not vertical but are inclined, so that they form an angle of nearly 90° with the upstream deck. The slope of these walls is such that the resultant of the forces which they resist, made up of the water pressure acting against the surface of the deck and the gravity component of the deck and the walls themselves, has the same direction as that of the longitudinal walls. The longitudinal and transverse supporting walls intersect at right angles and form a series of square openings when viewed in a direction normal to the deck. The deck panels, are exact squares and hence, may be reinforced in two directions. The reinforcing steel is, therefore, placed both longitudinally across the length of the dam and transversely up and down the deck. The spacing of the steel is logarithmic, the bars being laid closer together as they get nearer and nearer the middle of the panel.

The stresses allowed in the steel are 16,500 lbs. per square inch maximum. All of the steel used was re-rolled twisted bars, having an elastic limit above 55,000 lbs. The engineers considered the high elastic limit preferable to a high ultimate tensile strength, it being assumed that if stresses were imposed on the steel which would extend it past its elastic limit, the surrounding concrete would be probably crushed to such an extent that the structure would fail, and the only value that the steel could have lies in its resistance to distortion within its elastic limit.

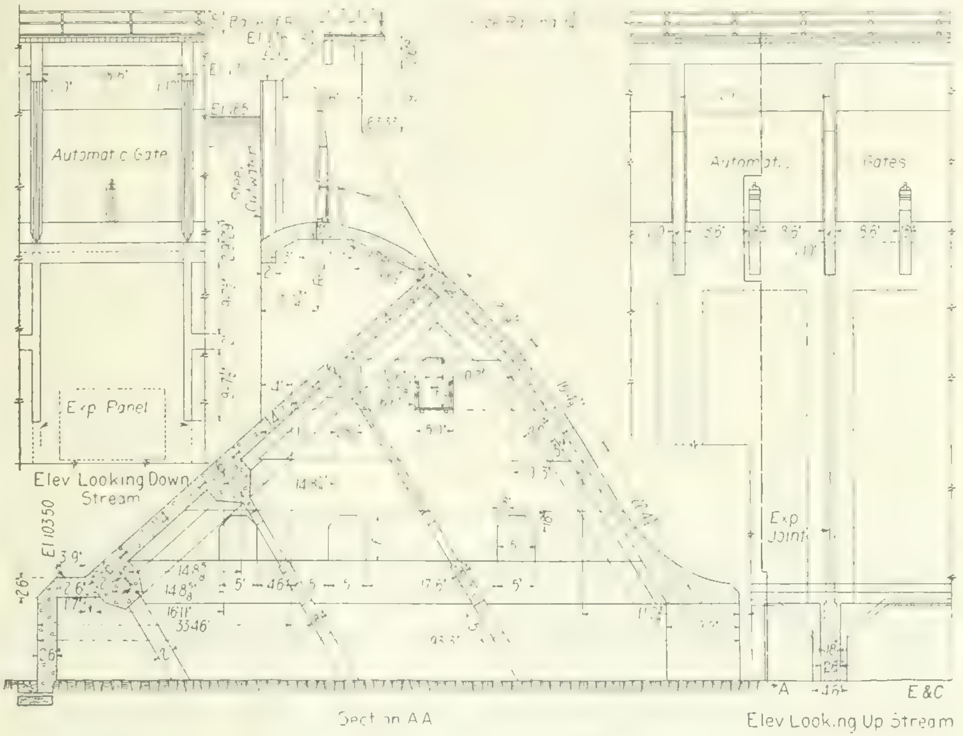


Fig. 1. Section of New Austin Dam Showing Crest Gates.

Owing to the difficult character of the foundation, as has previously been stated, it was desirable to make the distance through the bottom of the dam, measured from upstream to downstream side, as short as possible. In the usual form of design, the inclined deck goes up to the elevation of the crest of the dam, where it joins with the spillway. The form of the spillway is determined by the application of the ordinary parabolic formula, and this gives a certain distance, measured horizontally, from the crest of the spillway down to its toe. As shown in the typical section, Fig. 1, the spillway was designed in accordance with the usual method, and the sloping deck made to intersect it at some 25 ft. further downstream and 6 ft. lower vertically than in the customary design. By this method a proper length of theoretically designed spillway was made available, as well as an inclined deck of substantially the total height up to the spillway, and, at the same time, the length through the dam from front to back was reduced about 25 ft., diminishing in a like proportion the length of the transverse walls, the length of each transverse wall foundation, and eliminating one longitudinal wall. While the saving in material and labor, due to this form of design for a given factor of safety, was greatly reduced by the adoption of this design, the cost of the form work was increased so that the net saving effected though considerable, was not so great as would, at first, appear.

As indicated in Fig. 1, the vertical, transverse walls intersect the deck and the spillway, continuing on up above them in the form of piers, on the top of which are placed reinforced concrete girders that carry a railway track. Between these piers are placed the automatic crest gates, which have, before, been mentioned.

The vetrical buttress, or diaphram walls, have four large openings made in each, as indicated in the section. Through the topmost series of these openings is placed a walkway, with iron railings on either side, so that it is possible to walk through the new portion of the dam from end to end. Access is provided to the interior by means of spiral stairways, one placed at either end. These pass down through a stair-well, each well being formed in a pier, which is of sufficient width to accommodate it.

All the concrete used for making the deck and cutoff wall was rendered waterproof by an admixture of hydrated lime, in the proportion of 8 to 10 per cent (by weight), of the cement, the proportion being varied with variations in the voids in the aggregate. This has proved to be thoroughly satisfactory, as were also the tests made of it prior to adopting this as standard construction on the work.

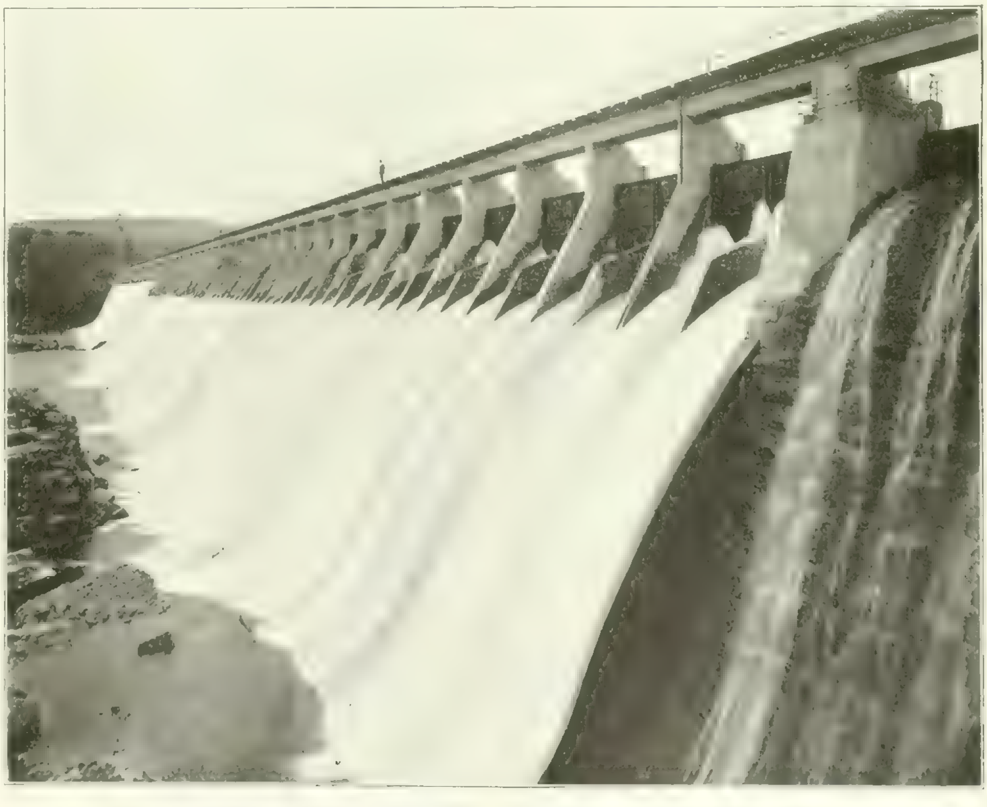


Fig. 2. View of New Austin Dam Showing All Crest Gates Closed.
(At extreme right hand appears end of old masonry dam, a portion of which failed in 1900.)

The concrete mixture was approximately 1-2-4, but no definite proportion of ingredients was used at any time. The proportions were fixed always, by making tests of the voids in the sand, stone and gravel. The proportions would be changed whenever the percentage of voids in these materials would show any change. Void tests were made every hour or oftener if indicated as mixing proceeded. The cement used was made by the Texas Portland Cement Co. and tested for the requirements of the engineers by the Pittsburgh Testing Laboratory. River sand and some river gravel were used for the other constituent parts. Most of the aggregate, however, was broken hard limestone.

EXPANSION JOINTS.

An ample number of expansion joints is provided in the new concrete dam, every fifth panel being an expansion panel. There are 28 panels in all. The first five panels, beginning on the east side, are monolithic, then comes an expansion panel, then five monolithic panels, and an expansion panel, and so on, until the west side is reached. These expansion panels have both the upstream deck and the spillway, entirely separated from the adjacent portions of deck and spillway on either side of it. A joint is made between the two abutting edges of the concrete slabs, which is water tight, but which permits lateral movement of the different sections of the dam without diminishing the tightness of the joint or rupturing any of the masonry. This joint is made of "Ingot" iron plate, ½x8 ins. One-half the width of the strip, that is 4 ins., is cast into the concrete of the abutting edge of a standard panel. This leaves 4 ins. of metal projecting out from the surface of the end of the panel. The end of the slab, together with the projecting iron, is painted over with a heavy coat of asphalt. The expansion panel is then cast so that its edge abuts against the edge of the slab of the standard panel. Due to the asphalt coating, the concrete cannot adhere to the metal of the expansion strip, nor to the adjacent concrete, while that portion of the iron strip cast into the standard panel and adjacent to the expansion panel, does firmly grip the metal. In this way, a watertight, sliding joint is formed. Since its construction, the dam has been subjected to temperatures varying from 32° to 90° and these expansion joints have proven thoroughly satisfactory. Before construction was quite completed and when the whole of the dam was still exposed to the sun and atmospheric conditions, it was possible to see the space between the abutting ends of the panels at expansion joints change more than ¼ in. in a few hours.

COREWALL.

Owing to the permeable condition of the limestone that forms the bluff on the east side of the river, a corewall joins the end of the bulkhead and passes eastward some 300 ft., forming, practically, a continuation of the dam into the rock. The depth of the corewall is somewhat lower than that of the foundation of the dam, varying from 75 to 90 ft. Without this impermeable, intercepting wall, there would be considerable leakage around the end of the dam, through the limestone that forms the eastern bluff.

PIERS.

The piers which are built on both the old and new sections are of the dimensions indicated in Figs. 1 and 2. Those on the crest of the low section, which are the taller and broader ones, are 22 ins. in thickness, while those on high section are 18 ins. thick. The large piers are continuations of the diaphram walls, which support the hollow dam section, and the reinforcing steel passes, continuously, from the foundation up to the top of these piers, so that they are amply strong to withstand the stresses produced by the pressure of the crest gates which they support.

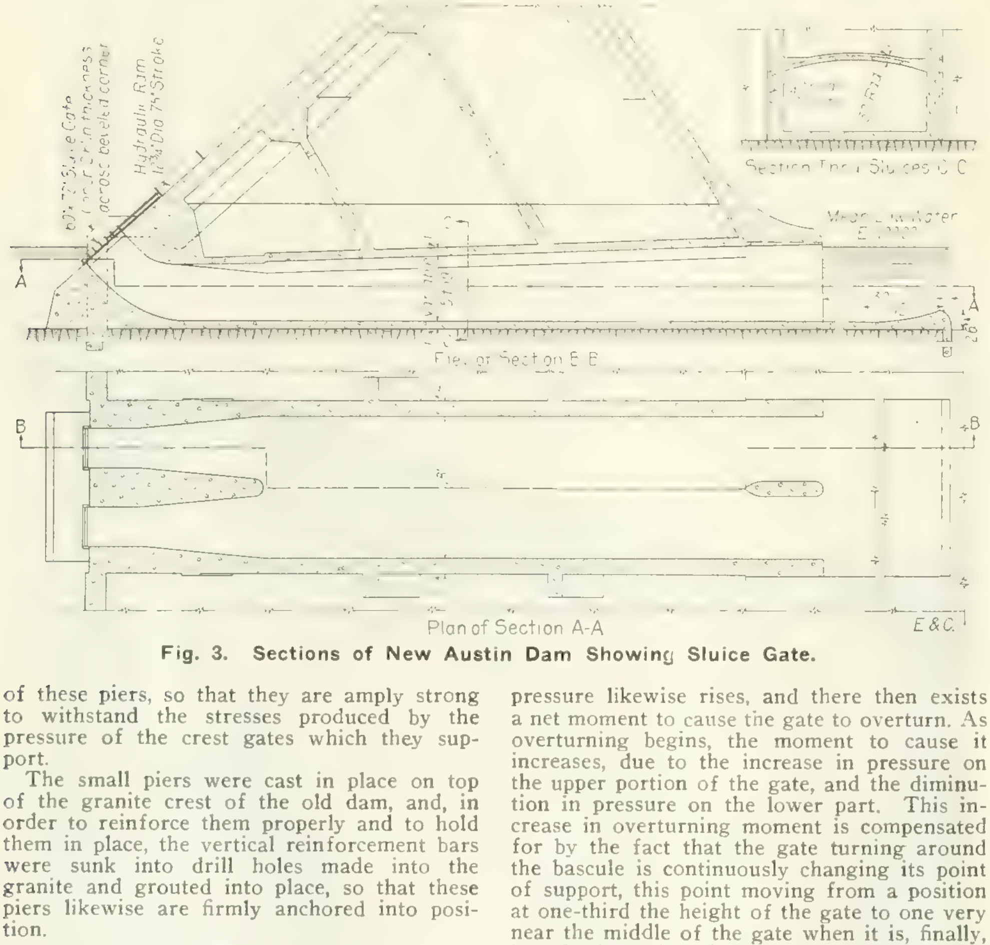


Fig. 3. Sections of New Austin Dam Showing Sluice Gate.

The small piers were cast in place on top of the granite crest of the old dam, and, in order to reinforce them properly and to hold them in place, the vertical reinforcement bars were sunk into drill holes made into the granite and grouted into place, so that these piers likewise are firmly anchored into position.

BRIDGE.

As shown in Figs. 1 and 2, a bridge is built across the top of the dam, being supported on the piers. This bridge comprises two reinforced concrete beams, each 1 ft. thick and 2 ft. 6 ins. deep, spaced 4 ft. apart, center to center, and covered with a concrete slab 8 ins. in thickness. On top of this slab are placed standard 6x8-in. cross ties, 8 ft. long, and a standard gage, railway track is laid on these, the rails coming, approximately, over the beams. The ties are floored over and a pipe railing is put on the downstream side of the walkway thus formed. The railway track serves to carry a heavy, steel derrick car across the bridge, and a railing on the upstream side is omitted so that there is nothing to interfer with the operation of the tackle of the derrick car in case it is desired to move any portion of the gates for repairs, or lift out heavy trees coming down as driftwood, that might be too large to pass through the openings.

CREST GATES.

The crest gates, which are placed between the piers that project upward beyond the crest of the dam, on both the high and low sections, are made up of a structural steel frame work, of which the lower portion is filled with concrete, while the upper part is covered with creosoted yellow pine. There are 28 large gates and 26 small ones, making a total of 1,091 ft. of spillway. These gates turn about rockers or bascules, which are fastened into the piers at either end of the gate. The large gates, which are placed on the low section of the dam, have, in addition, a middle bascule to support the middle and take the heavy water pressure, due to the great size of the individual gates. These large gates are, of course, continuous from pier to pier, and the middle bascule is placed on a low pier built entirely in the rear of the gate, the bascule projecting forward so that a portion of the rear surface of the gate rests against it. When the gates are vertical and the water is at normal height, the center of pressure coincides in elevation with the point of support on the bascule curve. When the water rises above the normal level, the center of pressure likewise rises, and there then exists a net moment to cause the gate to overturn. As overturning begins, the moment to cause it increases, due to the increase in pressure on the upper portion of the gate, and the diminution in pressure on the lower part. This increase in overturning moment is compensated for by the fact that the gate turning around the bascule is continuously changing its point of support, this point moving from a position at one-third the height of the gate to one very near the middle of the gate when it is, finally, in a horizontal position. In order to prevent the gates from leaving the bascules and being pushed downstream, guide pins are placed at either end of the gate, which pins operate in curved channels of cast-iron, set into the concrete faces of the piers. Obviously, when the gates are turned to a horizontal position, the impounded water flows over the spillway crest, the gate being simply a vane in the current. In the case of the large gates, the water reaches an elevation of 65 ft. 9 ins. before overturning takes place. When the gates are in horizontal position, after overturning, the depth of water from the crest to the under side of the gate is 5 ft. 4 ins., while the depth of water from the upper surface to the surface of the water is 8 ft. 5 ins., the thickness of the gate itself being 1 ft.

The small gates, which are 6 ft. in height, overturn when the depth of water is 65 ft. 4 ins., or when the water is 5 ft. 4 ins. in depth over the crest. These small gates, therefore, overturn before the large ones do, and, usually, the operation of the small gates gives more than ample discharge over the spillway to take care of normal river flow. Only in case of flood will the large gates open.

When the level of the water in the lake sinks sufficiently, these gates automatically close. This is effected by the counterweighting provided by the concrete filling in the bottom of the gates, so that the center of gravity of the gates is near the bottom, and there is a continual tendency for gravity to restore them to their normal, vertical position. The small gates close when the water has sunk down 63 ft. 10 ins. or when the level of the lake has dropped some 14 ins. below normal. The large gates close at a water elevation of 64 ft. 8 ins., or when the level of the lake has fallen to 4 ins. below its normal level.

These gates have not only operated in a thoroughly satisfactory manner, but have passed one heavy flood, together with some 50 or 60 acres of driftwood that came down the river and accumulated in the lake prior to the full opening of the gates. In this latter respect, their performance is remarkable. When one of the large gates opens and 14 ft. thickness of water begins to pass over the crest, the volume and velocity of discharge carry large trees through the space between the piers, and over the upper surface of the gates, and when the spread of the branches of these trees is greater than the openings between the piers, the force of the water breaks up the limbs and carries the broken trees through without difficulty.

The advantage of these gates under these particular conditions is obvious, and, by their use, the greater amount of the flood waters is discharged over the low section of the dam, preventing any considerable thickness of water over the crest of the higher section, and, in addition, the lake level undergoes no substantial change between the lowest and highest river stages, the minimum level being about 14 ins. below the normal and the maximum level for heavy floods is not more than 34 ins. above the normal level.

Obviously, the construction of these gates is strong and massive, due to the great pressures that they have to withstand. The pressure against each of the large gates, with normal elevation of lake level is about 64 tons, while the pressure against each of the small gates is about 8 tons.

SLUICE GATES.

There are eight sluice gates, which are located as shown in Figs. 3 and 4. These sluice gates are set in pairs, as shown, each discharging into its own opening; the two individual channels merging into one large tunnel, which passes through the dam. The gates are each 5x6 ft. and are operated by pistons working in cylinders, the working fluid being oil under a pressure of 750 lbs. per square inch. The cylinders are 12¾ ins. inside diameter and the pistons have a 78-in. stroke. It will be observed that the direction of the water is changed on entering the throat of the sluice gate passageway through a gradual curve until the direction of flow becomes horizontal, and also, that the channels increase in area gradually so that practically no eddy currents are formed until after the two individual channels merge into the single large one, which passes through the bottom of the dam. Since this angle channel is 18 ft. wide, and approximately 14 ft. high, the total area is 250 sq. ft., while the area of the openings of the two sluice gates is only 30 sq. ft. each, or 60 sq. ft. for the two. The velocity of efflux through the sluice gates will be about 60 ft. per second, while the velocity through the main channel will be less than 15 ft. per second.

It is to be noted that the oil pressure cylinders which operate the gates are placed on the outside of the deck of the dam instead of inside the dam, as is usually customary. In this way the cylinders could be placed much nearer to the sluice gates than is possible when the cylinder is inside the dam, and the sluice gates outside, with the thickness of the inset of the deck wall between the two. This, of course, shortens the piston rod, which, when the gate is being closed, acts as a long column, and for a given diameter of rod, it is stiffer, or for a given pressure, a smaller rod may be used. This means that the size of the cylinder may be somewhat reduced. Furthermore, the saving in concrete and form work, effected by mounting these cylinders on the outside instead of the inside, amounted to some $5,000. Not having any inset made in it, the dam is stronger at the bottom than it would be with one. It is true that this method of installation has the apparent objection that the cylinders cannot be inspected or repaired, as they are normally under 60 ft. of water. This objection, however, is a purely academic one. The amount of operation of these gates will never be sufficient, in many years, for the element of wear, to have any bearing on the subject. An ordinary Corliss engine, in two hours, will make more strokes than these cylinders will in fifty years. Metallic packing is provided so that it is permanent and not subject to deterioration with time, as most organic substances would be. The pisons are of bronze, so that there is no question of them sticking or rusting to the interior of the cylinders, and this is further prevented by the fact that the cylinders are continuously filled with oil.

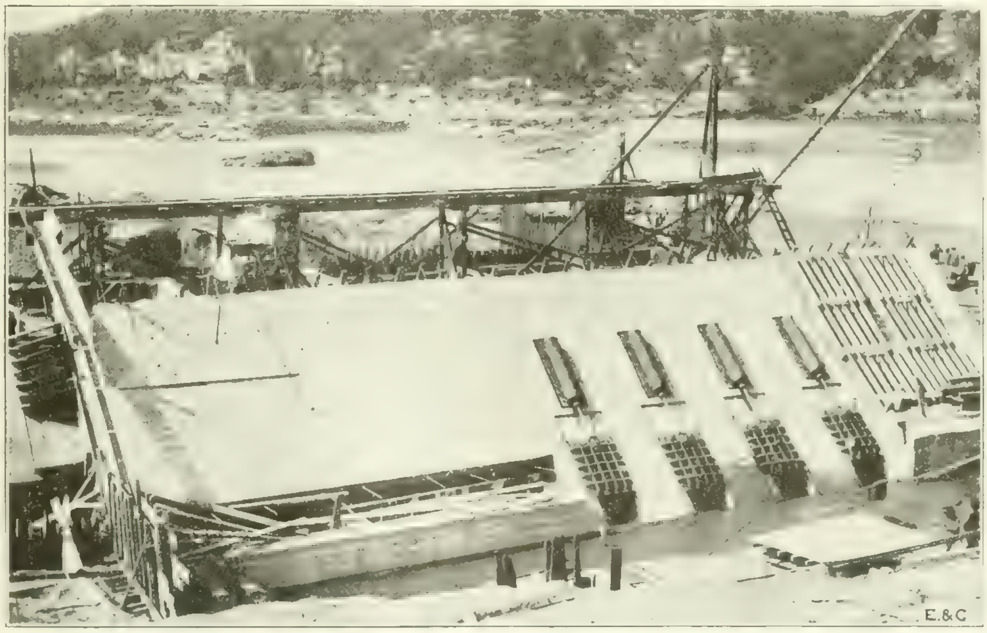


Fig. 4. Rear View of New Austin Dam During Construction Showing Sluice Gates.

A Deane, triplex, pressure pump, having a capacity of 40 gals. per minute, under a pressure of 850 lbs. per square inch, is installed in the power station and driven by a Western Electric, induction motor, which is belted to the pump. A pressure bypass is provided so that the pump can work continuously when the gates are being operated and any excess pumpage will pass from the discharge to the suction pipe, the bypass valve between the two opening when the pre-determined pressure for which it is set, has been reached. The high pressure service pipe, and the low pressure pipe for return of oil to the suction side of the pump, run from the power house into the dam and pass along the side of the walkway through the dam, these two pipes forming two of the three railings on one side of the walkway. At each of the branch pipe connections to the gate cylinders, is placed a specially designed, high-pressure four-way valve and the movement of a valve, in one direction or the other, admits the oil, under pressure, to one end or the other of the operating cylinder it controls, thereby causing opening or closing of the gate.

In order to determine the position of the gates, an indicator is provided on each one, which comprises a section of ⅜-in. copper wire cable attached to the gate, passing a short distance up the deck, then through the deck into the inside of the dam. In the hole through the deck is placed a piece of 1-in. pipe, which extends several feet into the inside of the dam, and it is through this pipe that the copper wire cable passes. A stuffing box is provided at the inner end of the pipe, so that there is no leakage through it, and on the inside end of the cable is hung a weight of concrete, of about 75 lbs. Where a change in the direction of the cable is made, it is properly guided on a pulley. Obviously, any motion of the gate produces a corresponding vertical motion of the weight at the end of the wire cable. Adjacent to the vertical path of this weight is placed a gage having the gate positions marked on it, corresponding to given vertical positions of the weight. In this way, a simple, positive and reliable gate indicator is produced.

The gates themselves are heavy slabs of cast-iron, about 1½ ins. thick, 5 ft. 8 ins. wide by 6 ft. 8 ins. long, the smaller dimension being the transverse one. Heavy ribs are cast at intervals on the outer surface of this gate, tapering from 4 ins. high at the end to 7½ ins. high at the middle, the thickness of the ribs being 1½ ins. The spacing of the ribs is 12 ins. These gates slide on heavy, cast-iron frame works, which are sunk into the concrete. The upper side of the gate frame and the under face of the gate are both lined with bronze strips 2 ins. wide by ⅜ in. thick. These gates have been operated a number of times under varying depths of water, and have proven themselves satisfactory in every particular. The sluice gates and frames were built by the Alamo Iron Works of San Antonio, Texas, while the cylinders with their pistons, and the operating, four-way pressure valves were made from special designs by the Tips Foundry & Machine Works of Austin, Texas.

HEAD WORKS.

The head works are located in the masonry bulkhead on the east side of the river. These, comprise three openings to penstocks, each opening and penstock being 9 ft. in diameter. Each penstock opening is divided into two, each having one-half the area of the single, 9 ft. opening. This is effected by the use of an H-column running, vertically, across the face of the flange, at the inner end of the penstock. There are, therefore, two headgates to each penstock, each headgate being 5 ft. wide by 10 ft. in height. The gates themselves are made of 4-in. creosoted, yellow pine, bolted together, and braced by sections of angle iron, which are fastened to the wood by means of lag screws. One of each pair of gates is provided with a filler gate, which was specially designed and made unusually heavy, owing to the depth of water over the headgates. In times of drought, the water in the lake may be lowered 15 ft., and, at this elevation, the water will be 3 ft. above the top of the penstocks. At its normal elevation, therefore, the water is 28 ft. above the bottom of the headgates.

A hand operated, worm gear headgate hoist, made by the Platt Iron Works Co., is provided for each of the six headgates. The rack is made of steel bars ¼ in. in thickness by 2 ins. wide, these bars being held together by ½ in. rods passing through them. The length of the bars is 31 ft., of which 29 ft. is submerged. The spacing of the bars is ⅞ in., center to center, which gives a ⅝ in. clear space between each pair of bars. The total length of the rack is 36 ft. The rack bars have a slope of approximately 15°. Racks of a very different kind and spacing were designed by the engineers, but this particular form of rack, with the spacing as given, was demanded by the City of Austin, and, as the municipality will take over the plant and conduct its operation, this demand was acceded to. The engineers of the City Water Power Co., who designed and constructed the dam and the plant, hold the opinion that, owing to the extraordinary length of the submerged bars as compared with the usual standard racks, the ordinary form would not be suitable here, and further, that the bars are placed so close together that it will be difficult to keep them raked clear during the autumn when leaves and light trash come down the river in considerable quantities.

PENSTOCKS.

There are three penstocks, each being 9 ft. in diameter, and made of steel plate, ¼ in. thick, which is covered on the outside with concrete. The exterior of this concrete is hexagonal in form, and it is 8 ins. thick at its thinnest section. The concrete is reinforced with steel wire mesh, and, by this construction, strong and permanent conduits have been provided. As a precaution against water hammer, surge pipes are connected with the penstocks, there being one to each penstock and joined to it at the point nearest to the turbine casing that is available. These surge pipes leave the penstocks horizontally, pass through the wall of the power house on the stream side of the building and then turn vertically upward, being anchored to the wall of the building.

Just after passing through the power house wall, each penstock is turned downward to the opening in the turbine casing, and this condition is one which is liable to produce collapse of a penstock, if the water wheel gates are rapidly opened, unless some provision against this is arranged. To prevent this, a vertical vent pipe is placed on each penstock, just outside the power house wall. Two of these are 66 ins. in diameter each and one 48 ins. in diameter, and the height of these vent pipes is such that the water normally stands in them about 4 ft. from the top. It has been found, in practice, that these vent pipes not only act to prevent collapse of the penstocks, but act also as surge pipes. When the water wheel gates are rapidly closed, water is ejected from the surge pipes before described, and also from the vent pipes.

Clean Town Contest.—The Utah State Board of Health is conducting a clean town contest similar to that so successfully carried out last year. All incorporated towns in the state will be scored, in six classes according to population. Scoring will begin August 1, and the awards will be based on sewage disposal, stables and corrals, garbage collection and disposal, water supply, sanitation of school houses and public buildings, sanitary marketing of foods, presence of flies, sanitation, cleanliness, and ventilation of the home, condition of streets, parks and alleys; general appearance of homes, barns and barnyards, lawns and flower gardens, vacant lots and fences.

BRIDGES

Design Features of the East Kansas Ave. Bridge Over the Kansas River at Kansas City, Kan.

(Staff Article.)

Construction work has started on an important highway bridge over the Kansas (Kaw) River at East Kansas Ave., Kansas City, Kan., the design of which presents a number of interesting and unusual features. The requirements of the Government, and those due to the conditions existing at the site, made it difficult to meet these requirements and still keep the cost within reasonable limits. The total length of the structure is 1,635 ft. Beginning at the west end of the bridge this length is made up as follows: Concrete retaining walls and sand fill, 358 ft.; steel viaduct, 401 ft.; main deck-truss river spans, 727 ft.; and steel viaduct, 149 ft. The contract price for the bridge is $479,700, which includes the removal of the present structure.

GENERAL REQUIREMENTS.

Following the disastrous flood of 1903 the Kaw Valley Drainage District was formed for the purpose of carrying out measures to prevent damage from future floods. After much litigation and negotiations between the interests affected the Drainage Board, working in conjunction with the War Department, established harbor lines, which, for a distance of about three miles above the mouth of the river, are parallel and 724 ft. apart. Levees have been constructed on each bank, with a slope of 2 to 1 on the river side. After the construction of these levees the Drainage Board ordered the reconstruction of all bridges over this part of the river, subject to the following general requirements:

(1) There shall be only two piers in the river between harbor lines, the upstream and downstream axes of which shall be approximately parallel to the current.

(2) The shafts, or "neat-work" of the piers shall extend "as clean masonry" (with no offsets) to at least 45 ft. below the levee grade.

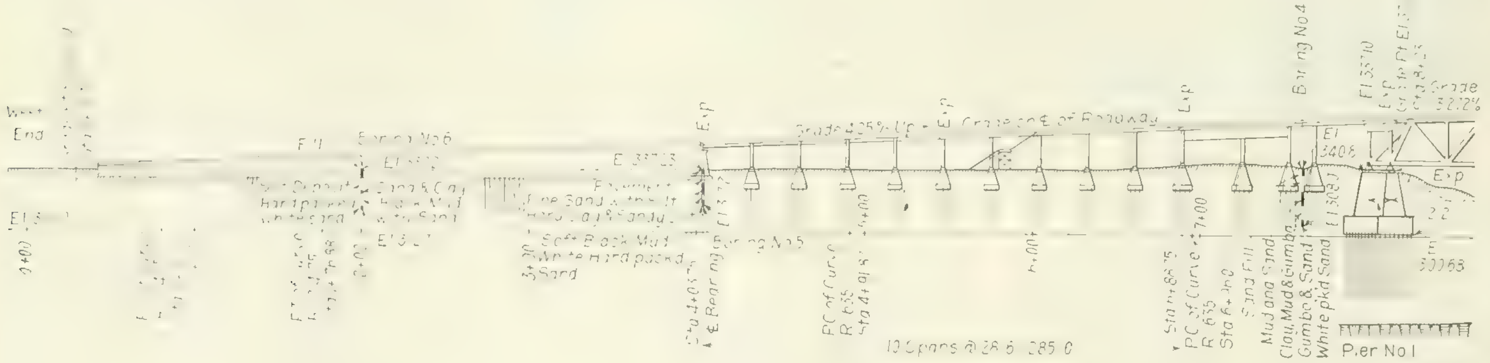


Fig. 1. General Elevation of East Kansas Ave. Bridge, Kansas City, Kan.,

(3) The lowest point of the superstructure (except shoes) shall be at or above the levee grade.

A further restriction imposed by the War Department was that the two river piers must be opposite the two piers of the Rock Island bridge, which is a short distance downstream, i. e., they must be at the same distance from the harbor lines. The present bridge is to be removed as soon as the new structure is completed.

The state line between Kansas and Missouri is about 90 ft. east of the east harbor line. The St. Louis & San Francisco Railway Co. has a 50-ft. right-of-way along and parallel to the state line, 28.35 ft. of which is on the Kansas side and 21.65 ft. on the Missouri side. It was necessary to span this right-of-way, and consequently a portion of the new bridge will be in Missouri. The bridge is being constructed by Wyandotte County, Kansas, except the part which extends beyond the Kansas state line; that part will be paid for by the city of Kansas City, Mo.

From the foregoing description it will be noted that the structure being built by Wyandotte County will end "up in the air," at the east side of the Rock Island right-of-way. From this point the bridge will ultimately be continued by the city of Kansas City, Mo., across a number of railway tracks to the bluff at 23rd St., a distance of about 1,750 ft. The present Allen Ave. viaduct over these tracks near the site of the new bridge will be torn down after the completion of the new structure. As there are no funds available for the construction of the Missouri portion of the bridge, it is planned to build a temporary wooden structure on piling to connect with the Allen Ave. viaduct, a distance of about 1,000 ft., at an estimated cost of $40,000.

The combined viaduct in Kansas and Missouri was so located as to afford the most direct route practicable between the Kansas side and the new Union Station. For that reason the Kansas River bridge crosses the river at an angle of 10° 26′ with the perpendicular between harbor lines. This arrangement gives the further advantage that the heavy traffic across the river can be provided for by the present bridge until the completion of the new structure and of the temporary structure on the Missouri side.

GENERAL DESIGN FEATURES.

As the piers are set at an angle of 10° 26′ with the longitudinal axis of the bridge, and because of the requirement that they be placed opposite the piers of the Rock Island bridge, a very awkward and unsymmetrical arrangement of spans resulted, there being two spans of about 317 ft. 6 ins. each on the west side of the river, thus leaving a distance to the east harbor line of only about 120 ft. Figure 1 is a general elevation of the bridge. This drawing shows the types of structure used, and gives a profile of the site; it also shows the subsoil conditions.

The west approach begins near the intersection of Kansas Ave. and Berger Ave., about 800 ft. west of the west harbor line, at which location the Union Pacific Ry. tracks are crossed at grade, it being found practicable to raise the grade of these tracks about 2 ft. Along the west harbor line the approach spans the right-of-way of the Kansas City Southern Ry., giving a minimum clearance of 21 ft. The span used here was made very shallow to reduce the approach grade as much as practicable—to 4.25 per cent. The grade thus fixed left available space for a depth of only 25 ft. 9 ins., center to center of chords, at the west end of the west river span. As this depth was much too shallow for the long span required, the ascending grade was continued to a point 191.58 ft. east of the west harbor line, the grade being broken at three points, so as to approximate a vertical curve (see Fig. 1). From this point eastward the grade is level, the available truss depth being 30 ft., center to center of chords.

If simple truss spans had been adopted the length of the two main spans would have been about 314 ft., and the trusses would have been less than one-tenth of the span, thus necessitating very heavy chord sections. For this reason it was decided to adopt a cantilever design.

The anchor span, which has a length of 317 ft. 6 ins., rests on the two river piers, and has a cantilever arm projecting from it at each end to receive the ends of the simple spans (see Fig. 1). The west cantilever arm has a length of 58 ft. for the north truss and 48 ft. for the south truss. The east cantilever arm is 95 ft. long for the north truss and 88 ft. long for the south truss. The north truss of the west simple span has a length of 262 ft. 6⅛ ins., while the south truss has a length of 267 ft. 4⅛ ins. The east suspended span is a plate girder type, the north girder having a length of 88 ft. 6¼ ins. and the south girder a length of 100 ft. 8¼ ins.

The lengths of the cantilever arms were so chosen as to make the negative moments over the supports and the positive moments at the center of the anchor span approximately equal. Another advantage of the cantilever design is that no pier is required at the east harbor line, the suspended plate girder span extending over the right-of-way of the A., T. & S. F. Ry. and that of the C., B. & Q. Ry. and resting on columns supported on small piers having pile foundations. A further advantage is secured by the use of a cantilever system, namely, the required width of piers is less than would be required with simple spans, as only one shoe is required under each truss.

The bridge carries two street railway tracks, one of which is bracketed from the north trusses, while the other is located at an equal distance inside of these trusses; it also provides a 36-ft. clear roadway (10 ft. 2 ins., of which cantilevers beyond the south trusses), and a 6-ft. sidewalk along the south side of the structure. The sidewalk does not extend throughout the west approach, but is carried to the street level in front of the Cudahy Packing Co.'s plant by means of a stairway (see Fig. 1).

The trusses and the east approach girders are spaced 38 ft. on centers to secure economy in the cross girders and piers. The trusses are so located that the total load on each is approximately the same. Due to the unsymmetrical cross section the dead load on the south, or highway, truss is much greater than that on the north, or street railway, truss; the reverse is true of the live loads.

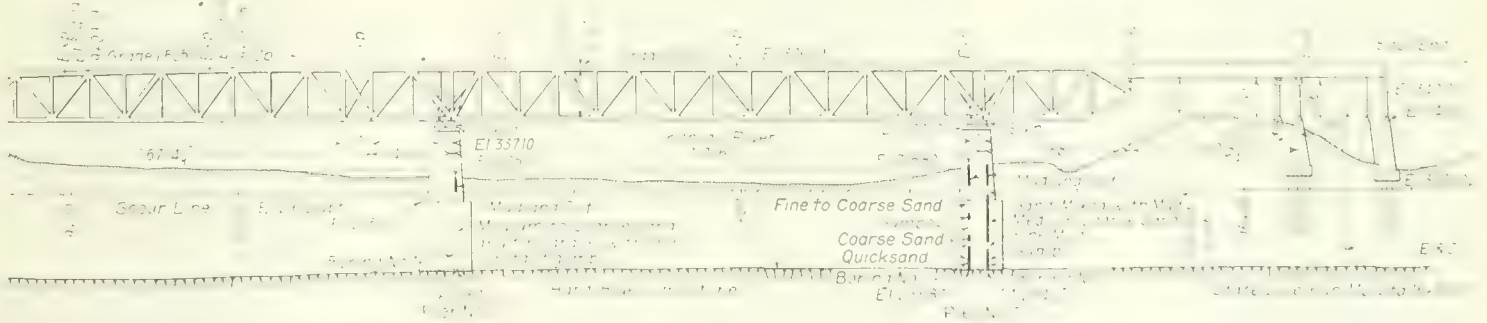
On account of the long cantilever brackets at each side the deck is loaded differently for each truss. The deflections of the trusses, which are considerable (due to the shallow trusses and to the cantilever construction), are quite different; and it was therefore deemed advisable to omit sway bracing except at the piers. The trusses are of the cantilever type, and are riveted throughout. The chords are spliced for 110 per cent of the strength of the sections, with the exception of the top chord splices in the west suspended span, which are spliced for the live and impact loads only.

The roadway will be paved with creosoted wood blocks, the pavement on the steel spans resting on a reinforced concrete base. The sidewalk also will be of reinforced concrete construction. The street railway tracks on the steel portion of the structure will have open decks of creosoted timber. There will be two lines of heavy gas pipe railing throughout the structure and on both sides of the stairway. Since the roadway slab is of reinforced concrete it was necessary to provide a number of expansion joints in the floor for each span.

SUBSOIL CONDITIONS AND FOUNDATIONS.

The subsoil under the retaining walls of the west approach, as shown by borings, consists mainly of successive strata of: silt deposit; sand mixed with clay, fairly well packed; black mud containing some sand; and white sand, packed hard, the latter being encountered at a depth of from 20 to 25 ft. Near pier No. 1 (see Fig. 1) the top surface consists of a thin layer of sand, followed by successive strata of partial fill, with mud and sand; soft yellow clay, changing to mud and gumbo; gumbo mixed with sand; and white sand, the latter being found at a depth of about 30 ft. The depth to rock at pier No. 1 is about 90 ft. At pier No. 2 rock lies at a depth of about 48 ft. below the bed of the river. At the location of this pier, mud and silt are found to a depth of about 5 ft.; from this level to the rock surface the material consists of medium to very coarse sand and fine gravel, with occasional thin strata of gumbo. At pier No. 3 the depth to rock is about 62 ft. At this pier, mud and silt are found to a depth of about 14 ft., followed by medium to coarse sand to a depth of about 52 ft.; below this level there is a comparatively thin layer of fine gravel and quicksand, between which and the rock there is a stratum of gumbo.

The pedestals and retaining walls of the west approach are to be founded on concrete piles, while the four pedestals at the east end will have timber pile foundations. Pier No. 1 will be founded on timber piles and piers Nos. 2 and 3 (see Fig. 1) are to be sunk to bedrock by the pneumatic process.



Showing Types of Structure and Subsoil Conditions.

LOADS AND ALLOWABLE STRESSES.

Loads.—The assumed live load on the two street car tracks consisted of two 50-ton cars on each track, or a continuous line of 40-ton cars on each track. In the 50-ton cars the axles of the front and also of the rear trucks are spaced 6 ft. 6 ins. on centers, the trucks of each car being spaced 31 ft. 6 ins. on centers, while distance between the center of the rear truck and the center of the front truck of the car following is 22 ft. 6 ins. In the 40-ton cars the axles of both trucks are spaced 6 ft. on centers, the distance between the centers of trucks on the same car is 26 ft. and that between the centers of front and rear trucks of adjacent cars 20 ft. The axle loads of each car of each class are equal.

For the roadway floor system the assumed live load was either a 20-ton road roller or a uniform load (the one which gave the larger stresses), the latter being expressed by the formula,

$$w_1 = \frac{79{,}200}{720 + L}$$

where w_1 = uniform load per square foot, and L = span in feet.

The road roller has 16,000 lbs. concentrated on the front drum, which is 4 ft. wide, and 24,000 lbs. on the two rear wheels, the latter having a width of 20 ins. and a capacity of 5 ft. on centers.

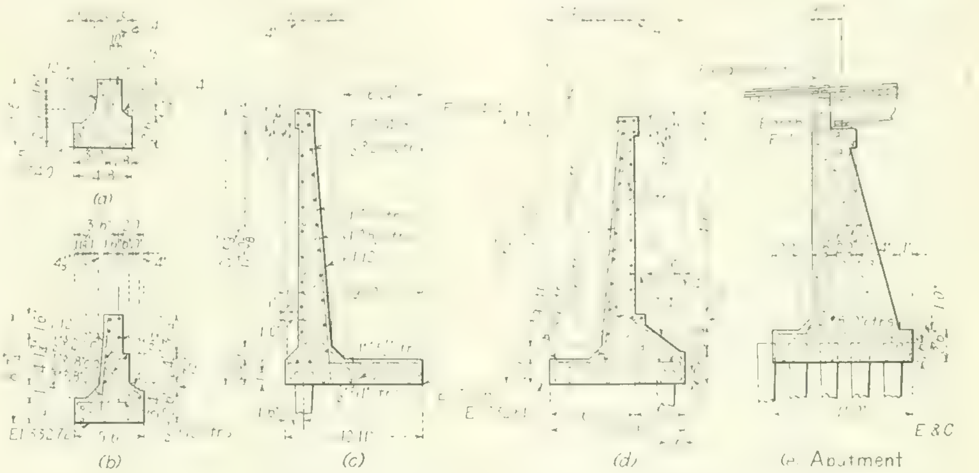


Fig. 2. Cross Sections Showing Types of Retaining Walls and Abutment Used in West Approach of East Kansas Ave. Bridge.

In designing the floor system of the sidewalk the assumed uniform load was w_1, given above. For computing the stresses in girders, trusses and columns, the sidewalk load used is expressed by the formula,

$$w_2 = \frac{68{,}400}{720 + L},$$

where w_2 = uniform load per square foot, and L = span in feet.

The impact increment is expressed by the formula,

$$I = \frac{300}{800 + L + \frac{L^2}{10}},$$

where I = impact increment, and L = loaded length in feet.

No impact was considered for the roller loading.

The dead load used was the actual weight of the materials in the structure.

The wind load was taken at 30 lbs. per square foot of exposed vertical area plus 300 lbs. per linear foot on the upper deck, the entire wind load being treated as a moving load.

Allowable Stresses.—The following allowable stresses were used in designing the sections:

	Lbs. per sq. in.
Tensile stresses:	
Bottom chords and main diagonals, built sections	16,000
Floorbeam hangers, built sections	12,000
Laterals	17,000
Flanges of floorbeams, stringers and plate girders (considering one-eighth of gross area of web as effective flange area)	16,000
Reinforcing bars	16,000
Compressive stresses:	
Chord sections	$16{,}000 - 70\frac{l}{r}$
Vertical posts of trusses	$14{,}000 - 60\frac{l}{r}$
Compression in extreme fiber of reinforced concrete members	650
Shearing stresses:	
Webs of plate girders, gross section	10,000
Shop rivets	10,000
Field rivets	8,000
Bending stresses:	
Extreme fiber for rolled sections of medium steel	16,000
Extreme fiber of pins	24,000
Extreme fiber of creosoted timber	1,600
Bearing stresses:	
Shop rivets	20,000
Field rivets	16,000
Pins	20,000

In considering reversals of stress, the following procedure was specified: Compute the required area for both tension and compression and add one-half of the lesser area to the greater, except for web members of trusses, for which use three-fourths instead of one-half. The rivets for end constructions and splices are to be computed in a similar manner.

For compression members of trusses the maximum value of $\frac{l}{r}$ was taken as 100, except for laterals and members whose main function is to resist tensile stresses; in such members $\frac{l}{r}$ was taken as 140.

RETAINING WALL DETAILS.

The reinforced concrete cantilever type of retaining wall was adopted, the heights of which vary from 5 ft. 6 ins. at the west end to 21 ft. 6 ins. at the beginning of the steel viaduct (see Fig. 1). These walls are to be founded on reinforced concrete piles. Figs. 2 (a), (b), (c) and (d) are cross sections of the retaining walls taken at various points. Fig. 2 (a) shows the type of retaining wall used at the west end of the approach; Fig. 2 (d) is a cross section of the wall near the abutment at the east end of the retaining wall approach, and Fig. 2 (e) is a cross section of the abutment. The concrete specified for all retaining walls consists of 1 part cement, 3 parts sand and 5 parts broken stone.

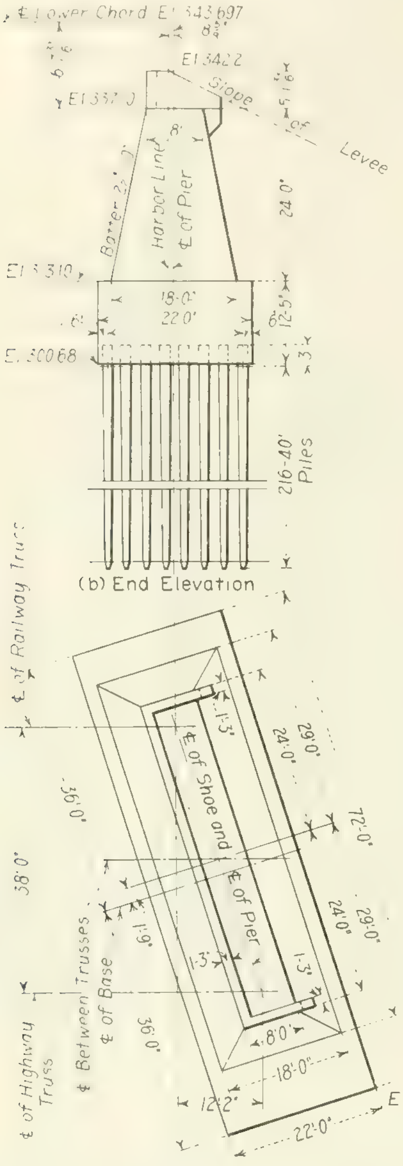


Fig. 3. Plan and End Elevation of Pier No. (at West Harbor Line) of East Kansas Ave. Bridge.

SUBSTRUCTURE DETAILS.

Piers for Steel Viaduct.—The concrete piers for the steel viaduct of the west approach are to be founded on 24-ft. reinforced concrete piles, the number of piles in each pier being either, 9, 12 or 16. Where 9 piles are used the pier footings are 9 ft. square by 3 ft. thick; while the pier shafts are 7 ft. 9⅝ ins. square at the base and 3 ft. square at the top, their height varying from 10 to 16 ft. Where 12 piles are used, the footings are 9 × 12 ft. × 3 ft. thick, the top and bottom dimensions of the pier shaft being the same as for the 9-pile piers. For the 16-pile piers the footings are 12 × 12 ft. × 3 ft. 9 ins. thick, while the pier shafts are 6 ft. 8⅛ ins. square at the bottom, 3 ft. square at the top and 12 ft. 3 ins. high. The piers are to be constructed of 1:3:5 concrete, with the exception of the top 1 ft. of the pier shafts, where a 1:2:4 mix is to be used.

The two piers at the east end of the bridge (see Fig. 1) are each to be founded on twenty-five 40-ft. timber piles. The footings of these piers are 15 ft. × 15 ft. × 6 ft. thick, while the pier shafts are 10 ft. 9 ins. square at the bottom, 4 ft. square at the top, and have a height of 27 ft. With the exception of the upper 1 ft. of these piers (where a 1:2:4 mix is to be used), the concrete proportions are to be 1 part cement, 3 parts sand and 5 parts broken stone.

The two pier shafts between those at the east end of the structure and pier No. 3 (see Fig. 1) are each to be supported on 30 timber piles. Their footings are 15 × 16 ft. × 16 ft. high, while the pier shafts are 10 ft. 3 ins. × 11 ft. 3 ins. at the base, 4 ft. 6 ins. × 3 ft. 6 ins. at the top, and 27 ft. high.

Piers for Truss Spans.—Pier No. 1, which is located at the west harbor line (see Fig. 1), is to be founded on 216 40-ft. timber piles. The footing of this pier is 22 × 72 ft. × 12 ft. 6 ins. thick, while the pier shaft, which is 18 × 58 ft. at the base and 8 × 48 ft. at the top, is 24 ft. high. An 18-in. parapet wall extends 5 ft. 1 3/16 ins. above the pier shaft. The parapet wall and the upper 2 ft. of the pier shaft are to be composed of 1:2:4 concrete, while a 1:3:5 mix is to be used for the remainder of the pier. Fig. 3 shows a plan and an end elevation of this pier.

The two river piers (Nos. 2 and 3, see Fig. 1) are to have pneumatic caisson and crib foundations, the tops of which are to be about 2 ft. below the scour line of the river bed. For pier No. 2 the caisson and crib is 20 × 60 ft. × 43 ft. 4 ins. high, while for pier No. 3 the caisson has the same section but is 42 ft. 6 ins. high. The caissons are to be founded on solid rock, into which they are to project about 18 ins. The pier shafts of these piers have semi-circular ends, while the sides and ends of the shafts have a batter of ½ in. in 1 ft. Fig. 4 shows a plan and end elevation of these piers and their caissons.

SUPERSTRUCTURE DETAILS.

West Approach.—Starting at the east end of the retaining wall construction, the west approach consists of a series of ten 28-ft. 6-in. spans, followed by four spans of irregular lengths (see Fig. 1). The floorbeams of these 28-ft. 6-in. spans are supported directly on steel columns, the 24-in. I-beam stringers spanning the spaces between the floor beams. The columns are braced together in pairs, to form bents, and are anchored to the concrete piers with four anchor bolts, each 2 ins. in diameter and 8 ft. long.

East Approach.—The east approach consists of two deck plate girder spans, as shown in Fig. 1. One end of the longer of these two spans rests on the cantilever arm of the adjacent truss span, while the other end rests on a steel bent, which in turn is supported on concrete piers. The girders in the longer span are of unequal lengths, one having a length of 99 ft. 10½ ins. and the other 87 ft. 8½ ins., center to center of bearings. The girders in the east span have a length of 52 ft. 2¾ ins., center to center of bearings. Figure 6 is a cross section of the floor system of these girder spans. This drawing gives the details of the floor system and shows the relative positions of the sidewalk, roadway and street car tracks.

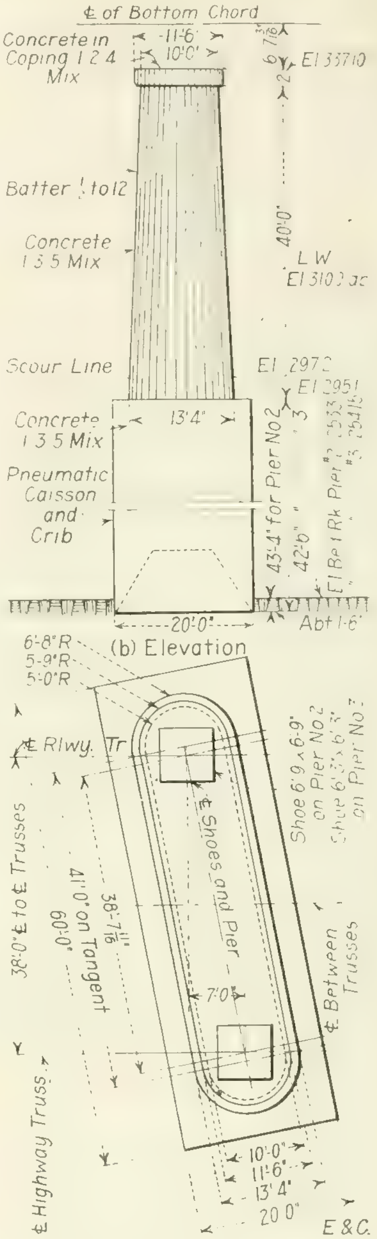


Fig. 4. Plan and End Elevation of Piers Nos. 2 and 3 (River Piers) of East Kansas Ave. Bridge.

Truss Spans.—The types of riveted truss

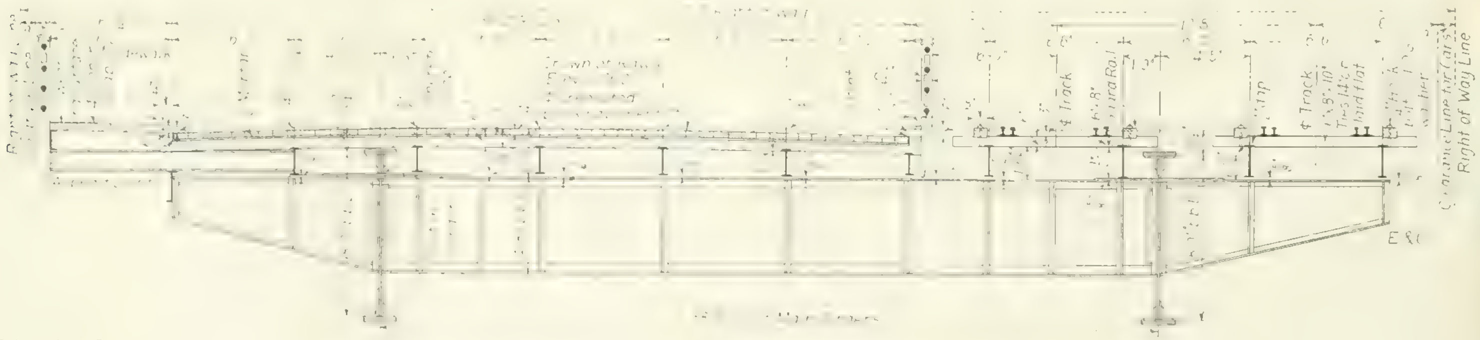


Fig. 5. Cross Section of Floor System for Girder Spans in East Approach of East Kansas Ave. Bridge.

spans used are shown in Fig. 1. It will be noted that the anchor span, which rests on piers Nos. 2 and 3, cantilevers beyond both piers. The trusses of this span have a depth, center to center of chords, of 30 ft., the spacing of trusses being 38 ft., center to center.

The floorbeams and cantilever brackets, which support that part of the floor system extending outside of the trusses, have their tops at the elevation of the top chords of the trusses. The stringers frame into the floorbeams, projecting above the tops of the latter from ½ in. to 5¼ ins., depending on their position in the floor system. This position of the stringers requires a different detail for supporting the sidewalk from that used on the girder spans. With the exception of these points the floor system for the trusses is similar to that shown in Fig. 5.

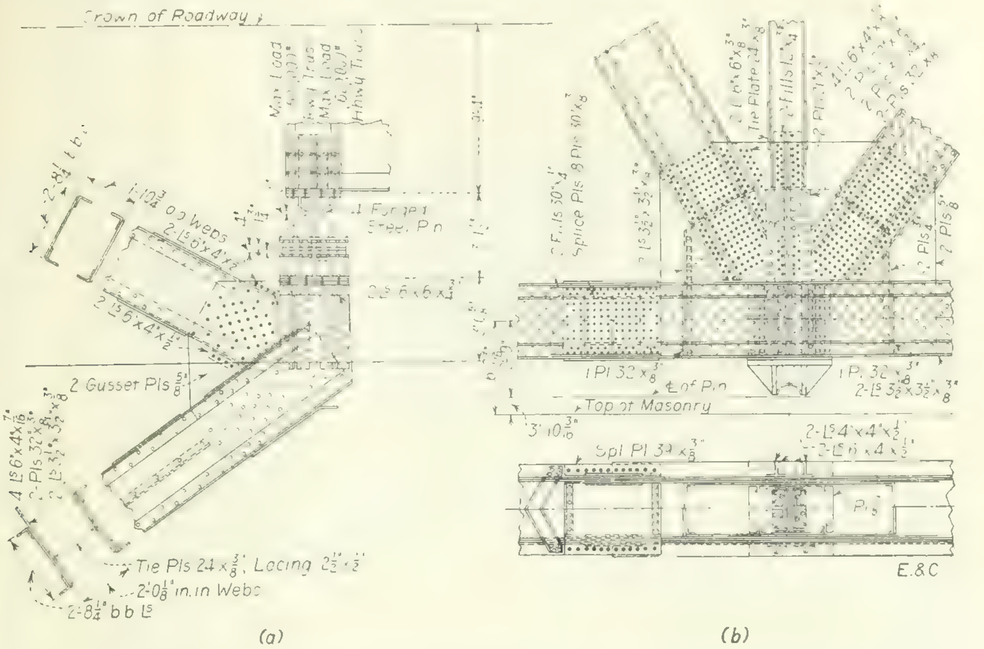


Fig. 6. (a) Detail of Connection Between East Cantilever Arm of North Truss Span and Approach Girder; (b) Detail of Lower Chord Joint at Pier No. 2 of North Truss of East Kansas Ave. Bridge.

Figure 6 (a) is a detail of the lower chord joint over the bearing at pier No. 2; and Fig. 6 (b) is a detail of the connection between the east cantilever arm of the anchor span and the adjacent girder span.

Figure 7 is a detail of one of the shoes at the expansion end of the anchor span, these shoes resting on pier No. 3 (see Fig. 1). The drawing also shows details of the 10-in. segmental rollers.

The details of the floor system and shoes of the simple span between piers Nos. 1 and 2 are similar to those shown for the anchor span. The feature of the simple span is that the trusses have different depths at the two ends, due to changes in grade.

PERSONNEL.

The plans and specifications for the bridge were prepared by Hedrick & Cochrane, consulting engineers, Kansas City, Mo., to whom we are indebted for the data upon which this article is based. The work is being done under the direction of R. L. McAlpine, county engineer of Wyandotte County, Kan. The Kansas City Structural Steel Co. has the general contract for the structure. The construction of the three main piers has been sublet to the Missouri Valley Bridge & Iron Co., and the remainder of the substructure to the Horton Construction Co.

The city treasury of Vancouver, B. C., will feel the effect of the reduction of travel over the street car lines, resulting from the growth of the jitney bus traffic. It is said that the city's revenue from the street car lines will be decreased this year about $30,000.

The Use and Care of Lifting Jacks.

The following instructions in the use and care of lifting jacks were issued by the engineering and inspection division of The Travelers Insurance Co. of Hartford, Conn.:

The demands of modern construction and transportation for portable mechanical appliances for raising and supporting heavy weights are adequately supplied by the lifting jacks of various types that are now so commonly employed. Screw jacks and reduction-gear jacks are capable of lifting loads up to 20 tons or so, while pneumatic jacks, and those operated by hydraulic power, range in capacity from a few hundred pounds up to 500 tons.

Because of the enormous weights sustained by lifting jacks, it is essential that all possible precautions be taken to insure their proper use and maintenance, so that accidents may be avoided.

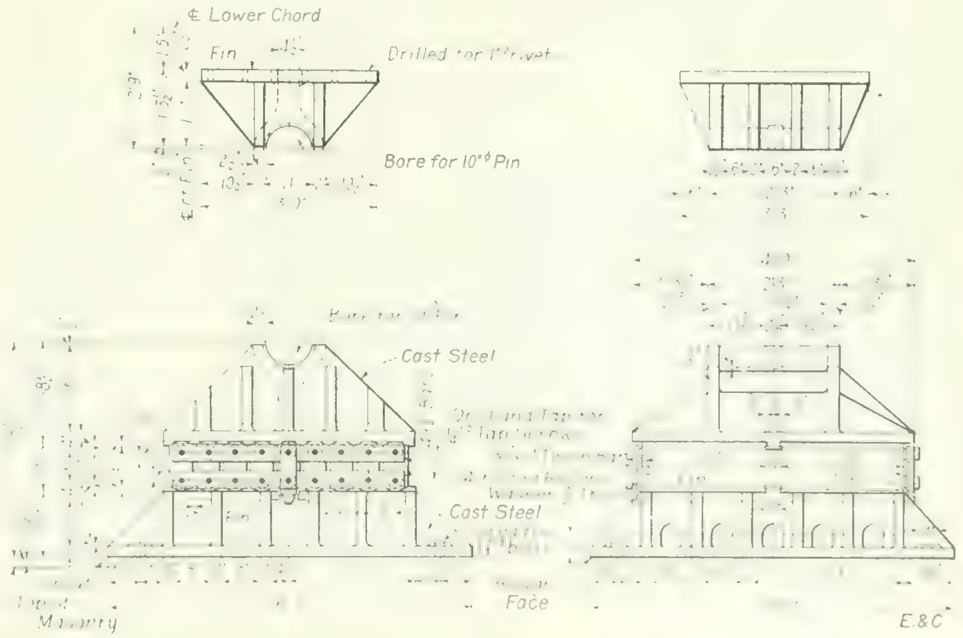


Fig. 7. Details of Roller Shoes for Truss Span at Pier No. 2 of East Kansas Ave. Bridge.

In some operations, and notably in track repair, unskilled labor is employed, and workmen of this class cannot be depended upon to exercise the best judgment in the use of jacks. A competent man should be in charge of the work so that by his advice and under his direction the safety of the workmen may receive due consideration.

The first procedure toward safety in the use of jacks is frequent and thorough inspection of the mechanical parts. Particular attention should be given to the racks and reduction gears, in jacks of this type, for a defect in one of these parts is apt to cause an accident. A broken, excessively worn, or otherwise defective gear or rack tooth may give way as pressure is applied on the handle, thus causing the operator to fall headlong. A broken or defective tooth, when it gives way, permits the total weight being lifted to fall until the next firm tooth is engaged, and the shock or pounding effect on this tooth may be sufficient to fracture it also. The remaining teeth are then apt to give way in a similar manner, thus permitting the load to fall to its original resting place. When such a break occurs during the raising of a railway coach or trolley car, the short interval of time that elapses between the breaking of the first tooth and the fall of the car affords little opportunity for the workmen to reach a safe place.

The top of the jack and the rack column should be frequently inspected and tested, for a defect in one of these sections would precipitate the whole load without any warning. Some jacks are equipped with a swivel claw attached to the jack by a ball-and-socket joint. This permits the use of the jack in close quarters, and low headroom. It is important that both the joint and the claw be in first class condition, as they are both likely to be subjected to extra stresses by reason of the fact that the claw can swing in a vertical angle of 30 to 40° from the frame. A claw that has a safe lifting capacity of 20 tons in a vertical plane, is very apt to be stressed beyond the safe limit if the same weight is applied at a 30° angle, and for this reason the manufacturers generally will not guarantee the full capacity of the jack when the load is applied on the claw at a vertical angle greater than 15°. Notwithstanding this fact jacks are often abused in this way, so that accidents frequently occur.

Even when this caution is kept in mind, it is very important to see that the base of the jack has a firm bearing surface. This is best accomplished by inserting a wedge between the ground and the bottom of the jack. If the workmen are thoroughly impressed with the importance of a full bearing surface on the bottom of the jack, and a wedge is provided which will not give a full bearing surface when the claw is swung more than 15° from the frame, reasonably safe practice may be expected.

A solid, full bearing surface for the base of a jack is a prime requisite. If the bottom of the jack is placed on a soft, yielding surface it is almost sure to tilt to one side, or subside, thus permitting the load to fall. Even if two or three jacks are used, and one of them gives way, the increased downward and lateral pressure thus caused is quite apt to tip the remaining jacks. A similar dangerous condition is brought about when the jacks under one side of a load are raised faster than those at the other side. This will produce a lateral pressure at the point where the load is raised least, and will tend to tip the whole set of jacks.

As a precaution against the occurrence of such accidents, it is advisable to have at hand blocks of different sizes. These blocks should be graded in 1 or 2-in. steps, and as the load is raised, inch by inch, blocks of increasing thickness should be placed beneath, so that at no time will there be more than 1 or 2 ins. between the bottom of the load and a substantial block. In case of a jack failure these temporary blocks will tend to minimize or entirely eliminate the chance of an accident. After the load has been raised to the required height, no further work should be allowed until permanent blocks, horses, trestles, or other substantial supports have been put in place, to relieve the jacks of the load. Some workmen, depending entirely on the jacks, especially in car-repair work, will crawl under the car without waiting for the horses to be put in place. The failure of the jack in such cases is almost sure to result in instant death to the workmen under the car; and since the precaution against such an accident is so simple, ordinary prudence would demand its use.

With some jacks of earlier types that are still used in track repairing, there is no provision for lowering the rack gradually. The release of a pawl or dog causes the rack to drop suddenly, with its load, and unless the workmen stand at a safe distance, they are likely to be severely injured by the descending load.

Most of the remarks which have been made concerning the reduction-gear jack apply with equal force to the hydraulic and hydro-pneumatic jack. The care to be exercised in securing a firm footing for the jack, the simultaneous raising of the load at all points, and the blocking of the raised load are just as important in the use of one type of jack as another. The lifting force of the hydraulic jack is dependent on an entirely different action from that of the gear jack. The fine adjustment of the valves, and the consequent necessity for using water free from grit particles, calls for special care, and when filling the head, a chamois skin, or other equally effective strainer, should be used.

Hydraulic-jack failures are commonly due to defective packing. Such defects are first evidenced by the failure of the jack to raise or hold the load, and when this is noted the jack should be examined to find out just where the packing fails to hold. This is usually indicated by leakage at the defective point. Obviously, repairs should be made before the jack is put back in service, for even a very small leak will permit the ram of the jack to settle gradually, and unless blocks have been used the entire load may topple over.

A well-known manufacturer of hydraulic jacks makes the following recommendations with regard to the valves and their seats: If the packings are in good order and the ram does not rise in pumping, the suction valves are not working properly. If the lever rises when the hand is removed, the pressure valve is not working properly. If the valves or their seats become worn or scratched, grind them to a fit with oil and a little flour of emery. Be careful not to grind them too much, and be sure to wash the valves and their seats perfectly free from emery before putting the jack into service again. If the valves are deeply scored or have become too much worn, replace them with new ones, and grind the new ones lightly to their seats, as described. If the seats are deeply cut they should be reset, and if very deeply cut they should be both reamed and reset.

Methods of Repairing and Patching Concrete.

(Staff Abstract.)

The following data on the various methods used in repairing and patching concrete structures were collected by the Committee on Masonry of the American Railway Engineering Association:

WET METHOD.

The surface of the old concrete is thoroughly roughened, cleaned, and drenched with water, and covered with a cement grout. Then the new concrete is mixed to a sloppy consistency and applied, being held in place till set by forms, as required.

From the reports received, it appears that many successes and many failures have followed this method. Where it has been successful, that result probably has been due to painstaking care and expense being employed in the preliminary cleaning and thorough wetting of the old concrete surfaces before the new concrete is applied.

MODERATELY DRY METHOD.

The surface of the old concrete is thoroughly roughened, cleaned, and drenched with water, and powdered with cement or painted with cement grout, after which the new concrete is applied and thoroughly tamped against the old surface. Generally, such patches are kept moist by sprinkling them with water for several days.

The same comment applies here as to the wet method.

DOWEL METHOD.

This is a modification of the two preceding methods, and is generally used for other than horizontal surfaces, although it may be applied to the latter. The new concrete may have any consistency to meet the particular conditions or the ideas of the engineer in charge; but usually a fairly wet concrete is used. This method includes drilling holes and setting dowels into the old concrete, with projecting ends to engage into the new concrete. Sometimes steel bars or metal fabric are connected to these dowels to further ensure permanency of the pitch.

This method can be made uniformly successful, but cannot always be applied. Where any considerable mass of new concrete is to be connected to old concrete, this is the only safe method to pursue.

WEDGE METHOD.

This method includes the cutting out of defective concrete in such a manner as to under-cut the surrounding good concrete so that the new concrete will be held in place, when set, by the shape of the binding edges of the old concrete.

The difficulty of under-cutting concrete so as to secure such edges is too great to make this method applicable in ordinary cases; and, except where a considerable depth of new concrete is to be put in, such under-cutting could not be successfully done, as concrete cannot be cut so as to leave sharp, clean edges.

CLEANING WITH STEAM.

This is a method of cleaning surfaces of old concrete, preparatory to putting on a patch of new, or of cleaning the top of a rough concrete floor before applying the "finish coat." The surface of the old concrete is brushed as clean as possible with stiff brushes, and then gone over at least twice with a steam jet. An ordinary piece of ½-in. gas pipe makes a very satisfactory jet nozzle. This short length of pipe is connected to a steam hose so that it can be readily moved about. The steam is supplied by the boilers of the mixer or hoisting engines. The steam will clean and heat the concrete surface, leaving it perfectly dry; so it is important to drench the surface thoroughly with water after cleaning with steam. In cold weather it is found advantageous to use hot water. Immediately after the surface is thoroughly cleaned and drenched, the new concrete is applied.

Excellent results have followed the use of this method of cleaning; but it is essential that the surface of the old concrete be thor- steam jet, otherwise the new concrete will not oughly drenched with water after using the adhere to the old.

CLEANING WITH ACID.

This method includes washing of the surface of the old concrete with a solution of hydrochloric (muriatic) acid (one part acid to two parts water), after which the surface must be carefully and thoroughly washed to remove any free acid.

This is a very commonly applied method of cleaning old concrete surfaces preparatory to placing new concrete against them, and, by many, is considered the only safe treatment to use, especially in cases where a "finish coat" is to be put on after the concrete base is set.

ROADS AND STREETS

Organization and Equipment of Convict Camps in Georgia: Methods and Cost.

Contributed by John C. Koch, 1332 N. Broadway, Baltimore, Md.

PART II.

SUBSISTENCE.

One of the most important features of the operation of a convict camp is supplying suitable food in an economical manner. Good substantial food, well cooked and in proper quantity must be supplied if the best results are to be obtained. In some camps 10 per cent of the men may be sick most of the time, and yet, in others operating under similar working conditions, but with better attention to food and sanitation, there will be scarcely any sickness.

The cooking and washing for the whole camp is performed by trusty convicts who are experienced in such work. Every day the foreman issues to the camp cook the food supplies to be used that day. Often all the foodstuffs except spices, baking powder and salt, are carefully weighed out the evening before they are to be issued. Records are carefully kept showing the amounts of the various foods used daily, and in this manner it is possible to eliminate waste, as well as to keep accurate cost data.

The Convict Ration.—A ration is the quantity of food estimated to subsist one man one day. It is customary to use 100 rations as the basis of presenting the quantities of the various foods required—from such a list by simple proportion it is easy to compute the amounts required for any force for any length of time.

The following ration list, prescribed by the Prison Commission of Georgia, is given as the minimum food allowances authorized. In many counties the allowances are somewhat more liberal in some of the items. The quantities are given for 100 rations and are closely estimated from the writer's experience where exact quantities are not officially stated.

FOOD ALLOWANCE PER CONVICT PER DAY.

Item.	Quantity per 100.	Cost of rations.
¾ lbs. salt pork per day......	75 lbs.	$13.50
1 lb. fresh pork, beef, mutton or kid, twice each week, or 1½ lbs. fresh beef..........	28 lbs.	4.20
Corn bread without stint at all meals except when wheat bread is furnished — Corn meal	60 lbs.	1.35

Wheat bread without stint three meals per week		
Wheat flour	15 lbs.	.50
Baking powder	1 lb.	.30
Syrup three times per week	1½ gals.	.60
Vegetables three meals each week	42 lbs.	1.68
One cup of coffee at breakfast	2 lbs.	.45
Salt, pepper and vinegar without stint—		
Salt	4 lbs.	.05
Pepper	2 ozs.	.05
Vinegar	1 qt.	.10
Cost at retail prices of 100 rations		$22.78
Less 15 per cent to approximate cost at wholesale prices and to cover cost of handling, etc.		3.42
Total net cost of 100 rations		$19.36

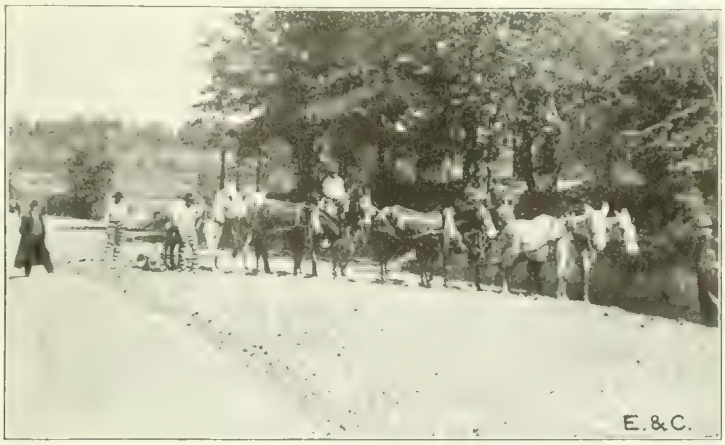


Fig. 1. Plowing Hard Earth. Note Method of Hitching Teams to Permit Plowing in the Ditches.

The following ration is representative of general practice in Georgia convict camps, and will be found to compare well in point of quantity and being well balanced, with the ration issued to the soldiers of any country. It is probable more varied and more liberal than the fare of most penitentiaries:

Item.	Quantity per 100.	Cost of rations.
Fresh beef, pork, kid or mutton	30 lbs.	$ 4.50
Salt pork, clear sides	75 lbs.	13.50
Corn meal	60 lbs.	1.35
Wheat flour	15 lbs.	.50
Molasses or syrup	1½ gals.	.60
Dried field peas or navy beans	25 lbs.	1.50
Potatoes, white or sweet, and other fresh vegetables	40 lbs.	.80
Baking powder	1 lb.	.30
Coffee	2 lbs.	.45
Salt	4 lbs.	.05
Pepper and other spices	4 ozs.	.10
Vinegar	1 qt.	.10
Total cost at retail prices		$23.75
Less 15 per cent approximate cost at wholesale prices		2.57
Total net cost of 100 rations		$21.18

Each convict is provided with a covered quart tin bucket, pint cup, large plate and spoon. Breakfast and supper are invariably served in camp in the mess hall. At meal time the convicts file past the cook and helpers and received their portions, after which they pass to the tables where they eat their meals.

An analysis of the above list, on the basis of nutritive food values, by the Atwater tables (which make proper allowance for refuse, etc.), indicates that each ration provides 83 grams of protein and has a total fuel value of 5,050 calories of energy. Atwater's studies lead him to believe that for a man at hard muscular labor 150 grams of protein and a total fuel value of 4,150 calories of energy per man per day should be provided. From this it would appear that in this ration there is an excess of about 25 per cent in fuel value and a deficiency of 45 per cent in the amount of protein regarded as necessary by Atwater. However, the convicts practically without exception seem to thrive on this fare under heavy work, and it seems likely that the protein supplied is sufficient for their needs. The diet is undoubtedly better both in quantity and quality than 90 per cent of the convicts have been accustomed to in freedom.

Guard Ration.—While there are no definite regulations regarding the details of subsisting foremen and guards, the following ration list, based on practice in a number of Georgia counties, is a fair example of the food allowances actually provided for these officers:

Item.	Quantity per 100.	Cost of rations.
Fresh meat, including fish	50 lbs.	$ 7.50
Salt pork	60 lbs.	10.80
Lard	10 lbs.	1.50
Corn meal	40 lbs.	.90
Wheat flour	40 lbs.	1.33
Baking powder	3 lbs.	.90
Sugar	15 lbs.	.75
Molasses or cane syrup	2 gals.	.80
Coffee	8 lbs.	1.80
Milk, evaporated, ½-pt. cans	10 cans	.80
Butter	8 lbs.	2.00
Rice, field peas, beans or other dried vegetables	25 lbs.	1.75
Potatoes and other fresh vegetables	60 lbs.	1.05
Salt	4 lbs.	.05
Pepper and other spices	6 ozs.	.30
Vinegar	1 qt.	.10
Total cost at retail prices		$32.33
Less 15 per cent to reduce to wholesale prices		4.85
Total net cost of 100 rations		$27.48

The above ration, though fairly liberal, is really very economical and satisfactory. In practically all cases the same quality of food is supplied in both convict and guard rations, the only difference being that the latter is more liberal and has a greater variety of food. In a number of camps the guards and foremen have the same ration as the convicts.

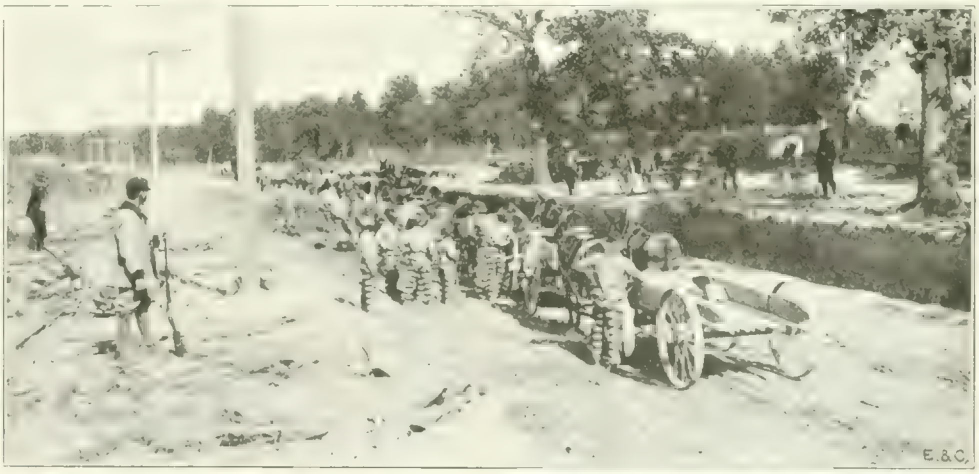


Fig. 2. Loading Wagons. Note Stations of Guards. Seven Guards for Eighty Prisoners.

All food is purchased at wholesale, and these prices have been approximated by deducting 15 per cent from the retail prices, which also includes an allowance for depreciation.

Stock Ration.—Average figures based on actual working conditions for the feeding of stock are given below. The prices quoted are subject to considerable variation depending on whether locally-grown feed is used. Feed shipped in from other places is 10 to 20 per cent higher than local feed. The following are the quantities of forage constituting 100 rations for horses or mules of 1,200 to 1,400 lbs. weight, equivalent to the amounts required to feed one animal 100 days.

Item.	Quantity.	Cost.
Hay	1,500 lbs.	$22.50
Oats	31 bu.	17.05
Cost per 100 rations		$39.55

In place of oats corn may be substituted, 20 bus. of corn being equivalent to 31 bus. of oats. The cost of the ration will be practically the same in both cases.

OTHER ALLOWANCES FOR CONVICTS.

Clothing.—There are two classes of convicts: Misdemanor convicts, whose term is one year or less; and felony convicts whose term is longer than one year. There are three grades of felony convicts, the grading being based on good conduct and faithful work, each grade is supplied with distinctive clothing. The highest or first class are clothed in dark gray cloth; the second grade in brown, and the third grade in ordinary prison stripes. The misdemeanor convicts are all clothed in ordinary prison stripes.

Each convict is supplied with three suits of clothing; of cotton cloth in warm weather and of woolen cloth in cold weather; of dark gray, brown or stripes according to his grade. The allowance of white or gray underwear is made sufficient to afford proper protection from the weather from Oct. 1 to May 1. Garments worn during the day must be removed and replaced by clean, dry garments for sleeping purposes. Each convict is numbered and all his clothing is marked to correspond so that each man's clothing may be identified and kept solely for his use. Hats, caps, shoes and socks are furnished as required. In rainy and threatening weather each convict working away from shelter is provided with a slicker.

The following is an average of the quantities of clothing worn out by one convict in one year:

Item.	Quantity.	Cost.
Underwear, suits	3	$ 1.89
Woolen suits	2	7.00
Cotton suits	3	6.00
Socks, pairs	24	1.50
Shoes, pairs	3	4.50
Hats	1	.50
Belt	1	.25
Total cost of clothing for 1 man		$21.55

Bedding.—Each cot or bunk is supplied with one tick, 3x6½ ft., well filled with excelsior or clean fresh straw; one slip of unbleached cotton fitting the mattress like a pillow slip; one sheet of unbleached cotton; one pillow filled like the mattress and covered with a pillow slip of unbleached cotton and blankets or other covering necessary for comfort. Slips and sheets are changed at least once a week.

The following is an average of the bedding material worn out by one convict in one year:

Item.	Quantity.	Cost.
Mattress slip	1	$ .35
Pillow slip	1	.15
Blanket	1	.80
Unbleached cotton cloth, yds.	5	.35
Straw, 80 lbs.		.30
Total		$ 1.95

Tobacco.—Each convict using tobacco is supplied with one plug of sound plug tobacco, or its equivalent, each week. The average amount issued per convict per year is as follows:

6 lbs. Plug tobacco	$1.80

MEDICAL ATTENTION.

While strictly speaking, medical attention is not an allowance, it is convenient to regard it as such on account of the special food and medicines included under this head. The compensation of county physicians for all services rendered a gang of 30 men will vary from $100 to $200 per year. Transportation is usually furnished by the physician. The average annual cost of medical attention for a gang of 30 men is as follows:

County physician, salary	$150
Medicines	30
Special foods	36
Total	$216

SUMMARY.

Based on a year of 300 working days (expenses for 365 days being distributed over 300 days), the average cost per day of convict labor according to the data presented in the foregoing is as follows:

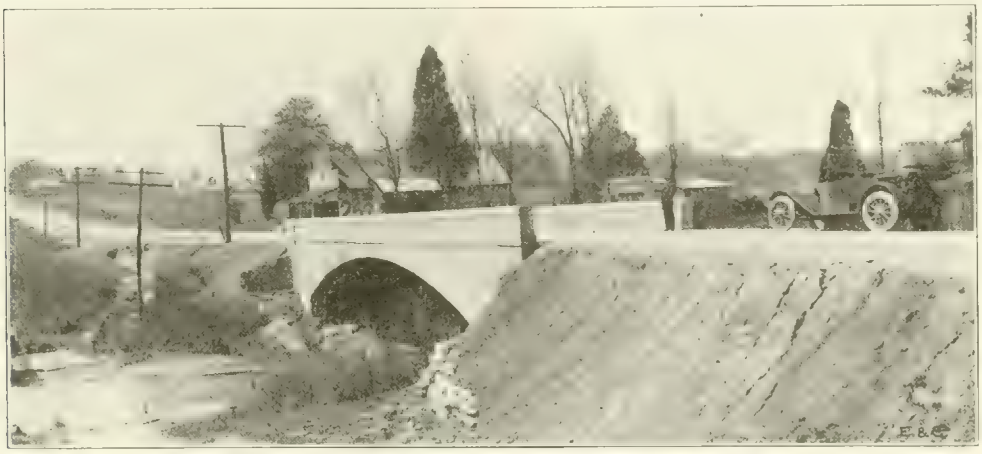


Fig. 3. Large Concrete Arch Bridge Built Entirely with Convict Labor.

Item.	Cost.
Food	$0.2573
Clothing	.0718
Bedding	.0063
Tobacco	.0060
Medical	.0240
Guards	.1275
Miscellaneous	.0150
Total	$0.5079

This is for a gang of 30 men with three guards at $30 each per month, with subsistence furnished. The item miscellaneous covers court costs, transportation to and from penitentiary, etc.

DISCIPLINE.

General.—Misdemeanor prisoners are not usually put in chains unless they are known to be dangerous characters, or men with bad records. Many of the felony or long-term convicts are put in chains until they have demonstrated by good conduct that they may be trusted to a reasonable degree. These chains though not much of an impediment to ordinary working operations, render attempts at escape much more difficult. These chains consist of two 4-ft. lengths of ⅛ or 3/16-in. chain, one end of each being fastened to a shackle around the ankle. These two chains are fastened to a third 4-ft. length by a 2-in. diameter ring, forming a Y. The free end of the third chain ends in a 2½-in. ring. When at work the chains are supported from the belt so that there is perfect freedom of motion for the entire body. At night if it is deemed necessary, a long chain of ½-in. acters, and largely accounts for the economy steel links is passed through all the 2½-in. diameter rings of the individual chains and both ends securely locked. This is a very effective way to prevent night escapes by the more desperate convicts and yet does not interfere with their sleep or rest. These precautions make it possible for such small guard forces to handle these desperate charin handling many small squads of convicts scattered all over the state.

The number of escapes per year averages about 1 per cent, one-half of whom are recaptured. Most of the escapes are effected during working hours when the men are scattered and more difficult to keep under continuous observation.

The hours of labor prescribed are from sunrise to sunset, with 1 hr. for dinner and rest during the period from November to February, inclusive; 1½ hrs. during March, April, September and October; and 2 hrs. during the period from May to August. Convicts are not taken from camp before sunrise and must be back in camp by sunset. Sundays, the Fourth of July, Thanksgiving and Christmas are observed strictly as days of rest on which only absolutely necessary work is performed about the camp.

Punishment for disobedience, laziness, etc., is administered by the withdrawal of the tobacco allowance, demerits which affect the prisoner's chances for release under the parole law, reduction in grades, placing in chains, etc. Corporal punishment is seldom inflicted and then only after all other less drastic punishment has failed. The strap is the only form of corporal punishment allowed and it is never applied to the bare skin, nor can the number of blows exceed ten. A complete record is made of the punishment inflicted upon each convict, with name, date, character of punishment, and a copy of this record under oath is sent to the Prison Commission monthly. The grading of convicts is based upon their records for good behavior and the distinctive clothing is prescribed as detailed under the head of "Other Allowances."

Guarding.—Each guard is equipped with a repeating shotgun and a heavy revolver. While the prisoners are being marched to and from camp all the guards are on duty; the prisoners in front with the guards on the sides and in the rear. If the distance to work is long the prisoners are carried in the wagons. Attempts to escape rarely occur on the way to or from camp. One or more bloodhounds are kept isolated in camp so as to provide promptly for aid in capturing escaped prisoners. The moral effect of the presence of these dogs is considerable. At night sufficient light is maintained in the buildings, tents or cars so that at all times the guard can see what is going on inside.

SANITATION.

The convicts are required to bathe the entire person twice a week and at these times make an entire change of clothing. Their hands and faces must be bathed before every meal. All beds and bedding are sunned twice a week and moderate use of any reliable "bug killer" adds much to the comfort of the men. All quarters are swept daily and scoured weekly. Kitchen waste cans and night-soil cans are emptied, cleaned and disinfected daily. The grounds about the camps are kept in a sanitary condition, and a weekly report is made to the Prison Commission by the county physician on the sanitation of the camp. The disposal of all wastes is accomplished by the use of open pits placed so as not to pollute the water supply. The material in the pit is kept covered with earth or a layer of air-slacked lime, and when filled they are covered with a 2-ft. layer of earth.

Medical.—As only sound male convicts are used in the road construction camps, the health of these men is usually very good. All cases of sickness are promptly attended to and when the nature of the sickness requires the patient is removed to the hospital at the headquarters' camp.

ROADWORKING EQUIPMENT.

For economical operation the roadmaking equipment should be selected with reference to the size of the force, the character of the work to be done, the topography and soil conditions to be encountered and the class of surfacing to be used. For sand-clay or ordinary earth road construction it is believed that the list of equipment that follows will be found highly satisfactory under the general conditons that prevail through the Southeastern States. This list is based on the experience of a number of Georgia road superintendents who have been in charge of such construction for the past 10 years or more. It is intended as a suggestive list to be modified as local conditions may require. The following is a list of the equipment required for a unit gang of 30 men:

Item.	Cost.
Heavy 6-horse road grader	$ 250
Light 2-horse grader	120
Heavy road plow	30
Rooter plow	20
12 large mules at $250	3,000
4 2-horse wagons at $70	280
6 sets double harness at $20	120
5 drag scrapers at $8	40
5 wheel scrapers at $60	300
25 shovels, 25 picks, 10 axes, 12 assorted rock drills, 6 sledge hammers, 4 heavy cross-cut saws	150
Total	$4,310

Except for the mules, the depreciation of the above equipment will average 10 to 15 per cent per annum, depending upon the care taken of it and the character of service. The investment in mules represents a very large part of the initial expense and with care in selecting live-stock, proper care afterwards and selling the animals as they get old and while still in good condition, and buying younger ones to replace them, the loss or depreciation in value of the stock can be reduced to almost nothing.

Part I on organization and on permanent and temporary camps was published in our issue of May 12, 1915.

An Interesting Example of Traffic Census.

(Staff Abstract.)

The traffic census described is interesting for the data of weights of vehicles, the diagram showing hourly fluctuation of traffic each day and the high density of traffic for a residence street. The point of observation was on Euclid Ave., Cleveland, O., and is known as University Circle. The classification was as follows:

Motor Driven—Motor cycles; small two-passenger; two-passenger roadster; four-passenger touring cars; five-passenger touring cars; seven-passenger touring cars; limousines;; electric runabouts; empty heavy trucks; loaded heavy trucks; light delivery trucks.

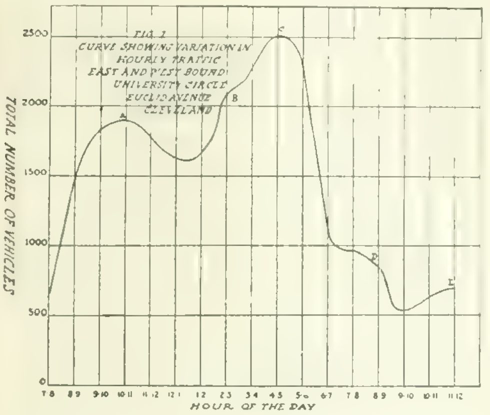
Horse Drawn—One-horse light; one-horse heavy; two-horses light; two-horses heavy; three-horses light; three-horses heavy; four-horses heavy; unclassified.

The observations lasted each day from 6 a. m. to 12 midnight.

A total of 121 hours of observation showed 25,062 vehicles of all classes passing east and west. Of this number 20,233 or 80.8 per cent were motor driven and 4,696 or 18.7 per cent horse drawn. The remainder, 133, were unclassified and amounted to .5 per cent. These were principally horsemen, having little weight as compared with the others.

The following table shows the analysis of the motor driven traffic:

	Per cent of M. D.
Pleasure vehicles—	
Seven-passenger touring	21.4
Electric runabouts	20.9
Five-passenger touring	16.9
Limousines	10.3
Roadsters, two-passenger	6.5
Two-passenger, light	4.9
Four-passenger touring	4.8
Business vehicles—	
Light delivery trucks	5.3
Loaded heavy trucks	1.9
Empty heavy trucks	1.1



Curve Showing Variation in Traffic.

A similar analysis for horse drawn traffic shows the following results:

	Per cent of H. D.
1 horse, light	54.0
1 horse, heavy	10.4
2 horses, light	18.3
2 horses, heavy	16.5
3 horses, light	.5
3 horses, heavy	.25

The primary object of this census was to arrive at an estimate of the tonnage being carried by the pavement on the basis of a yard width of traveled way. In order to estimate the weight of the motor-driven traffic queries were sent to the various automobile manufacturers and distributors in Cleveland. The weights of the different machines of the same class were so at variance that it was necessary to use the mean of all the weights found in this way. The following table of estimated weights was decided upon. These combined with the total number of the various classes of traffic give the tonnage during the time of the census:

	Unit wts. in tons.	Total tonnage.
Motor driven—		
Motor cycles	.125	23.0
Small two-passenger	1.0	999.0
Two-passenger roadster	1.5	1,914.0
Four-passenger touring	1.5	1,435.5
Five-passenger touring	1.75	5,960.0
Seven-passenger touring	2.0	8,618.0
Limousines	2.5	8,177.5
Electric runabouts	1.5	6,309.0
Empty heavy trucks	5.0	1,070.0
Loaded heavy trucks	10.0	3,650.0
Light delivery trucks	3.0	3,138.0
Horse drawn		
1 horse, light	1.0	2,527.0
1 horse, heavy	1.5	732.0
2 horses, light	2.0	1,721.0
2 horses, heavy	2.75	2,156.0
3 horses, light	3.0	69.0
3 horses, heavy	4.0	48.0
Unclassified	.5	66.5
Total		48,616.5

These figures give us an estimate of 450,000 tons per yard width of traveled way per annum.

University Circle was paved in 1912 with cement grouted brick laid on an old macadam base and a 2-in. sand cushion. Repairs amounting to about 15 sq. yds. have been necessary in two places on account of foundation failure. With the exception of these two cases the paving is in uniformly good condition, having worn to a smooth surface without the failure of the grout.

A few points in connection with the frequency of traffic are worthy of attention. The fluctuations in the curve of Figure 1 are a true index to the habits of the residents of the section of the city tapped by Euclid Avenue. The rise in the curve marked *A* is caused mainly by inbound morning traffic and deliveries. The slight increase indicated by the rise at *B* is caused by afternoon shoppers. The high point on the curve represents the home-bound traffic in the early evening, followed later by a slight increase at *C* and *D* for the theater.

The average number of vehicles per minute over the whole time of the census was 3.45 During the evening rush hours the average number of vehicles per minute increased to 8.

These records and data are from an article by M. B. Grenough, Instructor in Highway Engineering Case School of Applied Science, Cleveland, O.

Determining Voids in Fills by Puddling.

(Staff Abstract.)

Do not place too much trust in a fill which was partially made a generation or two ago. The older portion may be the more treacherous. Perhaps trees and brush were used in making the original fill. If they have decayed, the fill is in a honeycombed condition and likely to give way. The best method of locating voids is by puddling. Enclose your sub-grade with temporary earth dikes 2 ft. higher than the sub-grade and divide it into compartments by similar cross dikes. Fill the compartments with water, one at a time, and weakness, if any, will shortly appear. The usual method of relying on a roller for compacting a fill is not nearly so efficacious. In my experience, not more than 10 per cent of the fills can be properly compacted with a roller alone.—Extract from a paper before the Northwestern Road Congress by James M. McCleary.

Digest Road Laws, State of Washington.—State laws enacted in 1907 created a state department known as the State Highway Board, composed of the Governor, the State Treasurer, State Auditor, a State Highway Commissioner, and a member of the State Railroad Commission, designated by the Governor.

The State Highway Commissioner is the chief executive officer and secretary of the Board. He is appointed by the Governor for a term of four years at an annual salary of $5,000.00. The term of the present Commissioner began Dec. 11, 1913. His duties are to compile statistics relative to public highways throughout the state, advise county officials and supervise the expenditure of all appropriations from the Public Highway Fund. He may employ engineers and other assistants, and has general direction of all contract and force account work on state highways, and must approve plans, specifications, contracts, and make final inspection of all permanent highways, done under the supervision of the county authorities.

Two classes of roads come under direct supervision of the State Highway Board through the State Highway Commissioner; state roads which are built and maintained entirely at the expense of the state, and permanent highways which are built and maintained from the Permanent Highway Fund. This fund is created by 1½ mill levy, and each county is entitled to expend its portion of the taxes collected.

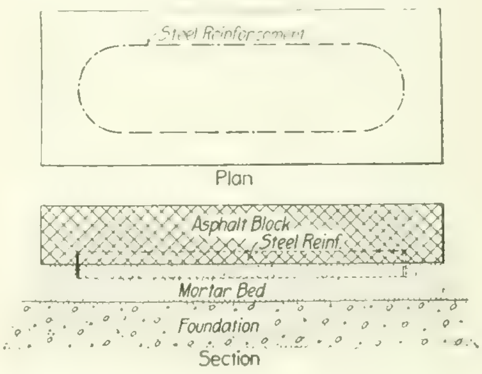
Unless the county is under township organization the county commissioners divide the county into districts and appoint a road supervisor in each district, to serve at the pleasure of the county commissioners. The duties of the road supervisors are to keep the roads and bridges in their several districts in repair, and supervise the highways generally under the direction of the county commissioners.

A county engineer is elected by the people of each county for a term of two years. His election takes place in November of even years. His duties are to make plans and profiles of all roads to be improved and to make recommendations as to the character of proposed improvement. All county commissioners and engineers take office on the second Monday in January following election.

Anchor Block for Asphalt Block Pavements.

(Staff Abstract.)

Asphalt paving blocks are made 12 ins. long, 5 ins. wide and 2 ins., 2½ ins. and 3 ins. thick. They are a mixture of trap rock, limestone dust and asphaltic cement molded under a pressure of 240 tons. In reinforcing macadam roads the old surface is brought to grade by scarifying and through rolling; soft spots are filled with concrete and over all is spread about 1 in. of Portland cement mortar, 1:4 mixture, just wet enough to be readily struck true to line. The blocks are bedded in the fresh mortar, the layers standing upon the blocks already laid. If the pavement does not extend from curb to curb, the edge of the pavement is secured by concrete edging or a border of anchor blocks. By thus adapting an old-tried and proven material to a new use, many miles of heavily-traveled macadam highways can be converted at moderate cost into permanent highways which otherwise would be a source of endless expense and annoyance.



Anchor Block for Asphalt Pavement.

Where firm old macadam foundation is not available or where the macadam is too thin to be serviceable, a foundation of Portland cement concrete is laid ranging from 4 ins. to 6 ins. thick. When blocks are laid upon a concrete foundation they are bedded in fresh mortar about ½ in. thick and the surface of the finished pavement is covered with a thin layer of clean sharp sand. The sand is broomed into the joints as thoroughly as possible and the surplus left upon the surface for 30 days during which time traffic works the sand into the joints. Asphalt blocks are malleable, and the action of traffic irons the top edges of the joints together so that in a few weeks the joints have almost disappeared and the surface is smooth and water-tight.

As motor truck traffic increased, it was found that the severe vibrations and pushing action of these vehicles had a tendency to crowd the asphalt blocks out of line and in extreme cases to distort the blocks. To remedy this trouble, an anchor block was devised as illustrated in Fig. 1. A steel strip 1 in. wide, shaped like an elongated letter o, is forced ½ in. into the block and projects ½ in. into the mortar. The anchor blocks are prepared at the plant and a row of them is laid across the street at intervals as required. This has effectually stopped movement of the blocks. The anchor blocks have been successfully used as borders, thus dispensing with expensive concrete edging.

This description is abstracted from a paper on Asphalt Block Pavement in "Cornell Civil Engineer," March-April, 1915, by Geo. P. Hemstreet.

Road Construction in Solid Rock Side Hill, New Mexico.

(Staff Abstract.)

The sketch shows a road section employed at Picacho Hill on the Roswell-Carrizozo highway in New Mexico. The roadbed was made 14 ft. wide in the clear between the outside retaining wall and the gutter which was blasted out of the solid rock on the side next the hill, with turn outs wherever necessary 18 ft. wide. The road was built in the solid rock, a gutter 2 ft. wide by 1 ft. deep being blasted out on the upper side and a retaining wall from 3 to 18 ft. in height constructed on the lower side. The retaining wall was formed of heavy stones from the gutter and the adjoining hill and with a face of 4 on 1. The roadbed was constructed as follows: First stones of all sizes were brought by hand and wheelbarrows from the gutter and hillside and used for the bottom of the fill, the surface being carefully leveled by hand. Next coarse gravel and earth mixed was brought from the hillside and a layer about 9 ins. in thickness carefully spread over the roadbed and on this was placed a layer of earth, entirely free from coarse gravel, 3 ins. in thickness. The road was then thoroughly wetted and packed by running over with loaded wagons, no roller being available. The wearing surface was formed by spreading gravel over the surface. This was carefully leveled, well sprinkled and well packed by running over with heavily loaded wagons producing a surface on which the heaviest loads made little if any impression. As a protection for teams and vehicles a guard wall, 2 ft. in height and 2 ft. thick, was built along the outside of the road. In order to prevent leakage from the gutter the side next the road was given a 4-in. coating of concrete and as a protection to this concrete as well as to the gutter, a row of heavy stones, 1 ft. wide and 1 ft. high, was laid along the side of the road adjoining. This information is taken from the biennial report of the state engineer of New Mexico.

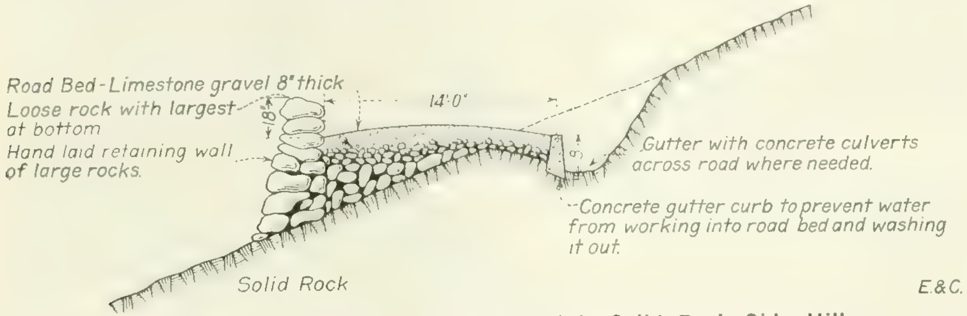

Road Bed-Limestone gravel 8" thick
Loose rock with largest at bottom
Hand laid retaining wall of large rocks.
18"
14'0"
6"
Gutter with concrete culverts across road where needed.
Concrete gutter curb to prevent water from working into road bed and washing it out.
Solid Rock
E.&C.

Fig. 1. Section of New Mexico Road in Solid Rock Side Hill.

A Method of Carrying Concrete Road Over Trenches With Soft Backfill.

(Staff Abstract.)

In constructing concrete pavement at Elizabeth, N. J., soft filling of old gas, sewer and water trenches in several places proved impossible to compact by roller to the solidity of the approach subgrade. To excavate and refill would cost excessively and recourse was taken by the engineer, W. H. Hunter Jr., to a method of bridging. He excavated the whole intersection 3 ins. in excess of the contract requirements, rammed broken stone in the trenches and when sufficiently dry applied 9 ins. of concrete over the whole surface thus prepared. By so doing the specifications were not exactly followed but the subgrade was prepared in such a manner that the extra concrete would bridge the trenches in a satisfactory manner. To make repairs to the road when cut through for future trenches a somewhat similar construction is planned as follows: The concrete will be cut 6 ins. wider on each side than the excavated trench, and will be excavated 3 ins. below the sub-grade on the shoulder; the refill must be made as compact as possible. The old concrete must then be cut as a skew back on each side so that the opening is 4 ins. wider at the top than at the bottom. Number ten expanded metal or its equivalent of ½ in. steel bars are to be placed 2 ins. above the newly prepared subgrade; the space is then to be filled with concrete while the sides of the old pavement are fresh cut and clean. After setting a sufficient time, sufficiently guarded against traffic, it is to be recoated with bitumen.

Expansion joints will be repaired with a suitable brand of hot paving pitch, being poured into the joint after it has been cleaned of loose foreign material, and the edges cleaned by chisel or other suitable tool after which it will be filled with ½-in. gravel and then allowed to set.

Cost of Trench Work Through Brick Pavement for Wire Conduit.

Contributed by F. L. Shidler, Contractor, Kankakee, Ill.

The trench was as near as possible to the curb and crossed under two sets of street car tracks and two street intersections. The costs given are for tearing up brick pavement down to grout base, trenching sand cushion and replacing same, relaying brick pavement and slushing with cement filler for laying a wire conduit for ornamental street lights. They also include the cost of sixteen 1 ft. 4 in. square holes about 16 ins. deep, cut through cement and stone sidewalks, filling these holes with concrete and setting four base bolts in each hole. The cost for the post holes, etc., was as follows:

Item.	Total.	Per hole.
Labor cutting, 25 hrs. at 50 cts.	$12.50	$0.78
Labor concreting	5.00	0.31
Total labor	$17.50	$1.09
12 wood templets for base bolts	3.00	0.19
2 cu. yds. concrete at $3.60	7.20	0.45
Miscellaneous	1.12	0.07
Total materials, etc.	$11.32	$0.71
Grand total	$28.82	$1.80

The cost of the trench 1½ ft. wide and 1,130 ft. long was as follows:

Item.	Total.	Lin. ft.
Tearing up and cleaning brick	$21.37	$0.019
Relaying brick	27.95	0.025
Teaming	4.00	0.004
Total labor	$53.32	$0.048
2 cu. yds. cushion sand	3.00	......
4 bbls. cement	6.00	......
300 new brick	4.00	......
Miscellaneous	5.00	......
Total materials	$18.00	$0.016
Grand total	$71.32	$0.064

Comparative Cost of Asphalt and Brick Pavement.

To the Editors: In your issue of May 12, page 433, under the article "A comparative study of pavements based on Chicago conditions" there is the following statement:

> "There are three pavements—brick, asphalt, and asphaltic concrete—that cost about the same."

I beg to challenge this statement as prices last year, and numerous biddings this year would indicate that brick on a concrete base is from 30 to 60 cts. higher than sheet asphalt or asphaltic concrete on a concrete base.

Yours truly,

J. R. Draney,
Sales Manager,
The United States Asphalt Refining Co.

New York, N. Y., May 13, 1915.

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American Highway Association.—A new project which holds great possibilities as an educational medium will involve the preparation of a series of educational papers dealing with road building, maintenance and management and the publication of such papers locally to co-operate with county papers. It is expected that this series of papers will deal with the subject in an elementary yet fundamental manner and will add powerfully in making known in local communities the proper methods of road building, maintenance and management. During 1915 it is estimated by the American Highway Association that nearly $200,000,000 will be spent locally for the building and maintenance of roads. The time has come therefore for the greatest care to be exercised in the expenditure of local road funds rather than in urging increased expenditure.

CURRENT NEWS

The Doings of the Week.

Business and finance showed no advance during the past week. On the other hand there was little recession. Uncertainty as to Germany's reply to President Wilson's note caused more or less hesitancy in general business. Bank clearings for the week ending May 27 were $3,002,200,000, as compared with $3,269,914,000 for the preceding week and $2,894,259,000 for the corresponding week of the previous year. The security market showed a net decline of a little more than one point in the general level of prices for the week. This in itself is a pretty good indication of confidence in the economic position of the country. There were some optimistic features during the week. E. H. Gary, chairman of the board of directors of the U. S. Steel Corporation, in an address last week before the American Steel Institute, stated that "the outlook for improvement in our lines of activity is better than it has been for more than a year." Mr. King of the Jones & Laughlin Co. went even further. In his opinion the turn for the better has come and with all the world now at the feet of the American manufacturer, trade revival in the United States may now be confidently looked for. The steel industry is now working around 80 per cent capacity and only a small increase in domestic business is necessary to bring about full operation. In the construction field the activities, judged from the amount of new work coming up for bids, was well up to the average of previous weeks of this year. Highway construction and street paving, and bridge building are offering many bidding opportunities. Few large municipal water works and sewerage undertakings, however, made their appearance last week. Bids were opened on several good sized jobs and a number of big improvements were placed under contract. In the iron and steel industry rail and bar orders were an important feature of the week. Rail contracts amounting to about 75,000 tons were placed. These included 25,000 tons for the Southern Pacific, 15,600 tons for the New York Central lines and 8,000 tons for the Chicago & Alton. Orders for bars, plates, sheets and shapes amounting to perhaps 100,000 tons were placed by car shops, and fully as much more tonnage is pending. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending May 26 were as follows:

Finished Iron and Steel.	May 26.	May 19.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia......	1.17½	1.17½
Iron bars, Pittsburgh.........	1.20	1.20
Iron bars, Chicago............	1.15	1.15
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York..........	1.369	1.369
Tank plates Pittsburgh.......	1.15	1.15
Tank plates New York........	1.319	1.319
Beams, etc., Pittsburgh.......	1.20	1.20
Beams, etc., New York.......	1.369	1.369
Skelp, grooved steel, P'gh....	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh.......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.75	1.80
Galv. sheets, No. 28, P'gh....	3.75	3.60
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh........	1.35	1.35
Barb wire, galv., P'gh........	2.10	2.10

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—No developments looking to the undertaking of any important new work by the railways occurred last week. Some of the western newspapers were busy building railroads, but none of these projects appear to be anywhere near the construction stage. Two or three new short lines awarded construction contracts during the past week. The Lulu-Homer R. R. of Lula, Ga., awarded the contract for construction and equipment of its line to William J. Redmond, Atlanta, Ga. The Roby & Northern R. R. let the contract for 4.4 miles of line, the work involving only about 34,000 cu. yds. of excavation and embankment. The Oscar Daniels Co., New York City, was awarded contract at $863,775 for Section 2 of Route 49 of the New York rapid transit system.

Roads and Streets.—Several notably large road and street improvements reached the calls for bids stage during the past week. Multnomah County, Oregan, began calling for proposals on work that will cost about $1,250,000. Philadelphia, Pa., commenced advertising the Northeast Blvd. improvement this week, involving 232,000 cu. yds. of grading, 58,457 sq. yds. bituminous pavement and much miscellaneous construction. New York is calling for bids on 21 state highway contracts aggregating about 70 miles; Illinois opens proposals June 9 on several state aid road jobs; Maryland opens bids June 15 for a 4.4 section of concrete paved highway. Philadelphia, Pa., opened bids on $500,000 of new street paving work; Washington, D. C., received bids on about $200,000 worth of street asphalt; State of Washington awarded several large contracts and Pierce County, Washington, awarded an $111,000 job. Illinois also awarded several road and bridge contracts.

Bridges. — A considerable amount of bridge construction, mostly for small structures, is being advertised. The State Roads Commission of Maryland, is asking bids on a reinforced concrete bridge of two 98 ft. arches. The Pennsylvania R. R. has taken bids on a reinforced concrete bridge of seven arches, 93 ft. each, to be erected on the Schuylkill Division. The McKinnon Construction Co., East Providence, R. I., was awarded contract at about $55,000 for bridge for Central Falls.

Drainage and Irrigation.—Several fair-sized jobs in the drainage field are now being advertised. Burleson County Improvement District No. 1 of Caldwell, Tex., is asking bids on about 360,000 cu. yds. of earth work; bids will be opened June 5 at La Grange, Ind., on the Eaton ditch, requiring 99,727 ft. of tile and 45,500 ft. of dredge work. The Wisconsin Drainage Co., Elkhorn, Wis., was awarded contract for 20 miles of town ditches in Outagamie County, Wisconson.

Water Works.—A fair amount of water works construction came up for advertising during the past week. Napoleon, O., is asking bids on a 1,500,000 gal. softening and filter plant; Temple, Tex., opens proposals June 8 for a gravity dam; Steubenville, O., is calling for bids for reconstruction and covering of low pressure reservoir; Salem, Mass., opens proposals June 21 on two 10,000,000 gal. pumps; Butler, Mo., is calling for bids on filter plant and other water works improvements; Philadelphia, Pa., awarded a $400,000 contract for new water distribution mains in South Philadelphia.

Sewerage.—Board Local Improvements of Chicago has commenced advertising for bids on system of brick sewers for Norwood Park, Ill.; assessment for this improvement is $683,000. Oklahoma, Miss., is asking bids on a sewer system requiring about 39,000 ft. 8 in. to 12 in. pipe; New Glarus, Wis., is calling for proposals on sewerage construction; Oswego, N. Y., is asking bids on a considerable amount of pipe sewers; Mt. Ayr, Ia., has about $40,000 worth of sewer work under advertisement.

Rivers and Harbors and Miscellaneous.—Bids were opened May 26 on the largest government levee letting so far this year. The Oglesby Construction Co., Memphis, Tenn., was low bidder on 1,930,000 cu. yds.; S. M. Bush, Memphis, Tenn., was low on 1,333,000 cu. yds., and Rodgers Bros., Memphis, were low on 630,000 cu. yds. Bids also were opened last week on a very large concrete job for the government. This called for the masonry for the fourth lock at Sault Ste. Marie, Mich. Oscar Daniels Co., Chicago, at $1,010,480 was low bidder. New York City is calling for bids for building a pier at the foot of 29th street, Brooklyn; Stone Harbor, N. J., is asking proposals for stone protection work. A considerable amount of work also is being advertised by the U. S. Engineering Corps. A notably large tunnel contract is being advertised by the Commissioners of Allegheny County, Pennsylvania. This calls for a traffic bore several thousand feet long and involves an expenditure of nearly $1,000,000.

War and Labor Supply.

The entrance of Italy into the European war will cause a reduction in the number of foreign laborers in this country. Whether or not this movement will result in serious inconvenience to contractors depends upon construction developments. At the present time there are more men than jobs. If the railroads had undertaken a normal amount of work this year it is probable that even now contractors would be hard put to fill out their gangs. During the past two or three years, owing to the dullness in the field of heavy construction, there has been a considerable exodus of the aliens who gained their livelihood from this kind of work. This loss has not been made up by the new immigration. Many Austrians and Russians also have returned to their native countries since the outbreak of hostilities. Nevertheless, in the Middle West, at least, there are plenty of idle Austrians, Italians and other foreign laborers just now, but this is due in great measure to the quietness in certain lines of construction. Italy's taking part in the struggle will mean that many of its citizens will return home. Canadian military authorities estimate that 7,000 to 8,000 Italians will go from Canada and 100,000 from the United States. The latter figure is open to question. There are, to be sure, 100,000 reservists in this country, but it is by no means certain that all of these will respond. In fact, no call for these men has been issued as yet. Many other Italians also will leave this country. It is believed, however, that not more than 33 per cent of the Italians that furnish the labor supply for contractors will go back. And this number would be reduced greatly if there was plenty of work at the present time. To the man out of a job free transportation home makes an especial appeal.

Irresponsible Bidder Again.

The irresponsible bidder is ever with us. Even in these days when real contractors go down to bed rock prices to secure work, the man with his office and equipment under his hat carries off a fat contract every now and then. Public officials in their eagerness to save a penny too often consider only the bidding prices in awarding a construction undertaking. The advice of their engineer is unheeded; the precautions of even an ordinary business transaction are not taken. They only see that the bid is several hundred or thousand dollars lower than those of the other bidders. The qualifications, equipment and financial standing of the bidder are secondary considerations. A short time ago a Western city held a letting for the construction of water works. Some exceedingly low bids were secured from responsible contractors. The Mayor thinking that he could scale down even these prices readvertised the work. At the second opening of bids, a proposal was received that was far below the estimated cost. It was so low, in fact, that the other contractors accused the bidder of having forgotten to allow for the cost of the material. The city officials were delighted and promptly awarded the contract to the "unknown." At the expiration of the time for signing the contract the low man was not to be found. The officials consoled themselves with the fact that they held the certified check. But their joy was short lived, for it came back from the bank with the notice "no funds." Even the certification had been forged.

The Lighter Side of Engineering and Contracting

THE foreman was breaking in a new section gang. He called the sons of sunny Italy around him. "Now, ye tarriers," said he, "kape your eyes open. Whin ye see a train comin', get out of the way. Jump as though the divil was after you and run like blazes." The Italians began to use the tamping bars.

In a few minutes the limited came rushing around the curve. Michael Angelo threw down his bar and started up the track as fast as he could run, yelling to the saints at every jump. The train overtook him and brushed him into the ditch. Somewhat shaken up and badly frightened, the Italian climbed up on the bank and sat down. "Ye damn fool," said the foreman, much relieved to find that a coroner's inquest was not necessary, "why didn't ye get out of the way? Why didn't ye run up the side of the cut?" Michael Angelo smiled feebly. "Why, I not run uppa da side hill; me no fool. If can't beata her ona da level how can beata her upa da hill?"

* * *

DEATH is a serious matter, and yet even the death certificates that round out our earthly career often contain unconscious touches of humor. For instance, the Michigan Monthly Bulletin of Vital Statistics claims that the following "causes of death" were given by country physicians in the final papers for their clients:

Went to bed feeling well, but woke up dead.

Died suddenly at the age of 103. To this time he bid fair to reach a ripe old age.

Do not know cause of death, but patient fully recovered from last illness.

Deceased had never been fatally sick.

A mother, died in infancy.

Died suddenly, nothing serious.

Pulmonary hemorrhage—sudden death. (Duration four years.)

Kick by horse shod on left kidney.

Don't know. Died without the aid of a physician.

Deceased died from blood poison, caused by a broken ankle, which is remarkable, as his automobile struck him between the lamp and the radiator.

Blow on head with ax. *Contributory cause*—another man's wife.

* * *

The Bohunk.

Who would a merry Bohunk be,
  On a dollar and a half a day,
With a blanket roll and a roving soul,
  And a thirst like the flowers in May?

He pounds on a rail spike all day long,
  With a blist'ring sun o'erhead,
Gets soaked at night in a bar-room fight,
  And then sleeps four in a bed.

Or he juggles a spade in an iceberg's
    shade
  And wears all his clothes to bed,
And the frost fiends eat all the toes from
    his feet,
  And he eats canned beans and bread.

Till one fine day he grabs his pay,
  And hikes for the nearest booze,.
Goes on a spree and a jamboree,
  And lands in the calaboose.

When his time is done he mushes on
  To the next big job on the trail,
He chucks his junk in a double-decked
    bunk,
  And digs in a ditch for his kale.

He hears of big pay on a job far away,
  And takes his roll and treks.
So he works and swears and drinks and
    dares,
  Till he cashes in his checks.

Oh, who would a merry Bohunk be,
  On a dollar and a half a day,
With a roving soul and a blanket roll
  And a thirst like the flowers in May?

JEROME DOWNING, the great little dirt mover of the Pan Handle District, is noted for his thoughtfulness and consideration for other people. The other day while he was standing in front of his construction office he noticed a colored woman holding a baby and waiting patiently on the street corner. It was a hot day, so Mr. Downing placed a chair in the shade of his shack and invited the woman to sit down. As soon as she had seated herself she proceeded to feed the picaninny in the way the Lord intended babies to be fed. The little fellow, however, was peevish and fretful and did not eat as he should. After fussing around with him for some time the woman lost patience and exclaimed: "See here, you fool chile, if you doan eat yo dinna I'll done gib it all to Mars Downing."

* * *

ANDY KOENIG, the labor king, is an ardent disciple of the gentle art of trap shooting. As a mighty smasher of the wily clay pigeon he has few equals in the St. Louis Gun Club, of which he is a member. Some weeks ago an eastern friend dropped into Koenig's office and made some derogatory remarks about the latter's skill as a marksman. Andy promptly challenged and arrangements were made for a contest. Koenig went down in inglorious defeat. In fact his shooting was so bad that in disgust he had the man at the trap throw up a hat in place of a target. When he made a clean miss of this he gave up in despair. That evening at a little dinner the friend confessed that he had removed the shot from Koenig's shells, and as a consequence Andy had been shooting felt wads in place of lead. Last week the man from Boston was again in St. Louis and at once proceeded to make life miserable for the labor king. Finally, Andy proposed that they try their skill again. The man from the east, really a clever marksman, accepted. The next day they repaired to the range. Koenig watched his shells with an eagle eye and rolled up a fair score, while his friend failed to break even one blue rock. The man from Boston could not understand it. He examined his shells and found the chilled shot in place. Finally he walked over to the trap and picked up one of the "clays" at which he had been shooting. It was cast iron. Andy had got even by ringing in an unbreakable pigeon for his competitor to shoot at.

* * *

Almost Any Camp.

FIRST BO: Rottenest chuck here I ever eat.

Second Bo: You said something then; 'taint fit for hogs.

First Bo: If that dish washer they've got for cook should lose his frying pan we'd starve to death.

Second Bo: It's fierce; that guy fries everything. I haint had a square meal for a week.

First Bo: This here camp has the worse grub on the whole line. They live high over to Mulcarney's. He's a right boss.

Second Bo: Last year I was with Doolin's outfit. We all got fat. Nothin' was too good for us. Meat three times a day, an' fish an' melons an' biscuits. Some cook with that outfit, I'd work for Doolin any time; he feeds his men right.

First Bo: How'd they expect a man to work with the grub they give him here? That coffee we had this morning was nothin' but slop and the biscuits—

Second Bo: Them wasn't biscuits; they were pebbles; they grind 'em up an' use 'em in th' concrete. Somethin' ought to be done or I'll hike.

First Bo: I'd like some meat; a big steak would hit me right; and some fish—fresh fish that didn't stink.

Second Bo: Fish, that's my first name. There's lot of them in these here brooks, but the boss is too stingy to send out a man to catch them.

The Cook: Surprise tomorrow, boys. Boss just got back from a fishin' trip. He caught mor'n 20 lbs. of speckled trout. Brook trout fried for dinner for you fellows. Couldn't get a better meal at the Waldor Astor.

First Bo: Git that; brook trout! The cheap skate; won't have to buy anythin'; fill us up on fish.

Second Bo: Yea! Caught them himself; what do you know about that? The —— —— tight wad.

* * *

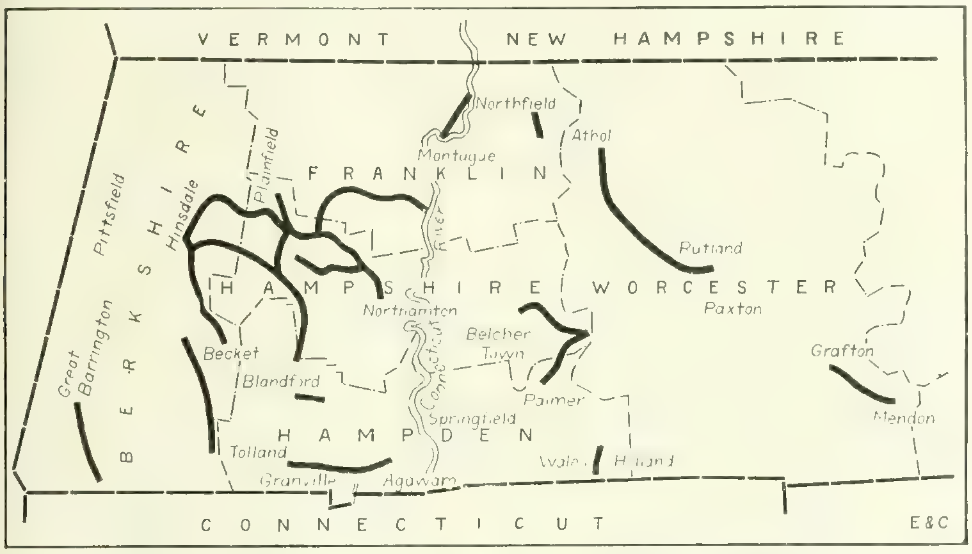
Skinner Mulvey says: "Mickey Dooly got his final estimate last week on his grading job and he spent the whole durn amount for a seegar. Pat Rourke just took a contract for diggin' tunnels fur a settlement o' prairie dogs."

$2,500,000 FOR STATE HIGHWAYS IN MASSACHUSETTS.

17 Routes in Western Counties to Be Improved.

Work to Be Done During Next Four Years.

The legislature of Massachusetts, as noted in our last issue, has authorized an expenditure of $2,500,000 during the next four years for the construction of state highways. This sum will be expended by the State Highway Commission principally for building roads in the western counties of the state. Under the legislative act 17 routes in Berkshire, Franklin, Hampden, Hampshire and Worcester counties are to be improved. A general idea of the location of these routes is shown by the accompanying map. The new highways will link up many of the main state roads already laid out in this section of the commonwealth.



General Location of 17 New State Highway Routes in Massachusetts.

The routes in general and their approximate lengths are as follows:

	Miles.
Great Barrington south	7½
Hinsdale to Cummington	13
New Boston toward Becket	14
Becket northwest to Hinsdale	12½
Huntington northerly	15
Hinsdale to Worthington	11
Cummington to Plainfield	4
Belchertown via Enfield and Ware to Palmer	20
Granville Corners to Feeding Hill	9
South Deerfield to Lithia	16
Northfield to Turner's Falls	6
Athol through Petersham, Barre, and Rutland	25
Hope through Grafton and Upton	8
Warwick to Orange	5
Blandford to Woronoco	3
Wales to Connecticut line	4
West Chesterfield to Williamsburg	13

The nature of construction of these roads will vary greatly. In some instances, the work will consist of grading and surfacing with the best local material available, while in other instances the work will consist of first class state highway construction. At the present time it is impossible to state just where the different types of construction will be used as the roads have not yet been surveyed. The construction work will be carried out under the direction of the Massachusetts Highway Commission, of which Arthur W. Dean, Boston, Mass., is Chief Engineer.

Concrete Work at Erie Harbor, Pa.

A 2,900-cu. yd. concrete job is being advertised by the U. S. Engineer at Buffalo, N. Y. The work calls for the construction of the concrete superstructure on the pier at the north side of the entrance to Erie Harbor, Pa. The pier is located 1½ miles from the State St. public dock in Erie Harbor. The pier is exposed to wave action on Lake Erie, but is more or less protected from this by Presque Isle Peninsula.

The work consists in removing the old timber superstructure for 540 lin. ft. on the north pier to a depth of 2 ft. below mean lake level and replacing it by a concrete superstructure resting on the cribs. The old superstructure consists of crib work of pine timber 12 ins. square, filled with stone and decked over with 3-in. plank. It is 8 ft. high by 30 ft. wide. The L at the easterly end is 7 ft. high by 30 ft. square. The inner edges of the concrete face wall and middle wall blocks will be supported on new hemlock timber which will be fitted to the crib timber. Timber filler blocks will be placed under each of the crib cross ties where the middle wall sills will rst.

The superstructure will consist of concrete about 3 ft. thick molded in place and founded on concrete blocks and on stone filling. It will be 6½ ft. high at the center, 6 ft. high at the sides above water level, and 30 ft. wide. The concrete blocks for the channel wall and lake wall will be 10 ft. long by 4 ft. wide by 4 ft. high. Cross wall blocks will be 10 ft. by 3 ft. by 3 ft. and middle blocks will be 10 ft. by 2 ft. by 2½ ft. The mix will be 1:2½:5. The mass concrete will be a 1:3:6 mix. The approximate estimate of quantities is as follows:

Old superstructure to be removed, lin. ft.	540
New hemlock timber, ft. B. M.	25,000
Timber filler blocks	60
Concrete blocks, set in place, 186 blocks, cu. yds.	810
Mass concrete in place, cu. yds.	2,100

Bids for the above work will be received until 11 a. m. June 19 by Capt. L. V. Frazier, U. S. Engineer, 540 Federal Bldg., Buffalo, N. Y.

STATE HIGHWAYS IN MAINE.

First Letting Held on May 19.

Bids Opened on 28 Miles, Concrete, Bituminous, Gravel and Sand-Clay Construction.

The first road letting of the year by the State Highway Commission of Maine was held on May 19. At this time bids were opened on 11 contracts covering a total of 28 miles of state highway. In all 24 different contractors submitted bids on the work. A majority of the bidders were from outside the state, Massachusetts and Connecticut being well represented. On none of the jobs was there more than 8 bidders and on the largest contract, Route A in Scarboro, only four contractors submitted bids. Several of the contractors figured on five or more contracts. The Ahern Construction Co., Willimantic, Conn., bid on eight contracts; A. D. Bridge's Sons, Meriden, Conn., bid on six contracts and A. Williams Co. also bid on six. The following tabulation shows the high and low bids and the number of bidders on each contract:

Route.	Town.	Miles.	High bid.	Low bid	No. bidders.
A	Scarboro	5.47	$73,578	$65,756	4
A	S. Portland	2.22[1]	24,174	17,193	8
A	S. Portland	2.22[2]	27,841	22,917	8
C	Bath	.83	6,308	4,594	2
D	Thomaston	1.28	6,136	5,934	4
E	Manchester	2.68	23,355	18,308*	7
H	Fairfield	2.29	19,075	9,789*	7
L	Prospect	.34	2,129	1,761	6
L	Searsport	2.53	14,569	9,718	5
N	Edmunds	1.95	13,673	9,666*	3
S	Oxford	3.77	28,137	15,988*	5
S	Poland	3.65	20,017	10,916†	8

*Awarded at this price. †Awarded at $14,089.

[1]On bituminous macadam. [2]On concrete; contract let on concrete at $25,440.

The 5.47 miles of road at Scarboro is to be of the bituminous macadam type, and bids also were received May 19 for furnishing bituminous material for its construction. The Barber Asphalt Co. was the only bidder on fluxed native asphalt, its figures being $12,947 in barrels and $11,817 in tank cars. For furnishing asphalt John Baker, Jr., at $5,898 was low bidder on this material in barrels and the Atlantic Refining Co., at $4,408, was low bidder for this material delivered in tank cars. For supplying refined tar the Barrett Mfg. Co., at $7,059, was low bidder on supply delivered in tank cars, while the Independent Coal Tar Co., at $9,248, was low bidder for delivering in barrels. On the 2.2 miles of state highway in South Portland, alternate bids were asked on Portland cement concrete or bituminous macadam. The contract was awarded to the Hassam Paving Co., Worcester, Mass., at $25,440 on concrete. On both of the above sections the pavement will be 16 ft. in width, and 6 in. in thickness, with 2½ ft. gravel shoulders on each side.

The work in Bath, Thomaston, Fairfield, Searsport, Prospect, Edmunds and Poland provides for gravel surfaced roads. All of these contracts call for a 16 ft. gravel surface, the depth varying with the location from 6 in. to 8 in. of compacted gravel. The shoulders will be 2½ ft. wide and constructed of the best material obtainable in the vicinity.

The 2.68 miles of highway at Manchester will be waterbound macadam, 6 in. in depth and 16 ft. wide with the customary shoulders. It is planned to surface treat this macadam as soon as conditions are right. The 3.77 miles of road at Oxford is to be of the sand clay type. The surface will be 16 ft. wide and at least 8 in. thick after thorough mixing and compacting.

In general the above types follow the standards prescribed in the specifications of the Highway Commission for last year. About the only exception is that the gravel surface is being thinned on one or two places where the traffic is less heavy than on some of the other sections.

The Highway Commission will advertise other jobs in the near future as soon as it has finally settled upon a few locations which are now undecided. Paul D. Sargent, Augusta, Me., is Chief Engineer of the State Highway Commission.

Engineers' Club of Baltimore.—The annual meeting of the Engineers' Club of Baltimore will be held at the club rooms, 6 W. Eager street, June 3, at 8 p. m. Officers will be elected, the following candidates to be voted on:

For President—J. Fletcher Apsey, Oscar F. Lackey, W. W. Pagon.

For Chairman of House Committee—R. M. Cooksey, John N. Mackall, W. W. Varney.

For Board of Directors (to elect three)—R. B. Clapp, R. K. Compton, O. C. Cromwell, W. W. Crosby, J. C. Little, J. H. Sutton, C. J. Tilden, H. A. Warren, Albert H. Weer, Ezra B. Whitman, H. D. Williar, Jr.

The Engineers' Club of Baltimore is now in a flourishing condition, having a membership close to 300.

Bids Asked on 4 State Buildings in West Virginia.

A considerable expenditure will be made by the State of West Virginia for building construction at various state institutions. Structures are to be erected for the University of West Virginia at Morgantown, W. Va., for the State Normal School at Glenville, W. Va., and for Marshall College at Huntington, W. Va. At the latter institution a building to serve as a science hall will be constructed. This will be 143 by 79 ft. in size and will have three stories. It will have a brick and terra cotta exterior. The first floor will be reinforced coicrete with composition top finish. The second and third floors will be joist construction and there will be a composition roof.

The work at the University of West Virginia is an addition to Mechanical Hall and a building for the School of Medicine. The latter structure will be 75 by 55 ft. in size, will have brick walls and will be of wood joist construction and composition roof. It will be three stories high. The addition to Mechanical Hall will be 141 by 44 ft. in size. with one wing 67 by 44 ft., and one wing 55 by 43 ft. It will be of slow burning type of construction, three stories high. Brick and terra cotta will be the principal materials used. It will have a slate and composition roof. The structure at the Glenville Normal School will serve as a dormitory building. It will have three stories and basement and will be 169 by 50 ft. in size. It will be of ordinary construction, brick and stone being used, and will have a slate roof.

The architect for the buildings is H. Rus Farne, Charleston, W. Va. Bids for their construction will be received until 2 p. m., June 29, by the State Board of Control, Charleston, W. Va.

A 172,000 Cu. Yd. Concrete Job at Sault Ste. Marie.

Bids were opened last week on one of the largest concrete jobs that has come up for letting so far this year. The work called for the construction of the concrete masonry for the fourth lock at Sault Ste. Marie, Mich., for the U. S. Government. It involved the placing of about 172,000 cu. yds. of concrete, the furnishing and delivering of 210,000 bbls. of Portland cement and considerable miscellaneous work. There were 13 bidders and the figuring was quite close as is indicated by the fact that there was a difference of only about 40 per cent between the amounts of the high and low bids. The totals of the three low bidders were as follows: Oscar Daniels Co., Chicago, Ill., $1,010,480; Maryland Dredging & Contracting Co., Baltimore, Md., $1,028,880; Greiling Bros. Co., Green Bay, Wis., $1,048,180.

The principal items in the contract were the concrete masonry and furnishing and delivering the cement. On the latter item the unit prices ranged from $1.15 to $2 per barrel. The Daniels Co. submitted a figure of $1.30 per barrel and the Maryland Dredging & Contracting Co. bid $1.40. This difference in price, by the way, was enough to change the standing of these two bidders. Bids were taken on two classes of concrete masonry: Class A and Class B. Class A amounting to about 135,000 cu. yds. will be placed in lock and canal walls and is in general massive work with little reinforcement. Class B, 37,000 cu. yds., will be placed in floors, culverts and miter walls. It will in general be in smaller masses and more heavily reinforced. The bids on the concrete ranged from $3.85 per cu. yd. to $5.25 on Class A, and from $3.85 per cu. yd. to $7.25 per cu. yd. on Class B.

The lock is located on the north side of the St. Mary's Canal. The concrete is to be placed in an area about 2,170 ft. in length and from 130 ft. to 150 ft. in width. Each lock wall will be 1,715 ft. long. Of this length about 1,200 ft. will be 26 ft. wide at the base and about 50 ft. high. The remaining 515 ft. will be occupied by gate abutments and recesses. The lock floor in general will be about 1½ ft. thick.

Rapid Transit Construction in New York City.

The contract for the construction of a part of the Gravesend Ave. elevated railroad, on which bids were opened May 20, has been awarded to the Oscar Daniels Co., New York City, at $863,775. The Gravesend Ave. line is to connect the 4th Ave., Brooklyn, subway with Coney Island. It will be a three-track elevated railroad. The bids were for Section No. 2, which covers the southern portion of the line, extending from Bay Parkway (22nd Ave.) to Avenue X. Bids will be opened June 15 on Section 1 of Route No. 29, being a part of the Eastern Parkway Rapid Transit R. R. (Nostrand Ave. branch). This will be a 2-track underground railroad in the Borough of Brooklyn, beginning at a point under Eastern Parkway about 192 ft. west of Nostrand Ave. and running thence under Eastern Parkway and Nostrand Ave. to a point about 220 ft. south of Church Ave.

The Public Service Commission for the First District also will open bids June 11 for the supply of 5,000,000 lbs. of steel rails and corresponding quantities of ties, spikes and other materials needed for track equipment.

The Commission has directed its Chief Engineer to prepare plans for the construction of Utica Ave. subway in Brooklyn. This subway will be a branch of the Eastern Parkway subway, which will be operated by the Interborough Rapid Transit Company. It will be a 2-track underground railroad, extending from Eastern Parkway down Utica Ave. to Flatbush Ave. The Utica Ave. route was not included in the Dual System contracts and the city has not appropriated money for its construction. Property owners in the vicinity have petitioned the Commission to have it built upon the assessment plan, the cost to be assessed against the property benefited. This method of construction is permitted by the Rapid Transit Act but has never before been used.

A new route for a connection between the Bronx Park branch of the existing subway at Simpson St. and the proposed Pelham Bay Park branch of the Lexington Ave. subway in The Bronx has been adopted by the Public Service Commission for the First District, and sent to the Board of Estimate. The new route provides for an elevated railroad running through Westchester Ave. so as to join the two lines.

Bidding Prices on Macadam in Kentucky Town.

The following data relate to some contracts that were let recently in the town of Jackson, Ky. The bidding prices in view of the large amount of macadam construction projected by various counties in Kentucky, are of interest. The bids were taken on two types of surfacing. One of these was known locally as second class telford. The base course of this consists of native sand stone and is to be 6 ins. to 9 ins. thick. The stone is not crushed to uniform size and rolled; neither is comparable with a true telford. The second course is 3 ins. thick, consisting of crushed limestone 1½ ins. down to ¾ in. The third course is composed of screenings from ¾ in. down. The macadam had a base course of 5 ins. crushed limestone sized from 3 ins. to 1½ ins. The bidding prices on the work are shown in Table I.

TABLE I.

	Est. quantities.	(1)	(2)	(3)	(4)	(5)	(6)
Excavation, earth	1,500 cu. yds.	$0.40	$0.40	$0.40	$0.38	$0.35	$0.40
Excavation, loose rock	625 cu. yds.	.40	.40	.40	...	.45	.65
Excavation, solid rock	375 cu. yds.	.40	.70	.40	.70	.70	1.25
Macadam	11,870 sq. yds.	1.00	1.40	1.20	1.20	1.47	1.32
Second Cl. Telford	11,870 sq. yds.	.99	.98	1.23	1.10	1.19	....
Scarifying	1,185 sq. yds.	.06½	...	.19	....	....	.02
Resurfacing (with second and third course)	1,185 sq. yds.	.52	...	.595	.80*	.77*	.50

*Includes scarifying.

The contract was awarded to bidder No. 1, John W. Dean, Jackson, Ky., on second class telford. Limestone is not available in the immediate vicinity of Jackson and has to be shipped in. The freight rate is 3 cts. per 100 lbs.

Concrete Bridge Construction in Illinois.

Bridge construction in Illinois is offering many opportunities to contractors specializing in smaller undertakings of this kind. During the past week the State-Highway Commission began advertising for bids on concrete bridges calling for a total of 1 294 cu. yds. of concrete. The County Superintendent of Highways of Woodford County is asking proposals on 15 small structures requiring 170 cu. yds. of concrete and 20,000 lbs. of reinforcing steel. Bids will be opened June 12 at Mt. Sterling, Ill., on two reinforced concrete bridges estimated to cost $1,970, and on another bridge estimated to cost $3,660 for a reinforced concrete structure and $2,855 for a steel structure.

The state work is located in the following counties: Pulaski, 277 cu. yds.; Jasper, 583.7 cu. yds.; Scott, 322.5 cu. yds. The two reinforced concrete bridges advertised for letting at Mt. Sterling will be built between Cooperstown and Ripley Townships. They will have spans of 30 ft. and 36 ft., and a roadway of 18 ft.; height over all will be 11 ft. and 10 ft.; estimated total concrete, 73.8 cu. yds. and 81.8 cu. yds.; reinforcing steel, 10,576 lbs. and 13,660 lbs. The nearest station is Mt. Sterling, 7 miles distant from the work. Gravel is reported available in creek within 200 ft. of bridge sites and may be obtained free of charge. Green timber for falsework may be cut near bridge sites. Low water flow, dry; high water, 7 ft. and 6 ft.; average depth of excavation is 6 ft. and 7 ft., and is to extend about 2 ft. below stream bed to gravel and rock foundation.

The $3,660 reinforced concrete or $2,855 steel bridge is to be constructed in Pea Ridge Township. It will have a span of 60 ft., 18-ft. roadway and height over all of 16 ft. The estimated total concrete in reinforced concrete structure is 214.6 cu. yds.; reinforcing steel, 33,844 lbs. For the steel bridge the estimated concrete for abutments is 103.9 cu. yds., reinforcing steel 6,150 lbs. The nearest railroad station is Mt. Sterling, 8½ miles. Gravel is reported f. o. b. station at $1 per ton. Low water flow is 3 ft. deep; high water, 8 ft. deep.

Foreign Orders for Railway Equipment.

The railway supply and equipment market, after nearly two years of dullness, is beginning to show signs of activity. Orders for cars especially have shown marked improvement. During the first three weeks of this month something like 25,000 cars were ordered by American railways. During May, 1914, the number was 7,500. Export sales, the direct result of the war, have been an important factor in the betterment. One of the largest car orders ever placed in this country by a foreign government was given out by Russia a short time ago. This provided for 22,000 freight cars and was divided among seven companies. Russia also, is understood to have negotiations now underway for the building of 40,000 additional freight cars in the United States. This order will call for an expenditure of about $25,000,000. In addition Russians are reported to have ordered 30 locomotives, 40,000 tons of light rails and are said to be negotiating for 20,000 tons additional, and for a large tonnage of bridge steel and track supplies. The French government has placed orders in the United States for 107 locomotives and has taken bids on 100 more. It also is reported that the French have placed orders for 12,000 tons of portable track and for 8,000 tons of girder rails.

A $900,000 Irrigation Project in Oregon.

Steps are being taken to secure funds for the construction of the development of the Teel Irrigation District in Umatilla County, Oregon. On July 6 the Board of Directors of the District will receive bids for the sale of $800,000 of the 20-year 6 per cent first mortgage bonds of the district. With the proceeds of this sale it is planned to begin work on the project. The district was organized in August, 1912, under the irrigation district laws of Oregon. In June, 1913, a $1,200,000 bond issue was voted. This was approved by the state engineer on Feb. 17, 1914, and by decree of court on Feb. 28, 1914. The water rights are owned by the district, and it also possesses power permit obtained from the state.

The constructional features of the development include a reservoir with a capacity of 31,300 acre feet of water, a tunnel 2.34 miles in length, and 79.57 miles of main canal, feeders and distributors. The dam for the reservoir will be 105 ft. high and will have a bottom width of 200 ft. and a top width of 650 ft. The tunnel will have a cross-sectional area of 49.47 sq. ft. and a fall of 26.4 ft. per mile. The main canal will have a capacity of 350 cu. ft. per second, and will have a length above the tunnel of 18.7 miles.

The Teel Irrigation District contains about 20,000 acres. J. Frank Spinning, Echo, Ore., is Secretary of the District, and W. B. Hinkle is Chief Engineer.

Bill Passed for Illinois 8-ft. Waterway.

There are some prospects that construction may be started in August on the proposed 8-ft. waterway for the state of Illinois. The bill authorizing this improvement has been passed by both branches of the legislature and probably will be signed this week by the Governor. The law goes into effect on July 1, and it is expected by that time the Waterway Commission which will be in charge of the work, will have effected its organization

The estimated cost of the development under the project recommended by a board of engineers is $3,075,000, itemized as follows:

Work on I. & M. Canal, Joliet to Dresden	$ 509,480
Locks and river connections at Marseilles	682,130
Dam, locks, etc., at Starved Rock	1,583,000
New locks at Sanitary District power house, Lockport	300,000

The project was outlined in our issue of March 3, 1915. It involves the deepening of the Illinois River from La Salle to Starved Rock; the construction of a lock and dam in the Illinois River at Starved Rock; the construction of a connecting channel and lock between the Illinois River and the Illinois and Michigan Canal at Walbridge Creek; the construction of a crib dam in the Illinois River just above Marseilles, and a connecting channel and lock between the Illinois and Michigan Canal and the Illinois River at this point. The other features of the plan involve the construction of a connecting channel and lock between the Illinois River and the Illinois and Michigan Canal at a point just below Dresden; the improvement of the canal by deepening the bed and constructing locks from Dresden to the Southern terminus of the drainage canal at Joliet; and the construction of a new lock at the Sanitary District power house at Lockport.

A 10-Mile Earth Embankment at New Orleans.

The city of New Orleans, La., will advertise for bids within the next 30 days for the construction of an earthen embankment across the marshes of Southern Louisiana. The structure will be approximately 10 ft. in height, with a crown width of 30 ft. and a base width of 60 ft. It will be approximately 51,000 lin. ft. in length and will be constructed for the purpose of creating a foundation above storm Gulf of Mexico level for use in connection with the building of a trans-continental highway leading out of New Orleans in an easterly direction.

The embankment naturally will have to be constructed with dipper or similar type dredges. The requirement will be that two dredges shall be operated, one at each end of the work, to a point of meeting. The entire embankment will contain about 600,000 cu yds. of earth and must be completed within one year after date of commencement. W. J. Hardee is City Engineer of New Orleans.

Classification of Technical Literature.—Delegates from about twenty national technical and scientific societies met in the United Engineering Society Building, 29 West 39th Street, New York City, on May 21, 1915, to perfect a permanent organization, the purpose being to prepare a classification of the literature of applied science which might be generally accepted and adopted by these and other organizations.

There was a generally expressed opinion that such a classification, if properly prepared, might well serve as a basis for the filing of clippings, for cards in a card index, and for printed indexes; and that the publishers of technical periodicals might be induced to print against each important article the symbol of the appropriate class in this system, so that by clipping these articles a file might be easily made which would combine in one system these clippings, together with trade catalogues, maps, drawings, blue prints, photographs, pamphlets and letters classified by the same system.

Permanent organization was effected by the election of the following officers: Chairman, Fred R. Low; Secretary, W. P. Cutter; Executive Committee, the above, with Edgar Marburg, H. W. Peck, Samuel Sheldon.

It was agreed that a special invitation to participate by the appointment of a delegate be sent to other national societies which might be interested in the general plan.

The name adopted for this organization is "Joint Committee on Classification of Technical Literature," and the temporary address of the Secretary, Mr. W. P. Cutter, is 29 West 39th street, New York City.

NEWS LETTERS

St. Louis Items.

The Bondurant Construction Co. of Hickman, Ky., has 200,000 yds. of levee work opposite Hickman, Ky., suitable for wheeler outfits to sublet.

Fire was kindled last week under the ovens of St. Louis' new $2,000,000 coke and gas plant in Carondelet, preparatory to the opening and actual operation which is scheduled for June 15. It will require several weeks for the ovens to become thoroughly heated. The plant was erected by the Laclede Gas Co. and will have a capacity of 750 tons of coke a day. The nine buildings occupy the larger part of 180 acres and stand on the site of the Old Vulcan Iron Works.

Construction of the state and highway east of Alton is being delayed by tests of 20 carloads of brick received for use.

Hickey Bros., Railway Exchange Bldg., St. Louis, secured the contract for constructing 4 earth dams, a diversion channel, an intake and a wet well at Paris, Ill.

Attorneys for the East Levee and Sanitary District filed a petition for condemnation proceedings in the Circuit Court in Belleville against the Southern Railway, the Venice & Carondelet, the Mobile and Ohio, the Alton & Southern, Julius Pitzmann, Edward C. Kehr, August A. Busch and Clementine Schunzel. The levee District is trying to get a right of way for its levee in the southern part of East St. Louis, but is unable to reach an agreement with the defendants as to the price for the land to be taken. The case was docketed for the September term.

Ed Peterson, 1402 W. O. W. Bldg., Omaha, Neb., can use some small team outfits in South Dakota.

List & Gifford Construction Co. of Kansas City, Mo., have sublet the concrete work on their M. K. & T. contract near Eufaula, Okla., to the Gould Const. Co.

J. J. McInerney expects to finish his levee work at Apex, Mo., within a few weeks. Is in the market for any kind of grading.

Mulvill Bros. have several outfits on road work in Washington County, Mo. They have teams at work on every road in this county.

Ed Harris has finished his work at West Frank, Ill.

M. L. Windham was with us a day last week. Windham is looking for team work. West Frankfort, Ill., will catch him.

Chester H. Krum, as special master in the Wabash case, has announced the sale of the entire property at the Franklin Avenue freight station on Wednesday, June 23. The master takes this action pursuant to the decree of foreclosures of the first refunding and extension mortgage entered in the Federal Court January 30, 1914, and is a step further in the early reorganization of the Wabash Co.

Hickey Bros. have 104,000 yds. of earth work at Paris, Ill., to sublet. The majority of this work is suitable for teams or drag lines.

Excavation work was begun last Monday on the site of a three-story warehouse and elevator to be erected by the Valier and Spies Milling Company at 2511-19 East Marcus Ave., at a cost of about $100,000. The warehouse which will have a ground area 60x90 ft., will be fireproof, of brick and reinforced concrete construction. It will be used for the storage of flour milled in the new plant of the company adjoining. The elevator will be 112 ft. high and a duplicate of the elevator standing near. Lichter & Sons, engineers, drew the plans and are superintending the erection of the structures. The contract has been awarded to the Fruin-Colnon Contracting Co.

Geo. King of Mt. Vernon, Ill., was awarded the contract for supplying 60,000 ties on the Cairo Division of the Big Four R. R.

The Woodriver, Illinois, refinery of the Standard Oil Co. is planning to build a new power house to include eight boilers of 500-HP. each, and of the water tubular type.

J. W. McMurray Contracting Co., Sharp Bldg., Kansas City, Mo., were low bidders for constructing about 4,200 ft. of standard three-row timber dike on Missouri river about a half mile below Cement City, Mo.

Rust & Swift have made a running start on their Government revetment job near St. Genevieve, Mo.

Lawrence Kjerulff of Kansas City, Mo., was elected president of the Missouri State Convention of the National Association of Engineers at the Final session here last week. Other officers elected were: Charles T. Parkinson, St. Louis, vice-president; Rice Nance, Kansas City, secretary, and F. Middleton, Sedalia, conductor.

The St. Louis Smelting & Refining Co. is going to build a 1,700-ft. spur from the Vandalia R. R. into their plant at Collinsville, Ill. There is approximately 15,000 yds. of grading to be done on this job. Richard Watson is Engineer for the St. Louis Smelting & Refining Co. at Collinsville, Ill.

The Kremer-Voirol Construction Co. of this city were awarded the contract to install new plumbing at the Marine Hospital in the southern part of the city. Its bid was $5,444. Work will start immediately.

A circular issued May 27th by E. A. Hadley, chief engineer of the Missouri Pacific-Iron Mountain System, announces the appointment, effective June 1st, of H. R. Carpenter to be assistant chief engineer, with headquarters at St. Louis, vice C. E. Smith, resigned; and A. F. Dorley as engineer of Maintenance of Way of the Eastern district, with headquarters at St. Louis. Mr. Carpenter, who was graduated from the engineering department of Yale, entered the railroad service as a rodman on the Union Pacific in 1884. Later he worked on the Denver & Rio Grande and served four years as chief engineer of the Colorado Springs and Cripple Creek Railway. He has been with the Missouri Pacific since 1905. Dorley was made an assistant engineer of the Missouri Pacific-Iron Mountain in 1906. He has been division engineer at various points on the Missouri Pacific proper and was brought to St. Louis on December 10, 1910, as engineer of water service. On April

1st, 1914, he was promoted to be principal assistant engineer.

Bids amounting to $1,000,000 for levee construction work were opened Wednesday by Maj. Markham, U. S. Engineer at Memphis, Tenn., and contracts will be awarded later. The bids were for the construction and repair of levees in the upper and lower St. Francis levee districts and in the White River districts. The following submitted bids: S. R. Hughes, Roper Bros., A. H. Carey, Oglesby Construction Co., Walter H. Dennison, H. B. Blanks Levee Construction Co., M. C. Conners & Co., Jackson Construction Co. Sessions, Walker & Hill, Bonder, Clark & Co., Bondurant Construction Co., R. L. Leonard, Rogers Bros., M. Tansey, Fred M. Grain & Co., Dunivan & Daily, W. T. Lowrence & Co., George F. Ramsey, J. A. Burke, Bond & McMurray, Campbell, Joyce & Co., Grant Smith & Locker, Roach & Stansell, LaLann Bros., J. M. Sullivan, Claude Cummins, E. Williamson, Yale Reagan & Co., Hercules Company, J. E. Scott and S. M. Bush.

The two weeks of continuous rain we had in this part of the country has put quite a number of our contractors, especially those working on the river, out of business temporarily. At this writing the river is coming up at a rapid gait and the weather bureau predicts flood stages along the Missouri and Mississippi rivers during next week. The crops in this part of the country have not been damaged to any extent, owing to the extremely dry spring. The ground is absorbing most of the rain which is more beneficial than detrimental to the farmers.

The Mississippi River Commission here will receive bids until 11 A. M., June 17th, for constructing about 175,000 cu. yds. of earth work in the East Side Levee and Sanitary district.

H. H. Hall Construction Co. of East St. Louis were awarded the contract for building two miles of state road in St. Clair County, Ill. The road bed will be 10 ft. of concrete with 4 ft. of macadam on each side, making the road 18 ft. wide. The cost will be borne in equal parts by the County and the State. The Hall Construction Co.'s bid was $16,900. The next nearest bid was $17,333 per mile.

The Burlington R. R. Co. are going to replace the old Hannibal Bridge at Kansas City with a new double deck structure. The Union Bridge and Construction Co. of Kansas City secured the contract for the substructure. The building of the steel superstructure will be done by engineers of the railroad. The total cost will be slightly over a million dollars. The new bridge will be 1,555 ft. in length. The substructure will consist of one 47-ft. octagonal pier, four rectangular piers, each measuring 27x72 ft., two abutments and several smaller piers. All the piers will be sunk by the pneumatic system to bed rock, at an average depth of 66 ft. below the water level. The superstructures, which will be all steel, will be built on two levels, the lower for a double railway track and the upper for a traffic way. There will be a draw span of 450 ft., two fixed truss spans of 330 ft. each, with girder spans on the approaches.

Owsley & Mann secured the contract for clearing right of way on the Little River Drainage Ditch near Kirk, Mo.

The 4 miles of streets in which all wires must be placed underground in the next year and the poles eliminated was fixed by an order of the Board of Public Service. The districts named were: Kings Highway from Arsenal st. to Scott ave.; Arsenal st. from Kings Highway to Spring ave.; Washington blvd. from Kings Highway to Taylor Ave. The wire using companies were required by the board to sign written agreements that at any time Union boulevard, from Lindell to Easton aves., is reconstructed they will place their wires in conduits and take down their poles on that highway. An ordinance enacted three years ago requires all wires in St. Louis to be placed underground. The wires on two miles of streets was to be placed in conduits the first year, three miles the second and four miles each year thereafter.

The Board of Public Service last Wednesday agreed to recommend to the Board of Aldermen drafts of ordinances establishing benefit or taxing districts, that is showing those whose property will be assessed for the cost of the following street improvements and reconstructions:

Reconstruction of Page blvd. from Whittier st. to Newstead ave.; improvements of West Park ave. from the east line of Forest Park Home place to McCaysland ave.; improvement of Marine ave. from the center line of Keokuk st. running east of Marine ave. to Broadway; improvement of Compton ave. from Chippewa st. to Winnebago st.; reconstruction of Gane ave. from Penrose st. to Florissant ave.; improvement of Forest ave. from Dale ave. to Clayton ave.; improvement of Crittenden st. from Indiana ave. to Gravois ave.; improvement of West Park ave. from McCausland ave. to City limit of 1876; improvement of Cherokee st. from Gravois ave. to Grand ave.; improvement of Crittenden st. from Lemp ave. to Indiana ave.; improvement of Ashby ave. from Euclid ave. to Kings Highway; improvement of Ohio ave. from Sidney st. to Shenandoah ave.; improvement of Thurman blvd. from McRee ave. to Folsom ave.

The Oglesby Construction Co. of Memphis, Tenn., were low bidders on 1,930,000 cubic yards of levee work in the upper St. Francis Levee District, bids for which were opened by Major Markham, U. S. Engineer in Memphis, Tenn., on May 26th.

S. M. Bush of Memphis, Tenn., put in the lowest bid for 1,333,300 cubic yards of levee and banquetting in the lower St. Francis District.

Rodgers Bros. of Memphis, Tenn., were low for 630,000 yards of levee work in the White River District.

Yale & Reagan of Chicago, Ill., were the only firm outside of Memphis contractors that were in the money at the big Government levee letting in Memphis on May 26th.

A. B. Koenig.

PERSONALS

Mr. John W. Moran has been elected superintendent of the Fall River Water Department, Fall River, Mass., after an open competitive examination. Mr. Moran was master mechanic and chief engineer for the Kerr Manufacturing Co. from 1906 to 1909. Since 1909 he has been chief engineer of the Fall River Water Department.

Mr. F. M. Rutter has been appointed assistant superintendent on the Ontario division, Canadian Pacific Railway. Mr. Rutter has been in the engineering department of that railway for the past thirteen years and has held the positions successively of chainman, rodman, transitman and resident engineer on location and construction; rodman, transitman and resident engineer and assistant division engineer in the maintenance of way department.

Mr. Frederick J. Anderson has been appointed city engineer of South Bend., Ind., succeeding Mr. W. S. Moore, who resigned to accept a similar position in Grand Rapids, Mich. Mr. Anderson graduated from Purdue in 1900. He was assistant engineer, maintenance of way, for the Big Four from 1900 to 1901, and for seven years thereafter was with Mr. A. J. Hammond, consulting engineer. During the year 1908 he was resident engineer on construction for the Chicago, South Bend & Northern Indiana (Electric) Railway, and in 1909 was engineer for that company. From 1909 to 1915 he was assistant city engineer of South Bend.

Mr. Howard W. Holmes has been appointed Assistant State Highway Engineer of Oregon, and as such will have charge of the design and construction of bridges, structures and "hard-surface" pavement construction, specifications and "standards," etc. Mr. Holmes has been actively engaged in the design and construction of bridges and highways during the past 11 years. He was assistant engineer for the Associated Oil Co. in Kern county, California, in 1905-06. For four years following he was employed as designing and construction engineer on bridge and highway work, and in 1910 was made designing engineer of bridges and structures for the city of Portland, Ore. In 1912-13 he was superintendent of construction for the city of Portland, and during the latter part of 1913 and until October, 1914, he was Chief of the Bureau of Highways and Bridges of Portland. Since October, 1914, Mr. Holmes has been engineer in charge of grade crossing elimination plans for the city.

Mr. Don H. Bark has been appointed by the Canadian Pacific Railway as irrigation advisor to settlers and management of the railroad's irrigation system, with headquarters at Calgary. The system consists of approximately one million acres of irrigible land lying east of Calgary in Alberta. Mr. Bark will inaugurate a department of skilled irrigation agriculturalists to aid and advise the settlers and management. Mr. Bark is well trained for this work. He was irrigation expert for the Twin Falls Land & Water Co., Twin Falls, Idaho, in 1905 and 1906, and held the same position with the Wyoming Central Irrigation Co. at Riverton, Wyo., during 1907. He was in charge of irrigation investigations for the U. S. Department of Agriculture in the state of Kansas in 1908, and was irrigation engineer in charge of U. S. irrigation investigations in Idaho from May 1, 1909, to May 8, 1915. While in Idaho, Mr. Bark planned and carried out a broad and comprehensive duty of water investigation, the results of which were published in bulletin form by the Idaho state engineer's office in 1913 and again in January, 1915.

CONTRACTORS.

William Flick, contractor of Cascade, Colo., was recently awarded the contract for 18 miles of automobile highway from Cascade to the top of Pike's Peak, including the grading, bridges and culverts. Mr. Flick has handled numerous other construction projects along that line. Among the contracts noted by Engineering and Contracting were the Ox Bow tunnel in Idaho, Colorado & Southern Railroad construction, and Union Pacific railroad work. Mr. Flick's office is located at 1556 William street, Denver, Colo.

OBITUARIES

John McKechney, a retired contractor, died at his home in Chicago, May 25, aged 70. Mr. McKechney was born in Quebec, and came to Chicago in 1864. The firm of Hill, McKechney & Co. was identified with the construction of the Illinois Central and other roads through the south and of the Baltimore & Ohio through Indiana. Later the firm of Weir, McKechney & Co., general contractors, built a section of the sanitary canal and the northwest land tunnel. Mr. McKechney retired eight years ago.

Richard R. Parkin, organizer of the Elgin Water Works and superintendent since its installation in 1888, died at Hume, N. D., May 13, aged 66. Mr. Parkin lived in or near Elgin nearly all of his life. After the Civil War, through which he served, he became a member of the city volunteer fire department and served as chief from 1878 to 1881. In 1882, when several hose companies were formed, Mr. Parkin organized the R. R. Parkin Hose Co., and was its foreman. In 1885 he was elected alderman, and resigned that office to assume the superintendency of the municipal water works in 1888.

Colonel Samuel D. Lehr died at his home in Allentown, Pa., May 18, aged 77. Mr. Lehr was born in Allentown, and began engineering work in the service of the Allentown & Auburn Railroad in 1853. Prior to the civil war he was for several years in the office of the Allentown city engineer. After the war, through which he served, rising to the rank of colonel, he returned to Allentown and joined G. A. Aschbach in civil engineering practice. In 1868 with Richard R. Emery he established a practice which was maintained until the death of Mr. Emery in 1872. In 1869 he became city engineer and filled that office for 20 years. He then took up private practice once more with J. Howard Mirtz as a partner. The association continued until 1897. In 1890 Col. Lehr was elected mayor of Allentown and held that office for several terms. At the time of his death he was superintendent of streets and public works.

James Barr, engineer in charge of the Victoria Park water supply project at Toronto, was one of the victims of the *Lusitania* disaster. Mr. Barr was on leave of absence from the city engineering department of Toronto, and with his wife was on his way to a visit with his father, Mr. John Barr, managing director for Messrs. Glenfield & Kennedy, hydraulic engineers of Kilmarnock, Scotland. Mr. Barr was 30 years old and had received his engineering education at the University of Glasgow. After being employed in engineering work first by a German firm and later by the firm with which his father is associated, Mr. Barr came to Canada in 1910 and entered the employ of the John Englis Co., Ltd., of Toronto. Later in that year he joined the staff of the city works department, Toronto, as assistant engineer. He rapidly gained promotion and soon became chief assistant to Mr. Milne, mechanical and electrical engineer for the city. In 1913, still retaining his position, he was also placed in charge of the Victoria Park scheme. He was a member of the American Waterworks Association.

Among the passengers on the *Lusitania* when it was torpedoed off Kinsale was James Blaine Miller, a member of the field force of the United States Coast and Geodetic Survey. The list of survivors does not contain his name, and it is practically certain that he went down with the vessel. For several years Mr. Miller had been in command of the Survey steamer *Patterson*, engaged in surveying work in the Hawaiian Islands and on the coast of Alaska, but in March of this year he was detached from that command and given several months' leave to enjoy a vacation in Europe. Mr. Miller was born in 1883, was graduated from Oberlin in 1903, and entered the Survey shortly after. His 12 years of service were devoted chiefly to hydrographic and leveling work. In 1914, while in command of the *Patterson*, he made a remarkable cruise of 1,600 miles to rescue the crew of the *Tahoma*, wrecked on a reef in Bering Sea. For this service he was presented with a medal by the rescued officers and crew of the *Tahoma*.

CIVIL SERVICE NEWS

The New York State Civil Service Commission announces the following examinations to be held on June 26:

Junior Assistant, Engineering Departments; $901 to $1,200 per annum.

Special Assistant in Chemistry; $1,200 per annum.

Landscape Draftsman, Bronx Parkway Commission; $1,500 to $1,800 per annum.

The U. S. Civil Service Commission announces the following examination:

Junior Railway Civil Enginer; $720 to $1,680 per annum; June 23.

NEW CATALOGUES

WATER METERS.—Paper, 3½x6 ins.; 16 pp. Thomson Meter Co., Brooklyn, N. Y.

The 1915 illustrated price list of the Lambert Meter, showing sectional view of meter and cuts of component parts.

VALVES.—Paper, 3½x6 ins.; 4 pp. Birch Valve and Manufacturing Co., 970 Montana St., Chicago.

Describes Birch pump valves, and shows views of top, lower side and cross-section.

LIQUID CHLORINE.—Paper, 4½x9½ ins.; 24 pp. Electro Bleaching Gas Co., 25 Madison Ave., New York City.

"Perfect Sterlization" is the subject of this booklet which describes the many uses and the different types of liquid chlorine equipment. Illustrated.

PISTON RINGS.—Paper, [illegible]x6 ins.; [illegible] pp. Burd High Compression Ring Co., Rockford, Ill.

Describes "Burd" high compression piston rings, their construction and application, together with data on sizes and prices. Illustrated.

VALVES.—Paper folder. Iowa Valve Co., Oskaloosa, Iowa.

Shows the Iowa patent fire hydrant and Iowa gate valves, indicator posts and valve boxes. List of sizes and prices of standard types.

OIL-DRIVEN COMPRESSORS.—Paper, 6x9 ins.; 24 pp. Chicago Pneumatic Tool Co., Fisher Bldg., Chicago.

Bulletin No. 34-U, giving instructions for installing and operating "Chicago Pneumatic" class N-SO fuel oil driven compressors. Illustrated.

BUILDING CONSTRUCTION.—Paper, 3¼x6 ins.; 12 pp. H. Edsil Barr, Mechanical Engineer, 907 Palace Bldg., Erie, Pa.

The Barr economic system of construction for industrial buildings, warehouses, etc., is briefly but explicitly described. Views of a number of structures of different types are shown.

STEEL FABRIC.—Paper, 7x9½ ins.; 26 pp. Clinton Wire Cloth Co., Clinton, Mass.

The April number of "Steel Fabric," the company's journal of fireproof construction and concrete reinforcement. Contains articles on Red River Levees, Waterproofing Steel-Floor Bridges, and a Cinder Concrete Floor Test. Illustrated.

CAST IRON PIPE.—Paper, 3½x6 ins.; 60 pp. American Cast Iron Pipe Co., Birmingham, Ala.

American Pipe Manual for users of cast iron pipe, giving standard specifications for cast iron pipe and fittings, and a number of other tables for use in making estimates on water and gas works construction.

SLIP JOINTS.—Paper, 4¾x6¾ ins.; 36 pp. Multiplex Manufacturing Co., Berwick, Penn.

Describes Crispin Slip Joints to be used wherever it is necessary to remove and replace a piece of pipe or any water works fixture, and in connection with pumping station and filtration plant piping. Gives dimensions, price list and directions for installation. Illustrated.

FEED WATER FILTERS.—Paper, 6½x3½ ins.; 12 pp. Ross Valve Manufacturing Co., Oakwood Ave., Troy, N. Y.

Description of feed-water filter or oil separator, used in stationary plants or on steamers for removing oil from feed-water, when a condenser is used. Shows photograph and sections and gives directions for operating, price list and table of dimensions.

STEEL TANKS.—Paper, 3½x6 ins.; 32 pp. Pittsburgh-Des Moines Steel Co., 316 Rialto Bldg., San Francisco, Cal.

Describes the exhibit of the company at the Panama-Pacific Exposition, shows views of a number of municipal, industrial or railway tanks, and gives some data on construction. Also gives a list of water towers and standpipes built by the company, with height and capacities.

FILTER EQUIPMENT.—Paper, 6x9 ins. Pittsburgh Filter Manufacturing Co., Pittsburgh, Pa.

Bulletin F. E. 5, illustrating the various devices for use in filtration plants, which have been designed by the company. Includes operating and sample tables, loss of head and recording gages, effluent controllers, strainer and manifold, valve stands, wash troughs, balanced and shutter valves, water level controller and water motors.

WATER METERS.—Paper, 6x9 ins.; 48 pp. Pittsburgh Meter Company, East Pittsburgh, Pa.

Catalogue of the Keystone and Eureka water meters, showing by duo-tone engravings all of the details of disc chambers, reinforced discs, bronze cases, and other parts. Describes special meters for various uses, shows application of Keystone portable test meter, Eureka water-cart or standpipe meter, etc., and gives directions for reading, proving, setting, etc.

MECHANICAL FILTRATION.—Paper, 6x9 ins.; 16 pp. Pittsburgh Filter Manufacturing Co., Pittsburgh, Pa.

Bulletin M. F. 7, illustrating and explaining the company's methods and means of producing pure water and showing a number of the municipal plants installed.

CONCRETE MACHINERY.—Paper, 9x11 ins.; 36 pp. Lansing Co., 2818 West St., New York City.

Catalogue No. 12-C, describing construction and operation and showing the various models and equipment of Lansing concrete batch mixers, advance continuous mixers, Lansing mortar mixers, gasoline hoists, concrete barrows, etc. Gives tables of sizes, capacities, general specifications, etc.

CATALOGUE REVIEWS

ASPHALT.—Paper, 6x9 ins.; 30 pp. The Barber Asphalt Paving Co., Philadelphia, Pa.

"Trinidad and Bermudez Asphalts and Their Use in Highway Construction," by Clifford Richardson. The pamphlet is illustrated with views of the asphalt lakes from which these materials are obtained, their transportation and application to road work. The deposits and their exploitation are described and the composition of the crude and refined products explained. Some data as to quantities of materials shipped, etc., the uses of asphalt in the construction of pavements, service tests, and types of pavement are given.

CHLORINE CONTROL APPARATUS.—Paper, 9x12 ins.; 36 pp. Wallace & Tiernan Co., Inc., 136 Liberty St., New York City.

Chlorine control apparatus for water and sewage purification is the subject of a comprehensive and interesting booklet being sent out by Wallace & Tiernan, manufacturers of chlorine apparatus. The history, theory and practice of utilizing chlorine for water purification are fully discussed, and the different types of Wallace & Tiernan apparatus described in detail, with views of typical installations and diagrams showing design. A chart of operation with explanation, description of efficiency test with diagrams, reports of experience of several water companies and miscellaneous chlorine data are included.

INDUSTRIAL NOTES

The United States Cast Iron Pipe & Foundry Co. will open a new office in Kansas City, Mo., at 1404 R. A. Long Building, about June 1st. The new office will be under the charge of R. C. Clifford, formerly of the St. Louis office of this company.

The Terry Steam Turbine Co., of Hartford, Conn., has appointed Mr. Merton A. Pocock as District Sales Manager for the territory included in the States of Minnesota, North Dakota and South Dakota. His office is 400 Endicott Bldg., St. Paul. This arrangement supersedes the previous selling agreement with Robinson, Cary & Sands Co. of St. Paul. The Terry Steam Turbine Co. also has appointed the Hawkins-Hamilton Co., Peoples National Bank Bldg., Lynchburg, Va., as its representative for the State of Virginia.

The Hyman-Michaels Co., 122 S. Michigan Ave., Chicago, which succeeded to the scrap iron and rail business of the Block-Pollak Iron Co. several years ago, has established a well equipped plant at Adelaide and Bulwer Aves. in the St. Louis district. The installation includes a number of shears, acetylene cutting apparatus, and contrivance for sorting, cutting and testing materials. The Hyman-Michaels Co. also have installed at St. Louis, a rail plant for the handling of new and relaying rails. Some time ago the company inaugurated a standard inspection bureau in connection with its rail department, the result of which has been highly gratifying.

RAILWAYS

BIDS ASKED.

Arizona:

Warren, Ariz.—Tucson, Cornelia & Gila Bend R. R., as noted in our last issue, is calling for bids until June 10 for constructing 42 miles of line from Gila, Ariz., to Ajo, Ariz. Bridge contractors can submit bids direct to railroad company on trestle and culvert portions of the work. R. H. Jones, Gila Bend, Ariz., is Chief Engineer.

Washington:

Seattle, Wash.—Until 11 a. m., June 10, by C. E. Dole, Purchasing Agent, Alaskan Engineering Commission, Seattle, for furnishing 880 tons relay rail, angle bars, turnouts, track bolts and track spikes.

PROSPECTIVE WORK.

California:

Highland, Cal.—Pacific Electric Ry., Los Angeles, is reported contemplating extending its Highland line from San Bernardino to East Highland and Del Rosa.

Connecticut:

New Britain, Conn.—Connecticut Co., New Haven, Conn., has completed plans for new line through Myrtle and other streets.

Idaho:

Lewiston, Idaho.—Lewiston, Nez Perce & Eastern Ry., incorporated early in April, has taken steps for financing its project and it is probable the first block of $250,000 of stock will be placed on market soon. Company proposes line east from Lewiston into Central Idaho. Z. A. Johnson, Lewiston, President Nez Perce & Idaho R. R., is interested.

Kentucky:

Barbourville, Ky.—Cumberland R. R., T. H. Hayden, General Manager, Barbourville, is considering building line from Warren to Jellico, Tenn., 18 miles.

Manchester, Ky.—Cumberland & Manchester R. R. Co. has been incorporated with $50,000 capital stock and proposes railroad from Manchester to Barbourville, a distance of 24 miles. The incorporators include F. M. Heidrick of Brooksville, Pa., R. E. Heidrick of Clarion, Pa., W. D. Clark of Franklin, Tenn., and C. B. Lytle of Manchester, Ky.

New York:

New York, N. Y.—The Governor has signed bill authorizing construction of marginal railway in Brooklyn by New York City. Railway will be operated by company of trunk line railways centering in Brooklyn.

Dolgeville, N. Y.—Jerseyfield R. R. Co., Salisbury Center, will construct 7 miles of line to tap timber tract. Work will be done under supervision of P. D. Mang of Dolgeville.

North Carolina:

Sanford, N. C.—Atlantic & Western R. R., H. P. Edwards, General Superintendent, Sanford, has surveys under way for line between Benson and Mt. Olive, and also proposes line from Lillington to Benson.

Utah:

Salt Lake City, Utah.—Southwestern & Pacific R. R. Co., proposing new line traversing southern portion of state, is reported planning expenditure of about $100,000 for surveys. Rollo E. Clapp, Salt Lake City, is Consulting Engineer. D. C. Collier, San Diego, Cal., is President.

Wisconsin:

Berlin, Wis.—Central Wisconsin Railway & Utility Co. has been granted certificate authorizing construction of railroad from Berlin, Green Lake County, through the villages of Redgranite and Lohrville, Waushara County, to the Badger Granite Quarry Co.'s plant in Waushara County, 10 miles long.

BIDS OPENED; CONTRACTS LET

Indiana:

Fort Wayne, Ind.—Rust Engineering Co., Pittsburgh, Pa., has been awarded contract by Pennsylvania R. R. for grading and masonry for track elevation at Wayne Trace crossing.

New York:

New York, N. Y.—Oscar Daniels Co., New York City, at $863,775, was awarded contract for Section 2 of Gravesend Ave. elevated railroad.

ROADS STREETS

BIDS ASKED.

Alabama:

Selma, Ala.—Until June 21, by County Board of Roads, for grading and graveling Barkersville Road 10 miles, also for grading and graveling 3½ miles in Blalock and Uniontown road.

District of Columbia:

Washington, D. C.—Until 11 a. m., June 5, by Depot Quartermaster, U. S. A., for resurfacing the Fort Myer Military roadway.

Colorado:

Fort Collins, Colo.—Until 11 a. m., June 8, by Nanny S. Murchison, County Clerk, for 2,400 ft. of road in Big Thompson Canyon, requiring 1,060 cu. yds. rock excavation, 1,875 cu. yds. earth excavation. Bids are also asked for distributing about 10,000 tons of gravel on state road No. 2.

Illinois:

Springfield, Ill.—Until 11 a. m., June 9, by State Highway Commission, Wm. W. Marr, Chief State Highway Engineer, for state aid work as follows: 2,200 ft. macadam in Union county; 600 ft. brick road in Bond county; 2,800 ft. brick road in Livingston county; 2,700 ft. concrete road in Kane county; and concrete bridges in Pulaski, Jasper and Scott counties. Advertisement in this issue.

Cicero, Ill.—Until 8 p. m., June 7, by Board of Local Improvements, Chas. Stoffel, Town Clerk, for paving South 60th Court and West 23rd st.

Chicago, Ill.—Until 11 a. m., June 9, by Board of Local Improvements, for 22 contracts for street improvements.

Chicago, Ill.—Until noon, June 9, by Commissioners of Lincoln Park, Geo. D. Crowley, Secretary, for repaving Diversey Parkway. Work includes about 2,520 sq. yds. of brick pavement.

Indiana:

Crown Point, Ind.—Until 1 p. m., June 9, by E. Simon, County Auditor, for several gravel roads.

Gary, Ind.—Until June 8, by Board of Works, for improving Massachusetts St., 19th to 20th aves.

Iowa:

Marshalltown, Ia.—Until 9 a. m., June 15, by J. J. Wilson, City Clerk, for paving 25 blocks of streets with concrete. W. H. Steiner, City Engineer.

Sheldon, Ia.—Until 8 p. m., June 9, by Scott Martin, City Clerk, for 13,500 sq. yds. of paving with brick, asphaltic concrete or Portland cement concrete. K. C. Gaynor, Engineer, Sioux City.

Kentucky:

Maysville, Ky.—Until 8 p. m., June 7, by Mayor J. Wesley Lee, for 38,000 sq. yds. brick paving and 19,500 ft. 6-in. concrete curb. W. L. Glazier, Engineer, Newport, Ky.

Covington, Ky.—Until 10 a. m., June 8, by J. B. Dillon, County Clerk, for 3 miles of 18-ft. wide concrete road.

Pineville, Ky.—Until June 5, by Bell County Fiscal Court, for the construction of about 20 miles of the main line of pike through the county from Middlesboro to the Knox County line; estimated cost, $70,000.

Maryland:

Rockville, Md.—Until noon, June 15, by B. E. Clark, Clerk County Commission, for 1.38 miles of state aid road.

Baltimore, Md.—Until noon, June 15, by State Road Commission, Wm. L. Marcy, secretary, for 4.4-mile section of state highway, to be constructed of concrete.

Massachusetts:

Holyoke, Mass.—Until 2 p. m., June 4, by Board of Public Works, for furnishing vitrified paving brick for 3,200 sq. yds. of pavement.

Minnesota:

Blue Earth, Minn.—Until 8 p. m., June 7, by City Clerk for paving work to cost about $50,000. Bids will be received on brick, creosoted blocks, asphaltic concrete, sheet asphalt, concrete, etc. E. T. Abbott, Engineer, 425 Kasota Block, Minneapolis.

Missouri:

St. Louis, Mo.—Until noon, June 7, by Jos. B. Thomas, Supply Commissioner, for furnishing creosoted wood paving blocks.

Kansas City, Mo.—Until 2 p. m., June 4, for concrete pavement on 75th St.

St. Louis Mo.—Until noon, June 11, by Board of Public Service, Wm. T. Findly, Secretary, for paving portions of Dalton Ave., Marcus Ave., Grand View Pl. and other streets with brick.

Kansas City, Mo.—Until 2 p. m., June 4, by Board of Public Works, for grading portions of 50th, 52d and Wyoming Sts.

Montana:

Hamilton, Mont.—Until June 7 by County Clerk for grading about a mile of road requiring about 5,000 cu. yds. of excavation.

Great Falls, Mont.—Until 8 p. m., June 8, by W. H. Harrison, City Clerk, for concrete pavement in alley.

Helena, Mont.—Until noon, June 10, by P. B. Snelson, Secretary Montana State Fair, for constructing driveway on fair grounds.

New York:

Binghamton, N. Y.—Until June 23 by Clerk Board of Contract & Supply for paving Glenwood Ave.

Albany, N. Y.—Until June 6 by Roscoe Irwin, collector of internal revenue for this district, for laying concrete sidewalks along the Broadway, State and Dean St. sides of the postoffice building.

Albany, N. Y.—Until 1 p. m., June 16, by State Commissioner of Highways, I. J. Morris, Secretary, for 21 contracts for improving roads covering about 70 miles.

North Carolina:

Bolivia, N. C.—Until noon, June 9, by Dr. E. G. Goodman, Chairman Road Commissioners, for 7 miles of sand-clay road. W. H. Banck, Engineer, Wilmington, N. C.

Ohio:

Columbus, O.—Until noon, June 15, by Geo. A. Borden, Director Public Service, for relocation of Grand Drive, in Franklin Park and grading and paving the same.

Grand View Heights, O.—Until noon, June 29, by Thos. G. Constable, Village Clerk, for improving Wyandotte Lane, Bluff Ave. to Fifth Ave., by grading and paving roadway with macadam and constructing curbs and gutters of concrete and sidewalks of concrete on both sides. Burgess & Long, Cols. Savings and Trust Bldg., Columbus, Engineers.

Grand View Heights, O.—Until noon, June 29, by Thos. G. Constable, Village Clerk, for grading, paving with macadam, constructing concrete curbs and gutters and concrete sidewalks on Lincoln Road, First to Third Aves. Burgess & Long, Engineers, Cols. Savings and Trust Bldg., Columbus.

Kenton, O.—Until noon, June 8, by G. S. Binckley, Clerk Public Service, for paving E. Franklin St. with asphaltum or other material.

Jefferson, O.—Until 1 p. m., June 7, by A. V. Hillyer, Clerk County Commissioners, for oiling (crude oil application) roads in Orwell Township.

Hamden, O.—Until noon, June 12, for paving 680 ft. of Railroad St. with brick.

Radnor, O.—Until noon, June 26, by Dr. T. K. Jones, Secretary Board of Education, for township high school building. W. R. Powell, architect, 1106 Hippodrome Bldg., Cleveland, O.

Cincinnati, O.—Until noon, June 7, by Philip Fosdick, Director Public Service, for paving Sycamore St. with wood block and granite pavement.

Tiffin, O.—Until July 25, by Director of Public Service, for 25,800 sq. yds. brick pavement on crushed stone or concrete base, 15,600

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Cost of Construction

EDITORS

H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Road Maintenance and the Road Engineer.

A road maintenance engineer is born not made and no ordinary amount of training will enable a man not endowed with a liking for detail and the ability to get along with men to succeed in competition with engineers so endowed. Conversely, a man lacking somewhat in engineering knowledge but endowed with these qualities and a love of his work will succeed in maintenance work. In substance this is the opinion of a road engineer of 20 years' experience in maintenance work and noted for the excellent condition of the roads under his care.

There are many elements of truth in the above statement. It must be remembered that successful road maintenance involves the efficient working of single men or isolated gangs that must not only be trained in the details of repair work but must be inspired to a love of such work by their superior that will lead to the close attention to small matters that is the fundamental principle of successful road maintenance. To that end it is essential that the road engineer have the good will of his men. To secure this no better policy can be pursued than impartiality as to the task to perform coupled with a personal knowledge of the character of each man that may be obtained best by cheerful personal contact. This knowledge gained, a respect and proper appreciation of the failings and good points of each man will lead to the good will of the men, without which successful maintenance work is hampered.

The failure of many engineers to recognize the qualities of human fellowship that foremen have developed through close contact with their men often loses for the engineer assistance of value. A road superintendent and a road engineer unless each has had much experience in the work of the other frequently make but one man. Each makes up for what the other lacks. Those counties in which this fact is recognized invariably have the most smooth running maintenance organization.

The distinction between road construction and road maintenance is well marked. The one deals with large works, the handling of many men and much material; the other has to do with numerous men isolated and each performing many varied tasks and with small quantities of material delivered and used at widely separated points. Construction works are conducted on a large scale at one point, maintenance works are conducted on a very small scale at many points.

Avoiding details for fear of obscuring the point to be emphasized we desire to call to the attention of engineers the importance of selecting for road maintenance work men fitted by natural endowment for the prosecution of such work. These are not necessarily men of great ability or wide training but men who love to complete a job in every detail and who have the gift of good fellowship.

Concerning Our Usage of the Term Capacity.

The word "capacity" is one of those seemingly magic terms which often appear to convey a meaning which they do not. Either the reader is misled, unknowingly, or he has suspicions that an attempt is being made to mislead him when such is not the case. Our present careless and often misuse of the term is such that considerable care must be exercised by one who desires to give a definite meaning to it. In trade catalogs, and in articles describing construction plant and performance, the term "capacity" has been used so loosely in the past that the average reader is apt to question the truth of any statement in which it appears, or at least mentally to make allowance for unstated conditions. Such a condition should not exist, and manufacturers and sellers of equipment will do much to restore confidence by carefully stating the conditions under which the rated capacity was, and may be, attained. Unless this is done the purchaser will often be disappointed in expecting unwarranted performance. For example, when a prospective buyer makes inquiry concerning a concrete mixer, what he generally wants to know is what type and size of machine will best do the work which he will demand of it—generally the first thing which the manufacturer tries to impress upon him is that *this* mixer has a greater capacity than any similar machine on the market. By the rated capacity the manufacturer often means that the mixer is capable of turning out (and there is a difference between "turning out" and "mixing") the stated yardage, provided every condition is favorable—which probably is never the case in practice. In some cases the buyer is largely at fault in that he does not explain his problems, but merely buys capacity—not knowing what he is buying. In most cases the manufacturer does not possess sufficient data to give authoritative information should he be questioned as to performance under conditions likely to be met in practice. Instead of studying carefully the individual needs of prospective buyers the manufacturer is rather inclined to try to sell a mixer of large rated capacity—in many cases larger than the user has need for.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

Again, we often hear it said that a certain plant is operating at, say, 75 per cent of its capacity. We generally accept such a statement without question and without realizing that it has little meaning to us. In most cases the person making the statement has no means of determining what the capacity of the plant really *is*. Possibly he knows its rated capacity at the time it was built—when the machinery was new and was supposed to be operated at its highest limit, although such operating conditions probably never did exist, due to unsatisfactory labor conditions. But what knowledge has he of its present capacity—when the machinery is old and worn, when parts of it have been replaced, and when operating conditions are entirely different. The actual capacity of a plant will depend upon a number of uncertain factors, such as available supply of unfinished materials, labor conditions, present condition of equipment, and facilities for handling and storing the finished product.

Examples of the uncertain use of the term "capacity" might be multiplied, but we believe those mentioned are sufficient to call attention to the need for a more accurate use of it. At least it is desirable that the conditions governing the determination of capacity be stated whenever the term is used in order that it may have some definite meaning. At the present time our loose usage of the term makes it exceedingly easy to create false impressions.

Testing of Materials and Inspection of Pavement Construction and the Consulting Engineer.

City engineers, as a rule, do not avail themselves of the services of consulting engineers to advise with them in the selection, testing and inspection of paving materials and in pavement construction to the extent that is desirable and profitable both to the municipality and to the city engineer. It is only fair to the city engineers as a class to say that this condition is not due to any holding back on their part. The average city council generally takes upon itself many of the functions of a consulting engineer—engineering "vox populi" as it were. The work of a city engineer is usually so largely of an executive nature that it is seldom he has the time to make studies as he would desire of some of the debatable questions that arise. Frequently also the assistants furnished him are not sufficiently experienced to carry out studies of this nature.

In large water supply, water purification or sanitation projects it is the quite general practice of municipalities to employ a consulting engineer; but upon street paving work that frequently in the aggregate involves a much larger expenditure, such engineering services are deemed unnecessary. Upon what line of reasoning is such a practice based? Failures in pavements certainly occur with much greater frequency than failures in other municipal works. Is this fact an argument for the employment of specialists in paving work? The answer is obvious.

It is undoubtedly true that the practice of employing experts on paving work is comparatively new. Also, in past years the services of the engineers of contracting paving companies were at the disposal of municipalities. Of late, however, except for concrete paving, these men have not been called upon as in former years. But even under the most advantageous conditions is it not better common sense to employ a consulting engineer engaged in a private practice the success of which is dependent upon the satisfactoriness of the work he supervises?

In the field of bituminous paving there exists a great need at the present time for expert advice. Much bituminous paving has been unsuccessful from the sole cause that a proper selection of material was not made and plant and surface inspection were faulty. The cost of the services of a consulting paving engineer is small when compared with the benefits derived.

Also such men are usually glad to instruct the city engineer in the details of plant inspection and surface laying to an extent that paving company engineers for very fair business reasons cannot go. For example, the comparative merits of competing brands of material may be clearly established by an engineer engaged in a private practice.

Under existing conditions the paving companies deserve the thanks of city officials and the profession for the services rendered by their staffs of engineers. These engineering staffs are maintained at no small expense to the companies. But the time has certainly arrived when engineers engaged in private practice should be employed for such work.

The Status of Scientific Management in the War and Navy Department Plants.

During the last session of Congress labor union interests were exceedingly active in attempting to secure legislation against the use of so-called scientific shop management methods in the navy yards, arsenals and other plants operated under the direction of the War and Navy Departments. The Taylor system has been in use at the Watertown arsenal for several years, during which time studies had been made of practically all work done at the arsenal. Based on data which have appeared from time to time in *The Iron Age*, the yearly premium paid at Watertown under this system amounts to about $45,000, and the management has accumulated a considerable number of data on the general run of work done at that plant. At the Frankfort arsenal time studies have never been made, but a premium system has been in operation, based upon what was considered to be a fair performance for one day. The recent reports of Gen. Crozier, chief of the Ordnance Bureau, have contained data which have strengthened the impression in favor of scientific management, and it was believed that the recent action of the Federal Industrial Relations Commission in undertaking an investigation of the subject would deter legislation at least until the commission should make its report. As the life of this commission terminates Aug. 1, 1916, it would, of course, be necessary to report before that date. This arrangement, however, was not satisfactory to the opponents of scientific management, and during the last session of Congress amendments were made to the army and navy appropriation bills substantially as follows:

> Provided, That no part of the appropriations made in this bill shall be available for the salary or pay of any officer, manager, superintendent, foreman, or other person having charge of the work of any employe of the United States government while making or causing to be made, with a stop watch or other time-measuring device, a time study of any job of any such employe between the starting and completion thereof or of the movements of any such employe while engaged upon such work; nor shall any part of the appropriations made in this bill be available to pay any premium or bonus or cash reward to any employe in addition to his regular wages, except for suggestions resulting in improvements or economy in the operation of any government plant; and no claim for services performed by any person while violating this proviso shall be allowed.

During discussion on this subject at that time scientific management systems were suspended at both the Watertown and Frankfort arsenals, to give the employes an opportunity to judge for themselves as to the value of such systems. On March 2, 1915, the House voted to prohibit the use of the so-called Taylor system in the navy yards of the country. The amendments to both the army and navy bills, which had been adopted in the House, however, were stricken out by the Senate, and the fate of the provision was left to the conference committees. Later, due to the fact that opposition to the provision might imperil the naval bill, the Senate at the closing hours of Congress yielded to the House and inserted the prohibition into the law. Soon after the conference report on the naval bill was adopted by both houses the Senate conferees on the army bill announced that they would no longer stand out against the bill, and that bill, carrying the House prohibition, was hastily reported and passed.

The prohibition in the army bill relates only to the use of funds carried by it, and as this measure does not become operative until July 1 one of the first acts of the chief of ordnance was to reinstate the time-study and premium system at the Watertown arsenal, which had been suspended during debate on the bill in Congress. As all premiums at the Watertown arsenal have been paid from funds provided by the annual fortifications appropriation bill, and due to the fact that this measure, carrying an increased sum for the fiscal year beginning July 1, was passed by Congress without any restriction as to the payment of premiums, it will be noted that the passage of the prohibition contained in the army bill becomes a dead letter, and it will not have the effect intended by its exponents. It is believed that the wording of the prohibition provision is such that it does not prevent the "routing" of work or the use of numerous other methods of scientific shop management. It does, however, prohibit a time study of a job "between the starting and completion thereof."

It is interesting to note that the Chamber of Commerce of the United States has recently announced that it will undertake a thorough investigation of the Taylor system of scientific shop management as operated in the plants under the supervision of the Ordnance Bureau at the Watertown and Frankfort arsenals. The investigation is to be conducted from the business man's standpoint and for the benefit of business men. The Chamber of Commerce has expressed the belief that the existing situation calls for prompt and vigorous action, not only in the interest of the Government, but on behalf of the manufacturers of the country, whose interests may be seriously affected should Congress enact a law forbidding the use of scientific shop systems in Government establishments. Efforts will be made to frame a report well in advance of the next meeting of Congress.

On account of the previous activity of labor unions, and due to the interest now being taken in scientific management by business men, it is probable that the next session of Congress will bring forth some important action on this subject.

Ultra-Conservatism and How to Expose It.

Between the extremist who is eager to adopt new things before trial has proved their defects and the extremist who is exceedingly loth to leave "the good old way," there is perhaps little to choose. Each acts in a manner not to be justified where economics is involved.

Ultra-conservatism is probably more predominant than we imagine, even in these times of progress. With difficulty can we now believe that only a dozen or so years ago several of the large railway systems in this country had no concrete masonry. The writer at that time had been studying the designs and methods of construction on the Pennsylvania Railway between Harrisburg and Philadelphia, where some $50,000,000 was being expended in line changes and other improvements. He had noted with surprise the absence of concrete. Stone masonry was everywhere in evidence, from small culverts to the huge arches that spanned the Susquehanna.

The writer asked the then chief engineer of the railway, the late Mr. Brown, why concrete had not been used.

"Young man, when you have reached my age you will have learned the wisdom of not adopting every new fad that springs up. We know that the Lord has made good stone, and we doubt man's ability to equal His."

The writer was prompted to suggest that some of the Lord's stone used in bridge abutments and walls on the New York Central Ry. had proved less durable than some of man's artificial stone used in culverts on the Erie Ry.

"That may be, but it only shows that the New York Central engineers didn't know how to distinguish the best from the poorest stone that the Almighty has provided."

The writer then asked Mr. Brown whether he would consider using concrete if it could be shown that after 40 or 50 years of service it still remained in sound condition.

"Yes, I might then consider it, but certainly not until at least such a life had been surely established."

Without now refreshing his memory by looking up the date of the first use of concrete in America, the writer believes that it was in the 60's. A paper long ago read before the American Society of Civil Engineers, describes the lining of certain stone arch culverts and tunnels with "beton coignet," or concrete. This concrete lining, the writer had found out, was then (1903) still sound after thirty odd years of service. In the tunnels it had been exposed to the severest test of acid fumes from locomotives. In the culverts it had been exposed to frosts and temperature stresses. Yet in both places it had resisted disintegration, although good stone masonry had not.

It seemed to the writer then, and it still seems, that the policy of the Pennsylvania and certain other railways as to the non-use of concrete was ultraconservative. Indeed it looked as if an *a priori* belief had actally prevented investigation of the age of concrete structures and their condition after the lapse of a long time.

Similarly, although not to such a pronounced degree, was the ultraconservatism of the engineers who advised the traction companies in New York City to install cable railways instead of trolley railways. When, in 1888, the writer saw cable railways replacing horse-car lines in New York City, he felt that an economic blunder was being made. The writer had come from the West, where, in many places, trolley lines were in successful operation. Upon the face of things it was evident that neither the first cost nor the operating expense of a cable line could be as low as that of a trolley line. Two arguments, however, were urged against the use of trolley lines in New York City. First, that nowhere had such means of transportation been long in use. Second, that even if usable in New York City a trolley system would involve underground conduits and not the overhead construction that had been used elsewhere.

It is not only interesting but profitable to review errors of judgment. Yet there are those who contend that from reviewing errors such as this or that, no profit can now arise, because the same conditions will never again confront engineers. That the *same* conditions will never exist, we may grant, but we may not grant that *similar* conditions will never exist. Spilt milk may be unrecoverable, but study of the cause of the spilling may lead to reduction of future spillings.

Hardly had cable railways been put into operation in New York City before it was resolved to displace the cable system with an underground trolley system. Why, we may well ask, were extensive experiments not made with underground trolleys before the cable system was installed? Had they been made, all the visions of short-circuiting due to water or snow in the conduits would have proved to have been groundless fears.

Why, indeed, was an underground trolley ever seriously considered? Overhead trolleys were clearly cheaper, and they had been used long enough to prove their merit. To the best of the writer's recollection, three objections were raised against overhead trolleys in New York City: (1) That the wires would interfere with the operations of the fire department—the raising of ladders, etc. (2) That broken trolley wires would endanger life. (3) That wires would be unsightly.

We see now how worthless each of these objections was, because in other large cities—Chicago, Philadelphia, etc., to say nothing of Brooklyn and other parts of New York City—it has been shown that none of these objections is at all serious.

To the objection as to unsightliness it might well have been replied that the signs over every store are vastly more unsightly than a trolley wire and its span wires. As for trolley poles, they could be almost entirely dispensed with by anchoring the span wires to buildings. And where poles were to be used, they could be at least as ornamental as the buildings that grace or disgrace the streets.

To the objection that broken wires would endanger life, the reply should have been: How many lives have been burned out in all the cities where trolleys have been used? And what has been the annual per cent of deaths from this cause? At once the *quantitative* answer would have made the *qualitative* objection look foolish. "Pins," it is said, "have saved many lives—by not swallowing them." So, trolley wires have saved all the lives that they might have taken—by not breaking.

As for the interference of trolley wires with the operations of a fire department, the most cursory study would have shown that even the dense masses of telephone and telegraph wires on poles in New York City had not appreciably interfered with the efficiency of the fire department, either in saving life or property. How much less, then, would be the interference from trolley wires.

Summing up, we see that *qualitative* objections were not met by *quantitative* data. And in the failure to do this we find the reason why New York City committed the colossal blunder of building, first, a cable railway system, and, second, a conduit trolley system.

Similarly many railways blundered in their failure to use concrete for stone masonry, because the objections to concrete were mere opinions unsupported by a quantitative analysis of facts.

Force the voice of the objector to utter numbers in place of words, and usually it will become dumb. Where it still remains strident, at least the objector's voice will utter things susceptible of some test of truth when it talks in figures rather than in those vaguer symbols of thought called qualitative words.

SEWERAGE AND SANITATION

Design, Construction and Cost of New Sanitary Sewer System at Carrollton, Ill.

Contributed by M. C. Poulsen, Field Engineer, Caldwell Engineering Co., Jacksonville, Ill.

About Sept. 1, 1913, the Board of Local Improvements of Carrollton, Ill., after being petitioned by the property owners, decided to start the proceedings for the construction of a sanitary sewer system, and the Caldwell Engineering Co. of Jacksonville, Ill., were appointed engineers.

Carrollton is a town of 2,300 population. It has no manufacturing industries of any kind, and is largely composed of retired farmers. It has had about the same population for the last 50 years; therefore, it was assumed that there would not be any marked increase in population in the very near future.

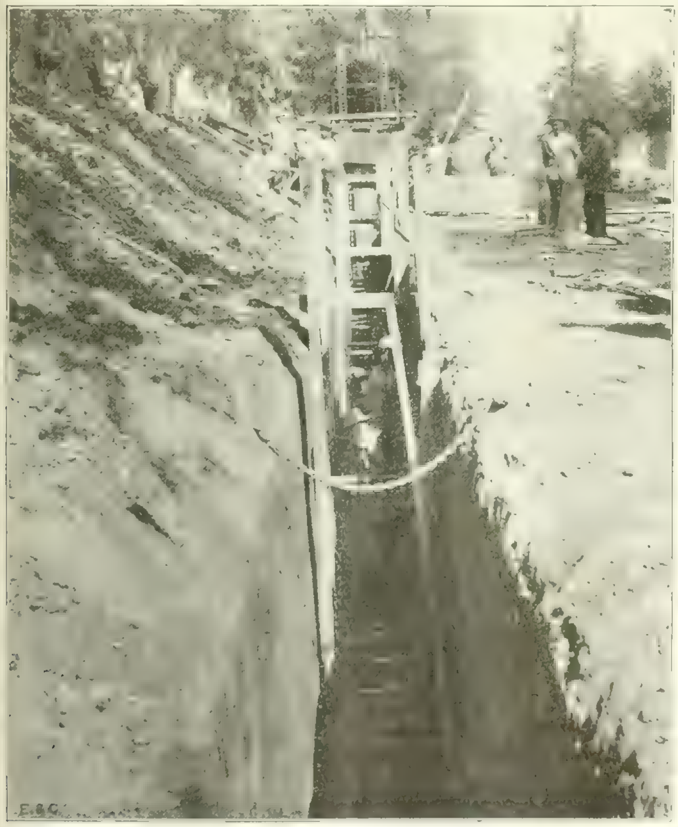


Fig. 1. View of Model "F" Parsons Steam Excavator Digging a 20-ft. Sewer Trench at Carrollton, Ill.

Fig. 2. View of Carrollton Sewer Trench as Backfilled—Before Rolling.

The center of the town is located on a high point from which the topography is sloping to all sides. Therefore, it was decided, because most economical, to divide the drainage of the town into two sections. One lateral, the outlet of which is a 12-in. pipe, takes care of the center and east part of the town; the other lateral, the outlet pipe of which is a 10-in. pipe, takes care of the west part of the town. The main sewer commencing at the junction of the two main laterals is a 16-in. pipe running into the south part of the town into a septic tank built on the bank of a small creek into which the tank empties.

Practically every street in town has a sewer line in it, ranging in size from 16 ins. to 6 ins., the majority being 8 ins. "Y" connections were left, one each way, every 60 ft., and where the cut was over 10.5 ft. they were brought up to within 7.5 ft. of the street surface. Manholes were placed at every street intersection and sometimes oftener where the distance was too great, placing them on an average of about 400 ft. apart. At dead ends where the grade was not too small lamp holes were constructed, but where the grade was too flat a lamp hole in connection with a flush tank was installed. There were two kinds of flush tanks constructed, a shallow design and standard design, the former being built of concrete and the latter of brick equipped with Miller syphons, and automatic regulators. The gradient of the sewer varies from 3 per cent to .1 per cent; the average grade is about .4 per cent. The average depth of sewer was 8.5 ft. and the deepest cut was 20 ft. Two thousand three hundred feet of the 10-in. pipe was laid at an average depth of 18 ft., which will account for the increase of excavating expense on the 10-in. line, given later on in this article.

The public hearing was held Feb. 2, 1914, and as there were no serious objections, the matter was taken through court without much delay. Bids were opened July 22, 1914, and the contract was awarded to Driscoll & O'Brien of Decatur, Ill., the same day.

Work was commenced by the contractors on Aug. 5, 1914, but actual excavating was started on Aug. 11 at noon with a "OO" Austin Trench Excavator at the outlet of the system working up the main sewer. On Aug. 19 a model "K" Parsons gasoline trench machine started on the work and from that time on there were two machines on the job until the work was completed. Later on the gas driven Parsons was exchanged for a model "F" steam Parsons excavator, which was able to dig a trench 20 ft. in depth, as shown in Fig. 1. The work was so arranged that this machine was kept on all the deep work. Fig. 2 shows the model "F" Parsons excavator on 20 ft. work and a "OO" Austin on 8 ft. work.

Grade and line stakes were set 3 ft. off center and 25 ft. apart. They were driven far enough in the ground so that they were not injured in any way by the wheels of the trench machine when passing over them. A small tack was driven into these stakes in a line parallel with the sewer line, thus serving two purposes: both that of grade and line control. Grade stakes were not set over one block ahead of the open ditch, thus lessening their chance of being disturbed.

The grade line was carried directly over the center line of the sewer supported every 25 ft. by a movable jack arrangement which was set at right angles to the ditch line and leveled on top of grade stakes. This jack was made out of a yellow pipe 4x4 in. 6 ft. long and in the center of which was nailed an upright 1x4-in. x 4 ft. long. Care was used to get this piece placed accurately at right angles to the horizontal 4x4 in. This upright was braced by means of a 1x4 in. nailed at an angle of 45° from 4x4 in. to upright on one side only, the other side being used to carry the grade line on. A tack was driven in 4x4 in. 3 ft. from grade line side of upright, which in setting jack was placed directly over tack in grade stake. Three jacks were always left standing when setting a new one thus making it feasible to detect any error that might have occurred in setting the grade line.

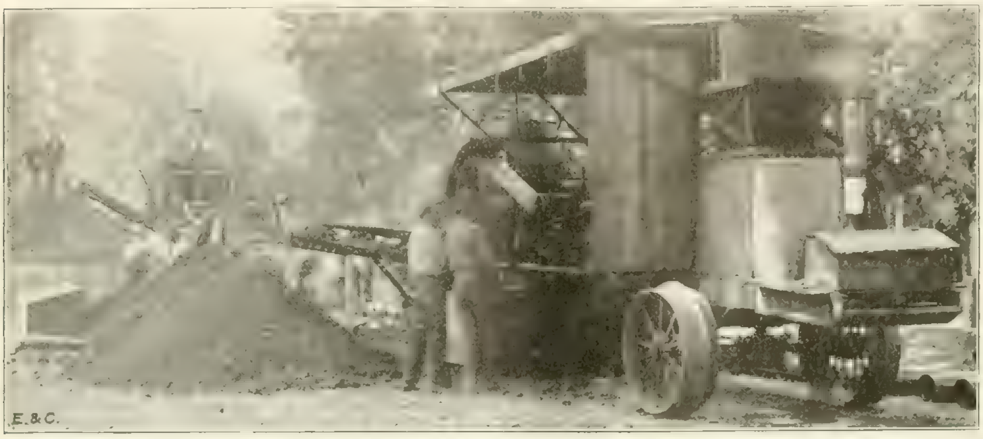


Fig. 3. View of Parsons "F" Excavator on 20-ft. Sewer Trench and Austin "00" on 8-ft. Trench at Carrollton, Ill.

Each pipe was graded with a grade rod and lined by letting a plumb bob down by the grade line over the top of the pipe. This method was found to give very good results as was shown at final inspection. Every joint was cemented very carefully with a mortar of a mixture of one part of cement and two parts of sand, water proofed with Ceresit Water Proofing Compound mixed in the proportion of 12 parts of water to 1 part of Ceresit. The most satisfactory method of applying the cement to the joints was with the hands using rubber gloves. Each joint was carefully wiped by drawing a swab through the pipe as each successive pipe was laid.

The waterproofing of mortar together with very careful joint cementing kept the infiltration of the whole system of 8⅓ miles down very low. At the time of completion and just after a rain it was found that the infiltration amounted to less than 4,000 gals. per 24 hours.

The backfilling was hand tamped for 1 ft. above all the pipe and settled with water tamping after being filled up to within 1 ft. of street surface, except in work over 10 ft. in depth in which case it was water tamped twice. All remaining dirt was crowned neatly over top of trench as shown in Fig. 3, and then a 20 ton steam traction engine with a 24-in. wheel was run with one wheel over center of trench. The engine drew a road grader behind thus putting the street into immediate shape for use in as good condition as it was formerly and in many cases better, as shown in Fig. 4.

About one-half mile of sewer was laid in a macadam street. The rock was torn up along the trench line by means of a rooter drawn by a steam traction engine and then scraped to one side. The sewer was then laid and trench properly backfilled and settled by water tamping and rolled and the rock was replaced.

A septic tank was also built at the outlet 30 ft., by 65 ft. over all, consisting of inlet and outlet chambers and two separate chambers in main body of the tank supplied with baffles and crosswalls covered with reinforced concrete roof.

COST DATA.

The following are some of the cost data kept by the writer on this work:

Item.	Unit cost.
16-in. pipe—	
Cost of hauling, per ft.	$0.03
Cost of digging, per ft.	0.17
Cost of laying, per ft.	0.07
Cost of back fill, per ft.	0.07
Cost of mortar joint, per ft.	0.01
Cost of Ceresit, per ft.	0.006
Cost of pipe, per ft.	0.375
Cost of "Y's," per ft.	0.06
Total cost per ft.	$0.79
12-in. pipe—	
Cost of hauling, per ft.	$0.015
Cost of digging, per ft.	0.150
Cost of laying, per ft.	0.100
Cost of back fill, per ft.	0.06
Cost of mortar joint, per ft.	0.004
Cost of Ceresit, per ft.	0.005
Cost of pipe, per ft.	0.22
Cost of "Y's," per ft.	0.03
Total cost per ft.	$0.584
10-in. pipe—	
Cost of hauling, per ft.	$0.015
Cost of digging, per ft.	0.26
Cost of laying, per ft.	0.07
Cost of back fill, per ft.	0.14
Cost of mortar joint, per ft.	0.003
Cost of Ceresit, per ft.	0.004
Cost of pipe, per ft.	0.175
Cost of "Y's," per ft.	0.025
Total cost per ft.	$0.692
8-in. pipe—	
Cost of hauling, per ft.	$0.01
Cost of digging, per ft.	0.08
Cost of laying, per ft.	0.06
Cost of back fill, per ft.	0.04
Cost of mortar joint, per ft.	0.002
Cost of Ceresit, per ft.	0.002
Cost of pipe, per ft.	0.135
Cost of "Y's," per ft.	0.02
Total cost per ft.	$0.349
6-in. pipe—	
Cost of hauling, per ft.	$0.01
Cost of digging, per ft.	0.08
Cost of laying, per ft.	0.065
Cost of back fill, per ft.	0.04
Cost of mortar joint, per ft.	0.001
Cost of Ceresit, per ft.	0.002
Cost of pipe, per ft.	0.08
Cost of "Y's," per ft.	0.01
Total cost per ft.	$0.288

All excavating was machine work except about 700 ft. averaging about 9 ft. in depth which was excavated by hand labor. The work was rushed from the start to finish although very carefully done. Everything was completed and ready for final inspection just 14 weeks after the first earth was excavated The work was started Aug. 11, 1914 and finished Nov. 25, 1914. No work was done on Sunday and rain stopped work about two weeks during this period, thus making the actual working time on this contract 12 weeks. Final inspection of pipe lines was made Nov. 19, 1914. The light test was made on every stretch of sewer line and was plainly seen circular in appearance through every line of sewer in the whole system.

The construction of this sewer system was superintended by the writer for the Caldwell Engineering Co., Jacksonville, Illinois.

Devices and Methods Used in Various Localities in Measuring the Flow of Sewage.

(Staff Abstract.)

Gaging the flow of sewage is becoming more commonly practiced as one of the steps preparatory to the design of new relief or intercepting sewers and the design of sewage treatment works. The measures adopted in several localities in sewer gaging are here described.

Massachusetts State Board of Health.—The Massachusetts State Board of Health uses a comparatively simple and inexpensive type of recording gage. It is described substantially as follows by Edward Wright, Jr.

The gage is used mainly for measuring sewage at disposal works where the sewage passes over a weir, although it has been used somewhat in the measurement of stream flow and in the measurement of the flow of trades wastes where it is possible to install weirs.

The gage, Fig. 1, consists of a copper float to which a rod and pencil are attached, and a cylindrical drum, which is caused to revolve by an ordinary clock mechanism. The float rod engages in two brackets which are provided with roller bearings. The paper upon which the diagram is indicated is wrapped around the drum and held in place by pins at the top and bottom and by rubber bands, and the elevation of the starting point in relation to the crest of the weir is obtained by means of a hook gage. The actual head on the weir is indicated.

The moving parts of the gage are constructed of brass, and while corrosion starts in very rapidly, the gage is so constructed that little or no difficulty ensues from this cause in its operation. The clock is so constructed as to run seven or eight days, and except when weather conditions interfere, the gage will run without attention for this length of time.

Fig. 4. View of Carrollton Sewer Trench as Backfilled—After Rolling.

Owing to the great amount of moisture which at times rises from the sewage in the tanks where the gage has been used, it has been found that it was impossible to produce a pen-and-ink diagram, and, in fact, the moisture rising at certain sewage disposal works has been so great that the paper would be torn by the pencil, and to overcome this the very best quality of paper has been used.

The most remarkable feature about this gage is that its cost exclusive of the weir is only about $25 or $30, which includes about $4 for the clock mechanism.

The gage is very sensitive and, in fact, the effect of matters rising with gas in the sewage in the measuring tanks under the float has frequently been indicated. The greatest cause for inaccuracy is due to the floating matters in the sewage, which displace the float and tend to clog the weir.

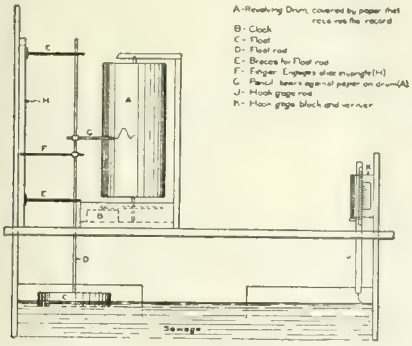

A-Revolving Drum, covered by paper that receives the record
B- Clock
C- Float
D- Float rod
E- Braces for Float rod
F- Finger Engages slide in upright (H)
G- Pencil bears against paper on drum (A)
J- Hook gage rod
K- Hook gage block and vernier
A
B
C
D
E
E
F
G
H
K
Sewage

Fig. 1. Sketch of Automatic Gage Used for Recording Heads on Weirs, by Massachusetts State Board of Health, in Measuring Flow in Sewers.

Marlboro, Mass.—The flow of sewage at the sewage disposal works at Marlboro, Mass., is measured by means of a trapezoidal or Cippoletti weir, placed in a channel leading to the sedimentation tanks. The sewage enters the screen chamber through a long cast-iron pipe siphon, passes through a coarse bar screen, and along a channel 7 ft. wide, to the trapezoidal weir, as shown in Fig. 2. The crest of this weir is 2 ft. long and the sides have a batter of 1 in 4. The crest of the weir is set 18 ins. above the floor of the channel. The weir itself is made up of 6-in. by 3½-in. by ½-in. steel angles bolted together and set in concrete. The inner edge or crest is planed to a true, sharp edge. The depth of flow over the weir is measured either directly by hook gage or rule, or by means of a recording gage of the Bristol type. This description is by Frank A. Marston.

The original plan provided a cast-iron pipe well, with connection to the channel a few feet above the weir, in which the diaphragm was suspended. The recording gage was fastened to the wall of the screen house. After operating the plant for several months it was found that considerable sludge and scum collected in the diaphragm well and proved to be objectionable, although it may not have had any serious effect on the diaphragm or on the operation of the recording gage. Because of this collection of scum the diaphragm was removed from the well and was suspended in the channel itself, which arrangement has proved more satisfactory.

The average depth of flow is obtained from the circular chart by the use of a circular planimeter, and the quantity discharged by the trapezoidal weir is computed from the following formula:

$$Q = 3.366\tfrac{2}{3}\, L\, h^{3/2}.$$

Q = quantity in cu. ft. per second.
L = length of crest of weir = 2 ft.
h = head on crest in feet.

There was considered, in the design of the plant, the possibility of using a Venturi meter or some other form of measuring apparatus which would obviate the necessity of constructing an open channel with its attendant difficulties due to the deposition of solid matter, but it was felt that the city would not be justified in going to additional expense for this purpose.

The trapezoidal form of weir was chosen because of the great variation in flow to be measured. During dry weather single daily flows have been recorded as low as 150,000 gallons per twenty-four hours, and during the spring flow has reached as high as 2,300,000 gals. per twenty-four hours for a single day.

In studying the operation of the plant, it was found desirable to know the number of doses discharged by the automatic siphon from the dosing tank each day, and to obtain this information Mr. George A. Stacy, the superintendent, installed another Bristol gage in the dosing tank. This new gage has operated in a more satisfactory manner than the other, perhaps partly due to the fact that the diaphragm is immersed in settled sewage. The charts obtained from this new gage have been satisfactory and of considerable value.

They show the rise and fall of the sewage level in the dosing tank, and are used not only as a check on the quantity of sewage, but especially to determine the quantity applied to the various filter beds.

After about one year's service, a new rubber diaphragm was installed in the screen chamber gage. The old diaphragm appeared to have been attacked by something in the sewage, possibly sulphides, which partially rotted the rubber.

From the beginning of the operation of the recording gage in the screen chamber, the attendant has kept daily readings of the depth of flow over the weir, measured directly at a point a short distance above the weir. The attendant was instructed to take these measurements at approximately 4 o'clock each afternoon, and from the data thus obtained it has been possible to check the readings of the recording gage and to fill in the records for the periods that the gage was out of commission.

A number of daily records were selected as being representative of the variations in flow, and from these a curve was plotted showing approximately the percentage which the 4 o'clock p. m. rate of flow is of the average for the entire day for varying rates of flow. By means of this curve the average daily flow was estimated, having as a basis a single measurement made at 4 o'clock in the afternoon. The results have been reasonably close and furnished a fair check on the working of the gate. The Marlboro sewerage system is largely on the separate plan, so that the variation in flow of sewage through the day is quite regular for certain average flows.

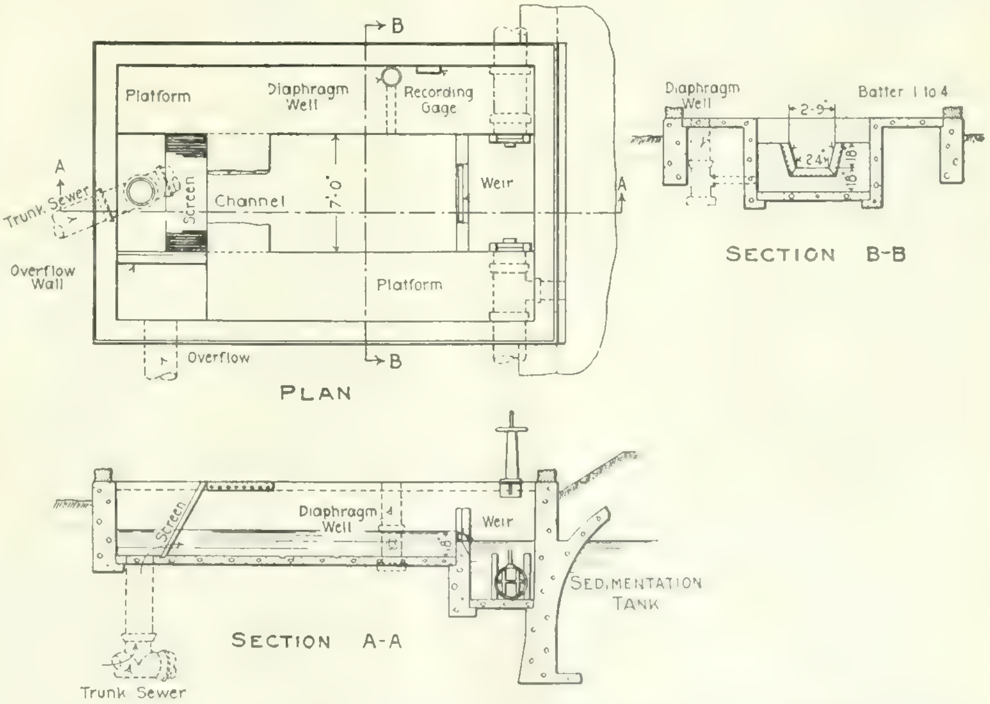


Fig. 2. Design for Arrangement of Weir and Other Apparatus Used in Measuring Flow of Sewage at Marlboro, Mass.

The experience with this type of recording gage at Marlboro, although somewhat adverse, is not of a sufficiently serious nature to prevent the gage being used in other places. The experience seems to point out, however, that it is very important that the gage be thoroughly tested at the factory before it is installed, and that every precaution be taken to make sure that the tube connecting the diaphragm with the recording gage be absolutely air tight. It is also of advantage to have the diaphragm immersed in as nearly clear water as possible, although the gage has operated successfully in what might be called thick sludge. Apparently septic sewage has some action on the rubber of the diaphragm, requiring its renewal perhaps once a year, but this can be easily done by a man of average mechanical ability and should not be a source of serious trouble. Where a slight leak does occur in the pressure tube or in some other part of the mechanism, it is exceedingly hard to locate and much harder to remedy. On the whole, the records obtained in Marlboro have been very valuable, and experience seems to justify this type of instrument as against a more expensive type, under the conditions at this particular plant.

Providence, R. I.—Some time ago Mr. Frank B. Sanborn had occasion to install a recording gage for measuring the flow of the sewage of the city of Providence and some features of the installation, here described, are somewhat unusual.

The flow of sewage is about 24,000,000 gals. per day, about one-tenth of which comes from a gravity system, the remainder being lifted 27 ft. at a point about 2,000 ft. from the disposal works.

The pumping plant consists of three Holly engines, each of which is connected with two centrifugal pumps, whose combined capacity is 43 million gallons per day.

The large size of these units necessitates a system of intermittent pumping during periods of small flow, as at night, or on Sunday, the sewage at such times being allowed to rise to a certain height in the large sewer leading to the pumping station, when the pumps are started, and operated until a certain low level is reached.

The discharge from the pumps, together with that from the gravity system, flows through an 88-in. conduit into a semi-circular open mixing channel, 150 ft. long and 16 ft. wide. In this channel are placed 20 slate baffles, set 6 ft. apart on alternate sides, and projecting 6 ins. beyond the center line of the channel. From this channel the sewage flows directly to the four large sedimentation tanks.

Briefly, the conditions to be met were as follows:

The location of the weir was limited to the mixing channel, in which the baffles caused a very great agitation of the sewage.

The weir must be higher than the level of the sewage in the tanks, to be independent of variations in the method of operation.

It must be as low as possible, to avoid increasing the work of the pumps.

The opening of the weir must be sufficient to accommodate a flow of 120 million gallons per day.

The recording device must give an accurate record of the flow, without being so delicate as to be disturbed by momentary variations in height, due to currents in the mixing channel.

Owing to the sudden fluctuations caused by starting and stopping the pumps, the chart must be in terms of volume rather than of height, so that the total flow per day could be determined by the use of the planimeter.

Since the weir would not correspond to the requirements of any formula, the actual flow must be determined by experiment.

A location was chosen at the last baffle in the mixing channel, and a 10-ft. rectangular weir was placed at this point, having its crest 9 ins. above the level of the sewage in the tanks, and 1 in. above the top of the baffle.

This greatly reduced the agitation in the mixing channel, but it was thought that the fall over the weir would give as good results as the former flow through the baffles.

By placing the weir at this location and height, no change was made in the conditions at the mouth of the 88-in. conduit leading from the pumps.

At a point 12 ft. up-stream a 3-in. pipe was built into the wall of the channel, 3 ins. lower than the crest of the weir. This pipe was carried into a large manhole, and another pipe was laid from the manhole to a 12-in. standpipe. The large amount of water in the manhole prevented the making of a wide line on the chart, due to momentary fluctuations in height.

The weir was then calibrated by experiment, the flow being measured in the various tanks of the plant, while observations were made of the height at the weir.

Points were thus obtained at rates varying from two million to 75 million gallons per day, and a curve was plotted to show the flow at any given height.

The recording instrument selected was the weir-gage made by the Hydro Manufacturing Company of Philadelphia. This instrument was intended to record height directly, and in order to get a record in terms of volume, the usual device was employed, of introducing, between the float and the recording pen, a cam or spiral which should be designed according to the formula for this weir. An 8-in. float was placed in the standpipe, and connected by a cord to a counter-weighted drum, having a diameter of 5 ins.

On one end of this drum was fastened a sheet-iron disk, 30 ins. in diameter, and on the surface of this disk, raised on blocks ½ in. high, was placed a brass track, whose curve was such that the distance from the center increased one-tenth of an inch for each million-gallon increase in the rate of flow.

On this track was made to travel a small wheel, whose axle was attached to the lower end of a vertical rod, on the upper end of which was fastened the pen-carriage of the recording device. By this means a chart was obtained which could be reduced to gallons per day by the use of an ordinary planimeter. After the device was in place it was repeatedly checked in amounts up to 7,000,000 gals., by actual measurement in the sedimentation tanks.

Newton, Mass.—The engineering department of Newton, Mass., maintained sewer gaging apparatus at three of the connections of its sanitary sewer system with the Metropolitan trunk sewer near the Charles River for a period of about a year during 1902 and 1903. These gages are described as follows by Edwin H. Rogers:

The gages were in the form of a weir, with apparatus to measure the depth of flow, consisting of a float and a connection therefrom which registered the rise and fall of the sewage on a perpendicular revolving drum operated by clockwork. No reduction gear was used, the actual rise and fall being recorded. The drums revolved once a week, requiring the renewal of the record chart every seven days.

The weirs were located in manholes of the sanitary sewers, and as their crests were raised from 1 to 2 ft. above the invert of the sewers, they proved more or less of an obstacle to the discharge of the solid matter in the sewage, retaining a considerable amount of sludge which had to be frequently removed.

Considerable difficulty was experienced in the maintenance of the clocks, principally on account of the dampness which rusted out the hair-springs in their escapements and also tended to promote the growth of mildew in the works in such quantities as to stop them within a month, even though they were entirely enclosed in brass boxes.

The results obtained were in the main satisfactory, owing principally to the care exercised to keep the apparatus in suitable working condition.

In 1906 to 1908 attempts were made by the department to record the flow in three of the main surface drains of its separate sewer system for the purpose of obtaining data relative to the run-off of storm water. In one drain a weir was constructed with automatic registering apparatus, but was a failure, owing to the sand and other wash from the streets interfering with the operation of the apparatus.

In another instance a float was installed in a chamber beside the drain and connected with the invert of the drain by an inverted siphon.

Owing to the amount of rise and fall of the flow it was necessary to use reduction apparatus between the float and the register chart.

This method of measuring the flow could not be considered a success, partly on account of the pipe connection between the drain and the chamber being clogged with sand and other materials, and partly from the difficulty of calibrating the chart for different depths of flow in the drain. The drain was laid on a 3 per cent grade and the flow through it caused apparent fluctuations in the float chamber which vitiated the attempts to obtain accurate records.

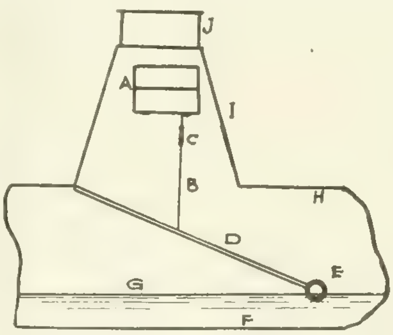


Fig. 3. Arrangement of Apparatus for Measuring Flow in Sewer at Brooklyn, N. Y.

The third installation consisted of a float in a 12-ft. by 6-ft. drain, connected by reduction gear with a clockwork recording dial. It was found advisable to use a boat-shaped float of 4-in. plank, some 18 ins. wide and 8 ft. long, hinged by a 10-ft. rod to the top of the drain, which floated smoothly and did not collect rubbish. The clockwork was housed without the drain in the open air, thus avoiding difficulty in its maintenance. This apparatus was in operation with fairly successful results for several months.

A self-registering rain gage was maintained in conjunction with these gagings of the drains.

The element of time being an important factor in the derivation of run-off data, it is important that the clocks in the apparatus be closely synchronized, a serious problem, owing to environment and climatic changes, unless a system of electric clocks is employed.

After a considerable sum of money had been expended, it was decided that the results obtained did not appear to justify the further expense of maintenance and operation and the gagings were discontinued.

BROOKLYN, N. Y.

Various methods have been employed for the measurement of the flow in Brooklyn sewers, and these methods are here described by Edwin J. Fort.

Of the several methods employed at Brooklyn the most successful have been the use of the self-recording water stage register and the knife-edge weir.

The self-recording water stage register referred to may be used in all sizes of sewers for domestic flow or storm water run-off. In using this method the hydraulic gradient of the flow is obtained by observation and measurement, as is also the cross-sectional area of the sewer for the depth of flow observed. The value of n, in Kutter's formula, is determined mainly by the exercise of judgment on the part of an experienced observer, in the absence of experimental data. Kutter's formula for velocity is then applied and by this means the quantity of flow is obtained.

Weir measurements are used in exceptional cases, especially where the entire flow of a drainage area or district can be weired in the out-fall trunk sewer.

The gage and weir, the description of which follows, have been used in experimental work of this character in a number of drainage areas in this borough, and the results have been quite satisfactory.

Objection may be made that such an estimation of the value of n is liable to considerable error and a resulting error in the volume of run-off, but even if this were true (of course the greatest care should be taken to estimate the value of n as correctly as our available information permits), the same value is also used in designing sewers, so that any such error would be compensated in the final result.

Self-Recording Sewer Gages at Brooklyn—The equipment used to measure the flow in sewers from the run-off produced by rainfall, consists of two Frieze self-registering water stage registers, and one vertical drum sewer gage designed by this bureau. Vertical flood sticks or maximum depth of water gages are also used to determine the maximum flood wave for a given storm.

Figure 3 shows diagrammatically: (A) A water stage register placed on a shelf in an indicated manhole; (B) a copper ribbon passing over the transmission gear of the register; (C) a lead counter-weight attached to one end of the ribbon to keep it in tension so that the motion of the float arm will be transmitted to the recording device; (D) an adjustable float arm to which the other end of the ribbon is attached; (E) a copper ball float; (F) represents the inner bottom of a 42-in. sewer; (G) the normal flow line; (H) the inner top of sewer; (I) the manhole and (J) the head.

The gages are calibrated by raising the float 0.5 ft. at a time, and noting the value of the movement on the recording device. In this way calibration curves and scales are drawn.

When installing a gage, the sewer in which it is to be placed is carefully measured, and a curve plotted showing the value of Q for all depths of flow. The gage is then placed in position, the ribbon attached to the float arm and counter-weight, a blank record placed on the drum and the pen inked and pressed down on the record ready for recording. The ball float is then placed 0.5 ft. from the bottom of the sewer, the position of the pen and the elevation of the float ball being recorded on the blank record; the float ball is raised 0.5 ft. more and the new position of the pen and elevation of the float recorded. This operation is repeated until the float ball has reached the inner top of the sewer. The elevations are then corrected for the depth of water required to float the ball. By comparing this record with the Q curve, a scale is made so that it will give the value of Q for any position of the pen on the record.

The height of a flood wave is shown on a well sanded vertical flood stick by the sand being washed off as high as the water rises. This gives a very sharp line for the height of the wave and is of advantage in determining the slope.

Weir Gaging at Brooklyn.—The use of the weir is well illustrated by a concrete example; one of our problems was to determine the infiltration and the maximum and minimum flow of sewage for a large district, the population of which was about 177,671.

To obtain the desired information a weir was used, and the flow automatically gaged during the entire day and night for each day of the week.

The weir used was located in the out-fall sewer, or outlet flume, and belonged to the sharp-crested type, with end contractions suppressed. The crest length measured 25.84 ft. and the height 2.17 ft. The head on the crest when not affected by storm or snow water varied from .362 ft. at 4:30 a. m. on Fridays to .543 ft. at 3:05 p. m. on Tuesdays.

The device for recording the heads consisted of an automatic water stage register placed over a "basin" pit located just outside of the channel and about 16 ft. up-stream from the weir crest. The pit was connected with the flume by means of a 3-in. iron pipe 3 ft. long, laid on the floor and perpendicular to the side of the approaching channel. The zero for the register was determined by means of a hook gage and a Y level. The correction for slack motion of the register was determined by the hook gage to be ½ of 1 per cent.

Bazin's formula, $Q = MLD\sqrt{2GD}$, for suppressed weirs with velocity of approach, was used to plot the results of the investigation. It is suggested, however, that Hamilton Smith's formula, $Q = 3.29\,LH^{3/2}$, for weirs of great lengths, may give more accurate results.

The total mean flow for 24 hours as indicated by the gage records was 18,123,000 gals. The total amount of water supplied to the district gage according to information received from the Water Department was 17,767,000 gals. Total amount of ground water (infiltration) per day, 356,000 gals.

ACKNOWLEDGMENT

The foregoing description of methods and apparatus for measuring the flow of sewage is taken from a discussion on this subject before the Boston Society of Civil Engineers as published in Vol. 1 No. 8 of the Journal of the Society.

ROADS AND STREETS

Road Maintenance Costs in Monroe County; New York State Highways.

(Staff Abstract.)

At the time this article is written the work of the New York State Commission of Highways is carried out under nine divisions. At the head of each division is a Division Engineer. Under the Division Engineer there are two departments, *i. e.*, construction and maintenance, in charge of the Resident Engineer and Superintendent of Maintenance, respectively. To each county, or part of county, where the mileage of improved roads is very large, the maintenance work is supervised by an engineer who reports to the Superintendent. Division 7 with headquarters at Rochester is composed of six counties—Monroe, Wyoming, Livingston, Orleans, Ontario and Genesee. Monroe County with its 220.19 miles of completed state and county highways in 1914 was divided into two sections, east and west of the Genesee River. This article has to do only with the costs of a portion of the maintenance work done during the past year in eastern Monroe County. The road numbers as shown in tables are arbitrary and have no connection with those given by the Commission.

In this territory in 1914 there were 99.303 miles of completed road of the following types of construction:

	Miles.
Waterbound macadam	14.591
Oiled waterbound macadam	41.380
Bituminous macadam	*27.149
Amiesite pavement	1.060
Asphaltic concrete	9.940
Concrete-bituminous top	4.250
Rock asphalt	0.990
Total	99.303

*Includes 1.45 miles of mixing method, Type 2, N. Y. State specifications.

There were built during the year 8.64 miles of road, all of which will come under maintenance in 1915, as follows:

	Miles.
Waterbound macadam	*1.03
Oiled waterbound macadam	6.30
Brick	1.31
Total	8.64

*Accepted and turned over to Maintenance Department in September, 1914. Some work done upon same by Maintenance Department. Included in list of completed roads above.

TABLE I.—APPLICATION BY CONTRACT OF HIGH CARBON TAR—COLD APPLICATION.

Repair Contract No.	Road No.	Bid Prices: Stone, ton.	Bid Prices: Cleaning old macadam, sq. yd.	Bid Prices: Bituminous material, gal.*	Bid Prices: Restoring shoulders and ditches, lin. ft.	Cost Per Mile: Oil and manipulation, including cover.	Cost Per Mile: Cover.	Cost Per Mile: Total.	Cost Per Sq. Yd.: Oil and manipulation, including cover.	Cost Per Sq. Yd.: Cover.	Cost Per Sq. Yd.: Total.	Amount bit. mat. per sq. yd.	No. sq. yds.	Average haul, miles.	Kind of cover.
A	1	$3.00	$0.001	$0.10	$0.02	$252.48	$453.57	$706.05	$0.0357	$0.0674	$0.1031	[illegible]	40,[illegible]34	4.00	Imported limestone dustless screenings.
B	2 3 4	2.80	.001	.095	.	311.52	548.57	860.09	.0336	.0580	.0916	[illegible]	58,582	4.00	Imported limestone dustless screenings.

*Item includes furnishing and applying bituminous material, and applying cover.

TABLE II.—APPLICATION OF LIGHT COAT OF BITUMINOUS MATERIAL BY CONTRACT.—COVERED BY DEPARTMENT.

Repair Contract No.	Road No.	Cost Per Mile: Oil and manipulation.*	Cost Per Mile: Manipulation, cover.	Cost Per Mile: Cover.	Cost Per Mile: Total.	Cost Per Sq. Yd.: Oil and manipulation	Cost Per Sq. Yd.: Manipulation, cover.	Cost Per Sq. Yd.: Cover.	Cost Per Sq. Yd.: Total.	Amount of bit. mat. per sq. yd.	Sq. yds.	Average haul, miles.	Kind of cover.	Kind of bit. mat.
C	5	$220.01	$14.76	$48.40	$282.17	$0.0220	$0.0014	$0.0052	$0.0286	.25	33,844	2.80	Local sand.	Low carbon tar cold application.
	6	220.01	21.27	128.15	369.43	.0220	.0020	.0120	.0360	.25	50,840	1.90	Imported plain limestone screenings.	
	7	220.01	21.61	66.17	307.79	.0220	.0028	.0088	.0336		30,880	1.45	Imported plain limestone screenings	
D	8	258.12	23.12	50.75	331.99	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.66	Local sand	High carbon tar cold application.
	9	258.12	6.35	11.10	305.87	[illegible]	.0007	.0048	[illegible]	.25	[illegible]	1.00	Local sand	

*Item includes sweeping road; furnishing and applying bituminous material.

TABLE III.—APPLICATION OF BITUMINOUS MATERIAL AND COVER BY DEPARTMENT.

Road No.	Miles.	Aver. haul, mi.	Sq. yd.	Cover: Kind	Cover: Tons per mile	Cover: Total tons	Bituminous material: Kind	Bituminous material: Amt. per sq. yd.	Bituminous material: Total gals.	Cost per mile: Bit. mat.	Cost per mile: Manip.	Cost per mile: Cover	Cost per mile: Incid.	Cost per mile: Tot.	Cost per sq. yd.: Bit. mat.	Cost per sq. yd.: Manip.	Cost per sq. yd.: Cover	Cost per sq. yd.: Incid.	Cost per sq. yd.: Total
10	3.165	2.00	29,76[illegible]	Impt. limestone dustless scr'gs	135	429.8	High carbon tar, cold application	.30	9,124	$191	$67	$2[illegible]	$7	$[illegible]	[illegible]	[illegible]	$0.011	[illegible]	$0.06[illegible]
11	1.030	3.25	9,650	"	19	[illegible]	" and cold oil	.25	2,511	[illegible]	73	21[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.02[illegible]		.049
12	2.430	2.75	22,400	Impt. limestone plain scr'ings	42	102.06	High carbon tar, cold application	.25	[illegible],711	[illegible]	[illegible]	96	[illegible]	[illegible]	[illegible]	.007	.011	[illegible]	.036
13	1.800	3.00	16,670	"	40	[illegible]	"	.25	4,255	[illegible]	61	[illegible]		[illegible]	[illegible]	.011	.010	.	.038

Cost of labor. Foreman, 30 cts. per hour. Laborers, 25 cts. per hour. Team, [illegible]

[1] High cost due to use of maintenance tar costing .096 cents per gal.

[2] Oil in barrels

[3] Cover picked up from Road No. 10 and hauled by auto truck onto Road No. 11. Average haul 3¼ miles

[4] High cost due to long, hard hauls of oil distributor from tank car to road

Cost of bituminous material f. o. b. delivery point, per gal.

Road 10	$0.066
Road 11	[illegible] (Tar)
Road 12	[illegible]
Road 13	[illegible]

The maintenance work in the field is done both by contract and by payroll system directly by the Department. The latter includes minor repairs by the patrolmen and more extensive repairs by organized gangs. Each patrolman supplies himself with a horse and cart and necessary small tools and is provided with bituminous material and stone. His duties comprise the making of small patch repairs to the pavement; the cleaning of ditches and culverts; the mowing of weeds and grass along the highways and around the guard rail and culverts; and the general inspection of his beat. The average cost of the salaries of such men was $67.00 per mile in 1914.

TABLE IV.—COST OF SCRAPING SHOULDERS.

Road.	Miles.	Total cost.	Total cost. Labor.	Total cost. Team.	Av. cost per mile. Total.	Av. cost per mile. Labor.	Av. cost per mile. Team.	Remarks.
14	3.165	$ 88.03	$ 56.25	$ 31.78	28	18	10	No material hauled away.
15	3.306	87.25	62.25	25.00	26	19	7	No material hauled away.
16	2.430	137.50	100.00	37.50	57	42	15	All material hauled away.[1]
17	1.819	47.00	42.00	5.00	26	23	3	No material hauled away.
18	4.019	157.50	102.00	55.50	39	25	14	30 per cent of material hauled away.[2]
19	1.000	64.50	40.00	24.50	65	40	25	All of material hauled away.[3]
20	1.576	35.25	14.00	21.25	22	9	13	No material hauled away.
21	2.960	138.00	103.00	35.00	47	35	12	No material hauled away.
22	1.800	79.25	55.75	23.50	44	31	13	No material hauled away.
Total	22.075	$834.28 100%	$575.25 69%	$259.03 31%	38	26	12	

[1] Av. haul = ¾ mi. [2] Av haul = ½ mile. [3] Av. haul = ½ mile.

Cost of labor—Foreman, 50 cts. per hour.
Labor, 25 cts. per hour.
Team, 62½ cts. per hour.

TABLE V.—TRAFFIC CENSUS—TIME 7 A. M. TO 7 P. M.—FAIR WEATHER.

Road No.	Type of construction.	Motor-cycles.	Runabouts.	Touring cars.	Trucks.	Total motors.	1-horse light.	1-horse heavy.	2-horse light.	2-horse heavy.	Total horse.	Total both.
23	Bit. macadam.......	127	257	993	74	1,451	102	82	12	112	308	1,759
24	Waterbound	119	89	462	77	747	197	128	36	153	514	1,261
25	Waterbound	35	85	221	33	374	28	315	3	288	634	1,008
26	Asphalt	135	80	277	44	536	24	72	0	817*	913	1,449
27	Waterbound	37	58	203	38	336	14	22	2	17	55	391
28	Waterbound	22	33	92	27	174	96	82	57	126	361	535
29	Bit. macadam......	25	38	150	22	235	108	103	26	48	285	520
30	Bit. macad. and conc.	63	63	303	52	481	29	42	17	63	151	632

*Includes 385 loaded 2 cu. yd. sand wagons.

The total amount of money spent in 1914 up to Dec. 1 was $68,705.83, divided as follows:

		Average per mile.
Patrol	$ 6,589.00	$ 67.00
Repairing, painting and building guard rail........	2,550.48	26.00
Maintenance material, stone and oil	6,013.49	61.00
Ordinary repairs	5,963.16	60.00
Oiling 40.669 miles	19,870.75	488.00
Resurfacing 1.45 miles bit. mac. mixing method, Type 2	23,007.77	15,867.00
Engineering and expenses...	4,711.18	47.00

Engineering and inspection, 4.94 per cent.

Of the oiling work done during the year 32.244 miles were done by contract and 8,425 miles by the Department directly. The cost of this class of work is itemized under Tables I and II respectively.

In the work shown in Table I both the cover and bituminous material were applied by contract. The cost of cover as shown in this table is excessive, due to the fact that the cost as given covers all material bought and delivered upon the shoulders of the road. In the case of each of these contracts approximately 100 tons of cover per mile were applied.

In Table II the bituminous material was applied by contract, cover being furnished and applied by the Department. The amount of cover used was approximately 50 tons to the mile.

Table III shows the cost of oiling work done entirely by the forces of the Department.

During the season, particularly in the late fall, the shoulders on 22.075 miles of road were scraped and shaped up, an ordinary two-team road scraper being employed. The cost of this work is shown in Table IV. It is difficult to state an average cost upon this class of work, owing to the great variation in conditions. Where it is necessary to pick up and haul away the surplus material the cost becomes large as shown on Roads Nos. 16 and 19. However, where average conditions prevail and all the material may be used to widen out the shoulders a fair average cost of $25 per mile may be assumed.

In the early part of the summer all the wooden guard rail was repainted one coat. Ready mixed paint was used, costing $1.50 per gallon f. o. b. points near Rochester, and was applied by the Department's own forces. In most cases a gang of three or four men, including the foreman, was employed. These gangs were transported from road to road in a box wagon which was also used to carry paint, brushes, oils, material and tools for making small repairs, etc. The cost of this labor was as follows, the driver of the wagon being used as a painter:

	Per hr.
Foreman	$0.50
Labor	.25
Horse and wagon, including driver......	.37½

Each man painted approximately 300 lin. ft. of rail per day on the average and used 0.6 gallons per 100 linear feet. The itemized cost of this work was as follows:

Total No. lin. ft., 49,998. Cost labor, $478.50. Cost material, $475.77. Total cost, $954.27. Average cost per ft.—Labor, $0.0096; material, $0.0094; total, $0.019.

Cost of paint used	$450.00
Cost of oil and turpentine................	18.79
Cost of brushes...........................	6.98
Cost of labor	478.50
Total cost	$954.27

Below is shown the cost of erecting new concrete guard rail. The cost of hauling 2¾ miles is included in the labor.

COST OF CONCRETE GUARD IN PLACE.

No. of lin. ft..........................	1,440
Total cost of labor......................	$ 237.00
Cost of rail and frt.....................	1,053.76
Total	$1,290.76
Av. cost of labor per ft.................	$0.164
Av. cost of rail per ft..................	.732
Total	$0.896

On three days of the year a census of traffic was taken on all the improved roads in the state. In order to obtain an idea of the amount of travel Table V is given. Roads Nos. 23, 24, 25, 26 are highways in the vicinity of the city of Rochester, while Roads Nos. 27, 28, 29 and 30 are farther from the center of traffic. The figures are those taken on one of the average days.

Division No. 7 is under the charge of Perry Filkin, Division Engineer, and H. G. Hotchkiss, Jr., Acting Superintendent of Maintenance. This article is reprinted from the Cornell Civil Engineer for May, 1915, the author being Paul Macy, Engineer in direct charge of the work described.

Cost of Resurfacing Macadam Walks With Asphalt, Lincoln Park, Chicago.

Contributed by M. D. Blumberg, Assistant Engineer, Lincoln Park.

In Lincoln Park proper there are about 50,000 sq. yds. of walks built principally of cinders, limestone macadam, and gravel macadam. In 1913 the attention of the commissioners was drawn to the difficulty of keeping these walks in condition for foot travel. In wet weather pools of water would stand in the walks, in dry weather the protruding large stones caused a great deal of discomforture to the pedestrians, thereby causing many of them to walk on the grass, while in winter the removal of snow was unnecessarily difficult. In deciding upon what methods to use to eliminate the above difficulties the following considerations were born in mind: (1) Low first cost and low maintenance; (2) The walks should be in harmony with the park surroundings; (3) The utilization of the foundations of the walks as they stood; (4) The walks should be of such a nature as to induce people to use them rather than the grass.

TABLE I.—COST OF BASE AND WEARING SURFACE FOR 26,657 SQ. YDS. OF WALK, LINCOLN PARK, CHICAGO.

BASE.

	Per sq. yd.
Labor:	
Shaping bed of walk..........................	$0.023
Mixing	.080
Spreading	.020
Rolling	.006
Total	$0.129
Material:	
Asphalt	$0.050
Stone	.051
Coal	.012
Miscellaneous supplies	.002
Total	$0.115
Teams:	
Hauling (surplus material after shaping walk)	$0.014
Hauling (binder)	.019
Total	$0.033
Overhead charges:	
Plant	$0.015
Superintendence	.004
Total	$0.019
Total cost per sq. yd.:	
Labor	$0.129
Material	.115
Teams	.033
Overhead charges	.019
Total	$0.296

WEARING SURFACE.

	Per sq. yd.
Labor:	
Mixing	$0.054
Spreading	.021
Rolling	.006
Total	$0.081
Material:	
Asphalt	$0.105
Screenings (limestone)	.028
Stone dust	.016
Sand (torpedo)	.001
Sand (fine)	.043
Cement	.001
Miscellaneous	.001
Coal	.013
Total	$0.208
Teams:	
Hauling	$0.018
Overhead charges:	
Plant	$0.019
Superintendence	.004
Total	$0.023
Total cost per sq. yd.:	
Labor	$0.081
Material	.208
Teams	.018
Overhead charges	.023
Total	$0.330

With these considerations in view the choice was narrowed down to building Portland cement concrete walks or resurfacing with an asphaltic mixture. It was finally decided to build some experimental sections with an asphaltic top. These experiments proved so successful in 1913 that in 1914 enough money was appropriated to cover nearly 40,000 sq. yds. of walks with an asphaltic wearing surface.

The plant used for this job consisted of one portable asphalt plant of 1,600 cu. yds.

TABLE II.—COST OF WEARING SURFACE FOR 13,329 SQ. YDS. OF WALK, LINCOLN PARK, CHICAGO.

	Per sq. yd.
Labor:	
Shaping bed of walk	$0.022
Mixing	.055
Spreading	.023
Rolling	.007
Total	$0.107
Material:	
Asphalt	$0.107
Screenings (limestone)	.028
Stone dust	.017
Sand (torpedo)	.001
Sand (fine)	.044
Cement	.001
Coal	.012
Miscellaneous supplies	.001
Total	$0.209
Teams:	
Hauling (wearing surface)	$0.010
Overhead charges:	
Plant	$0.020
Superintendence	.004
Total	$0.024
Total cost per sq. yd.:	
Labor	$0.107
Material	.209
Teams	.010
Overhead charges	.024
Total	$0.350

capacity (inch thick) manufactured by the Link Belt Co. and a combination roller which furnished the power for the plant. The material was wheeled in barrows up an elevated platform from which it was dumped into the hopper. The plant was centrally located and the binder and top were hauled to the job in two yard dump wagons. The wagons were covered with canvas to retain the heat in the mixture. The average haul was one-half mile. Sufficient teams were used to keep up with the output of the plant. The greatest number used per day was five teams.

About one-third the area, or 13,329 sq. yds. of walk, were sufficiently compact and rough to pave with a wearing surface only. The balance, or 26,657 sq. yds., required a binder and top. The binder used was composed of ½-in. to ¾-in. stone and asphalt. A number of tests showed that the percentage of asphalt used by weight was as follows: Minimum 3.85 percent, maximum 5.15 per cent, average 4.25 per cent. The binder was laid so that it was ¾ in. thick after being rolled with a 5-ton roller. The wearing surface mix consisted of asphalt, limestone screenings, stone dust and bank sand in the following proportions:

	Per cent.
Asphalt	10.50
Passing 200-mesh	12.50
Passing 80-mesh	18.00
Passing 40-mesh	36.00
Passing 10-mesh	13.00
On 10-mesh	10.00
	100.00

The wearing surface was laid ¾ in. thick after being rolled with a 5-ton roller. Immediately after rolling Portland cement was brushed over the surface and then rolled with the 5-ton roller. The cement fills the minute voids in the surface and also improves the appearance of the walks.

It will be noticed from the cost report, Tables I to III, that there is a torpedo sand charge. At the beginning of the work it was found that the mix contained too large a percentage of coarse material. Limestone dust was substituted in place of the torpedo sand and the mix proved very successful. No forms of any kind were required for the work.

TABLE III.—SUMMARY OF COSTS AND QUANTITIES OF WALK CONSTRUCTION, LINCOLN PARK, CHICAGO.

Base and wearing surface	26,657 sq. yds.	
Wearing surface only	13,329 sq. yds.	
Total	39,986 sq. yds.	
Average width of walks	8½ ft	
Amount expended on paving walks with base and wearing surface cost (ttl.)		$16,908.58
Cost per sq. yd.	$0.633	
Amount expended on paving walks with wearing surface only		4,466.31
Cost per sq. yd.	$0.350	
Total amount expended on walks		$21,374.89
Average cost per sq. yd.	$0.519	

From the cost report it can be seen that asphalt walks can be laid at approximately 60 per cent of the cost of concrete walks where both binder and top are used, and at about 35 per cent of the cost of concrete where a wearing surface only is used.

The paving was done under the supervision of Mr. George T. Donoghue, chief engineer for the commissioners of Lincoln Park. Mr. W. F. Enault, foreman of road construction, was in immediate charge of the work.

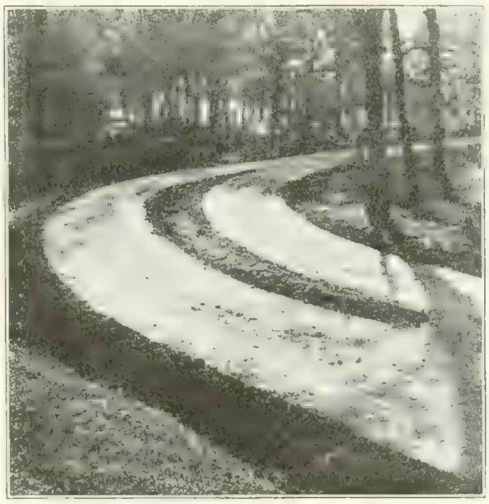


Fig. 1.—Two Track Concrete Road on Curve on Grade.

Method and Cost of Street Oiling in Carlisle, Pennsylvania.

Contributed by John C. Hiteshew, City Engineer, Carlisle, Pa.

The oiling of streets is done by the Street Department under the supervision of the writer. An increasing number of streets have been oiled each year beginning in 1911 when the Standard Oil Co.'s crude oil was used. It was fairly satisfactory for the price but was poorly applied. In 1912 the Sun Company's Emulsifying Oil was used; a mixture of one part oil and one part water was applied with ordinary street sprinkler with oiling attachment. In 1913 Dustoline was used and would have been satisfactory had not an unusually heavy shower washed practically all the oil from the streets within an hour or two after it was applied. In 1914 Emulsifying Oil was again selected because of its previous success. It had very little odor and after a few hours dried sufficiently not to track onto the sidewalks. Also the price played a large part in the selection.

The manner of applying the oil was as follows: An overhead siding was used from which the oil was run from tank car to sprinkler by gravity. An ordinary water sprinkler of 500 gals. capacity was used, and filled about one-half full, the sprinkler was then taken to the block to be oiled and the other half filled with water at the nearest fire plug. The oil and water were then thoroughly mixed with a hoe, but later on it was found that time was saved and as perfect a mixture was secured by placing the hose connected with the fire plug in the bottom of the sprinkler and turning on full pressure of the water, which would then literally "boil up" and thoroughly emulsify.

The sprinkler distributed the oil so uniformly that no brooming was required after oiling. The streets were lightly swept before oiling in order to clean them but to leave sufficient dust for the oil to take hold or penetrate.

The cost of oiling approximately 160,000 sq. yds. or 34 blocks, or eight miles of street averaging 45 ft. in width, giving the whole two applications, was as follows:

Materials	
26,509 gals. emulsifying oil at .0446c	$1,182.31
Demurrage	16.00
Total	$1,198.31
Labor	
Foreman, 5 hrs. at 20 cts.	$ 1.00
Labor, 65 hrs. at 16 cts.	10.40
Labor, 97 hrs. at 15 cts.	14.55
Labor, 5 hrs. at 10 cts.	.50
Team, 103 hrs. at 15 cts.	15.45
Team, 25 hrs. at 10 cts.	2.50
Collector, 21 days at $1.00	21.00
Collector, 6 days at $1.50.	9.00
Total	$ 74.40
Grand total	$1,272.71
Per square yard	$0.008

Two Part Construction for Concrete Road on Curve on Grade.

(Staff Abstract.)

Two-track construction was adopted on curves on grade in building the Minnetonka Lake shore concrete road near Minneapolis, Minn. The illustration shows this construction on a moderately sharp curve on a 5 per cent grade. The main approaching roads are 16 ft. wide, 8 ins. thick at center and 6 ins. thick at sides, on the cure the road slab is split into two 8 ft. wide slabs separated by a dirt strip as illustrated. The idea of this construction is of course to keep separate the traffic in opposite directions on curves on grade where it has a tendency to swing across road. The photograph was taken before dirt strip and shoulders had been leveled and so does not indicate the neat appearance of the finished work. Where such construction is adopted on roads in suburban and resort locations the dirt strip offers opportunity for planting shrubs and flowers and thus adding to the general attractiveness of the surroundings. We are indebted to the Universal Portland Cement Co., Chicago, for the information given in this note.

BUILDINGS

Design and Construction Features of the Massachusetts Institute of Technology Buildings.

(Staff Abstract.)

The construction of the new buildings of the Massachusetts Institute of Technology represents one of the most comprehensive schemes for an educational institution that has been developed in this country. The site includes an area of 50 acres, while the buildings themselves cover an area of 3½ acres, and if placed in a straight line would extend for a distance of 2,500 ft. With the exception of the stairways, which are of structural steel, reinforced concrete is used throughout, the buildings requiring about 40,000 cu. yds. of concrete and 3,600 tons of reinforcing steel.

This article will deal chiefly with the structural features of the work, and especially with the engineering studies and investigations which determined them. In connection with the general description of the layout of the work, however, the more essential construction features will be treated.

ARRANGEMENT AND TYPE OF BUILDINGS.

The complete plan provides for over 30 buildings, with 17 of the larger and more important ones grouped around a central court so arranged and constructed as to form one continuous structure. Figure 1 is a plat of the site, showing the arrangement of buildings.

The buildings now under construction are shown by light full lines, while the heavy full lines indicate the arrangement of the plant used in their construction. At present only 13 of the buildings are being erected, but the plans for those shown dotted in Fig. 1 are well under way.

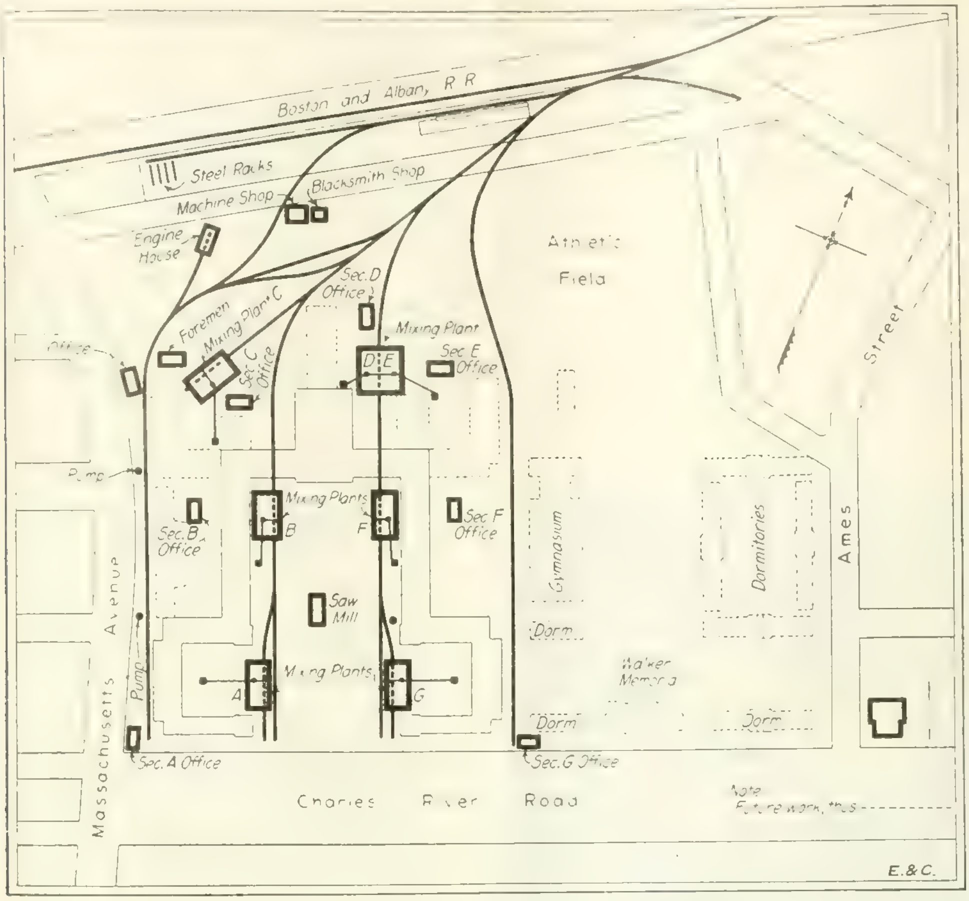


Fig. 1. Construction Plant and Building Layout for Massachusetts Institute of Technology Buildings.

The buildings which face directly on the major and minor courts (see Fig. 2) and on important streets are faced with Indiana limestone; those facing on the secondary courts and other less prominent places are faced with pressed brick.

The buildings facing on the major court are four stories high, while those on the minor courts have a height of three stories. On the latter, however, there are two pavilions, one on each side of the main entrance from the street, which run up to the fourth story.

CONSTRUCTION PLANT.

The size of the job made it convenient for construction purposes to group the buildings into seven sections, A to G inclusive (see Fig. 1), each section having its own organization, with field office, mixing plant, etc.

Materials are carried direct, by means of switch tracks laid from the Boston & Albany R. R., on trestles to each mixing plant. The sand and gravel are dumped under the trestle into pits holding 300 and 400 cu. yds. respectively. Cement is stored in houses, one for each plant. The ¾-cu. yd. mixers are located in pits so that all material can be fed by gravity. The mixed concrete is poured into cars which are run up inclined tracks to the hoist towers, the latter being located in a central position so that the concrete can be hoisted and distributed through chutes to the various sections. The concrete, however, is not chuted directly to place. In order to handle it by chutes and at the same time maintain the proper consistency, it was found necessary to limit the slope of the chutes to 30° with the horizontal. This slope is therefore maintained, and the concrete flows from each chute into a hopper, from which it is poured into two-wheeled "Ransome" barrows, and wheeled to place. Tests of specimens of concrete taken at different points in the system indicate that the strength was increased rather than decreased by flowing through a chute in this manner. Figure 3 is a view of one of the concrete distributing plants.

MATERIALS AND CONCRETE PROPORTIONS.

Although Massachusetts is largely covered with glacial deposits of sand and gravel, it is by no means easy to find aggregates which will make first-class concrete. Available sources of supply were sampled and tested before the contract for construction was let. Finally a new bank, located about twelve miles from the building site, was opened, and a contract was let for excavating, screening and delivering the material.

"Universal" Portland cement is being used, the cement being tested regularly at the mill and also at the author's laboratory.

As sand tests are fully as important as cement tests, the inspector goes to the bank at regular intervals for samples of sand, which are sent to the author's laboratory for testing. The specifications require a ratio to standard of 70 per cent for 3 days and 85 per cent for 7 days. Although this is somewhat lower than the "Joint Committee" recommendations, it was found that the aggregate produced concrete of the required strength; furthermore, the values could be used as absolute minimums on short-time tests. As a matter of fact the tests made thus far have averaged 91 per cent for 3 days, 100 per cent for 7 days, and 102 per cent for 28 days—an excellent record, especially for New England sands.

Immediately after deciding upon the aggregates, compression tests of cylinders 8 ins. in diameter by 16 ins. long were made to determine the best proportions and allowable stresses. As a result of these tests three different mixes were chosen, a 1:2:4 mix for the footings and foundation walls, a 1:1½:3 mix for the superstructure, and a 1:1:2 mix for a few important columns which required especially high stresses.

FIELD TESTS OF CONCRETE

Test Specimens.—Two field samples of concrete were taken regularly on each section of the job at least four times a week for tests at 14 and 28 days, both samples from the same batch in order to arrive at the true relative value. Wherever possible the samples were taken directly from place; but for

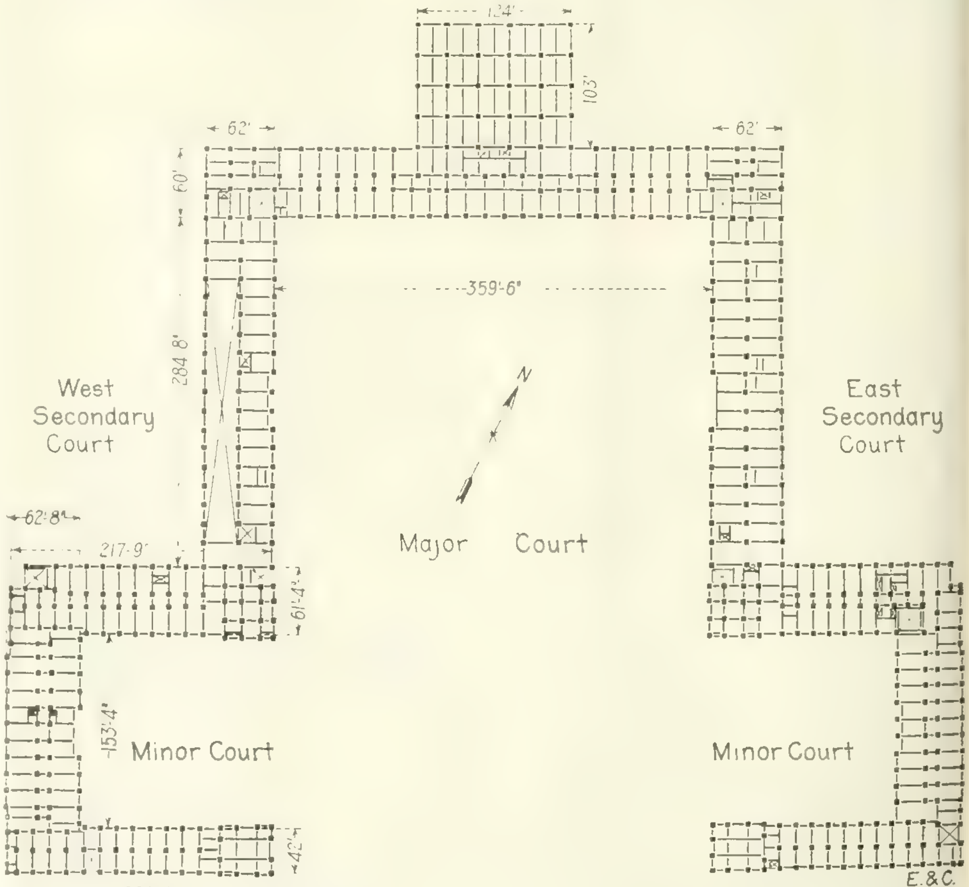


Fig. 2. Arrangement of Buildings Under Construction and Framing Plan of Second Floor—Massachusetts Institute of Technology.

beams, columns and girders this was impossible, and samples were taken from the barrow before placing.

The concrete was shoveled into two 14-quart galvanized iron pails, then carried to the molding yard, remixed to eliminate any segregation of materials due to carrying from the work, and poured into iron molds embedded in moist sand. The maximum and minimum temperatures were recorded every day. For mass concrete work, where the size of aggregate runs up to 2 or 2¼ ins., samples were cast in 8x16-in. cylinders; but for the superstructure concrete, where the largest size of aggregate is not over 1½ ins., 6x6x12-in. prisms were used as the material for the larger size of specimen was too heavy to carry from the upper stories. The bottom of each mold was formed of a ½-in. iron plate. The concrete was tamped in the mold with a 6-in. ice chopper, about the same precautions being taken as on the regular work. Each sample was given one tamp on each face and four tamps at 90° in the center. The time of the operations of dumping into the molds and tamping never exceeded five minutes. Just previous to the initial set the top surfaces were carefully troweled with a plasterer's trowel in order to obtain a uniform bearing in the compression machine. After 48 hours the blocks were removed from the sand, taken from the molds, and reburied in the moist sand, where they remained until the day before they were tested.

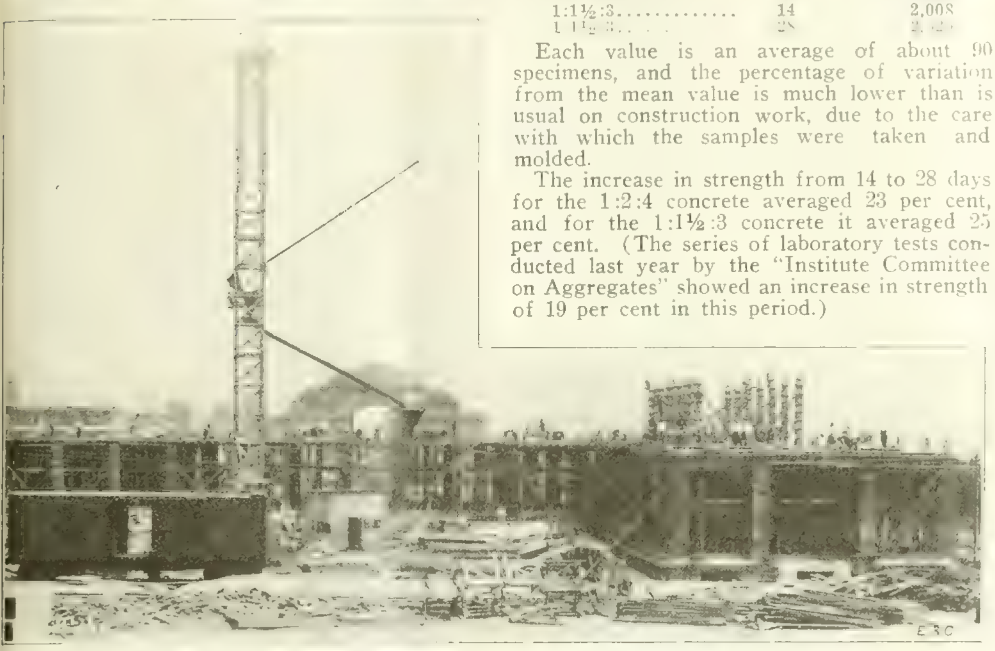


Fig. 3. Typical Arrangement of Tower, Chute and Hopper Used in Concreting Massachusetts Institute of Technology Buildings.

Results of Tests.—The average results of compression tests of these three specimens were as follows:

Concrete mix.	Age, days.	Compressive strength per sq. in.
1:2:4	14	[illegible]
1:2:4	28	[illegible]
1:1½:3	14	2,008
1:1½:3	28	[illegible]

Each value is an average of about 90 specimens, and the percentage of variation from the mean value is much lower than is usual on construction work, due to the care with which the samples were taken and molded.

The increase in strength from 14 to 28 days for the 1:2:4 concrete averaged 23 per cent, and for the 1:1½:3 concrete it averaged 25 per cent. (The series of laboratory tests conducted last year by the "Institute Committee on Aggregates" showed an increase in strength of 19 per cent in this period.)

The practical value of this system of sampling and testing was shown at the beginning of the job. Some of the test specimens of 1:2:4 concrete gave low values, and the method of handling the concrete on the job was changed at once, with the result that subsequent specimens gave proper strengths. To be sure that the concrete which had been previously placed was satisfactory three or four samples were cut out of a solid footing three or four weeks old. After being sawed to the standard 8x8x16-in. size, compression tests of them were made, the average value being 2,200 lbs., a satisfactory strength for this portion of the structure.

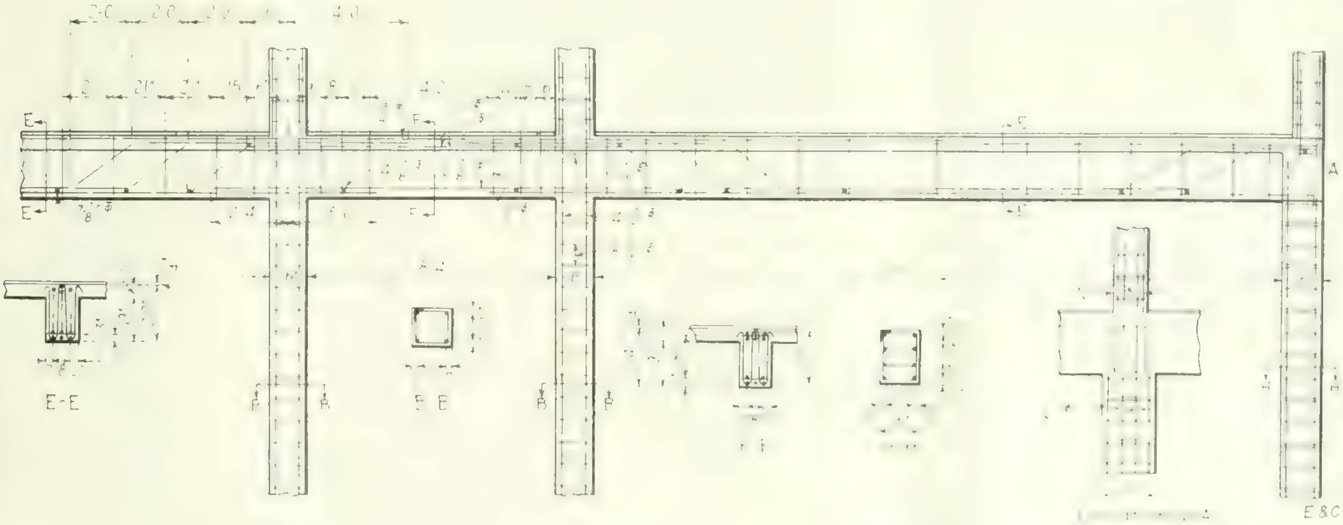


Fig. 4. Typical Beam and Column Details for Three-Bay Construction on Minor Courts.

PROPERTIES OF REINFORCING STEEL.

The cold twisted steel used for reinforcement was tested at the mill with the following results:

Yield point varied from 57,000 to 64,000 lbs. per square inch.

Tensile strength varied from 70,000 to 81,000 lbs. per square inch.

Elongation in 8 ins. for larger bars, [illegible] to 10 per cent.

Elongation in 8 ins. for sizes below ½-in., [illegible] per cent.

Reduction in area for larger bars, 33 per cent.

Reduction in area for sizes below ½-in., 50 per cent.

The fracture was a half cup.

Bending tests for ½-in. and larger bars were 180° around their own diameters.

Bending tests for bars below ½-in. were 180° flat.

Phosphorus ranged from 0.01 to 0.02 per cent.

Sulphur ranged from 0.03 to 0.04 per cent.

BEAM TESTS.

The stresses were so chosen that no cracks would be visible under ordinary working loads. Before reaching a decision as to the allowable working stresses tests were made of full-size T-beams.

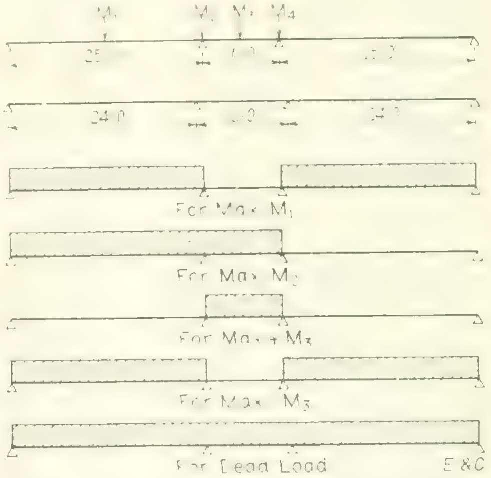


Fig. 5. Typical Arrangement of Beam Spans and Positions of Loads for Maximum Moments at Various Points.

As a result of the tests it was evident that the cracks in beams reinforced with twisted steel are less objectionable under a steel stress of 18,000 lbs. per square inch than in beams reinforced with plain round bars under a stress of only 16,000 lbs. per square inch. Moreover, so much of the tension was carried by the concrete that with a theoretical stress of 18,000 lbs. the actual measured stress was only 8,000 lbs. per square inch. In beams reinforced with twisted steel there were many more cracks than in beams reinforced with plain round bars, but these cracks were small and well distributed, and therefore unobjectionable; whereas in the plain round bar beams the cracks were large and more noticeable. The stress in the steel at failure for beams reinforced with twisted steel averaged 93,000 lbs. per square inch, and for beams reinforced with plain round bars 60,000 lbs. per square inch.

Methods of Design.

Complete specifications, following substantially the recommendations of the "Joint Com-

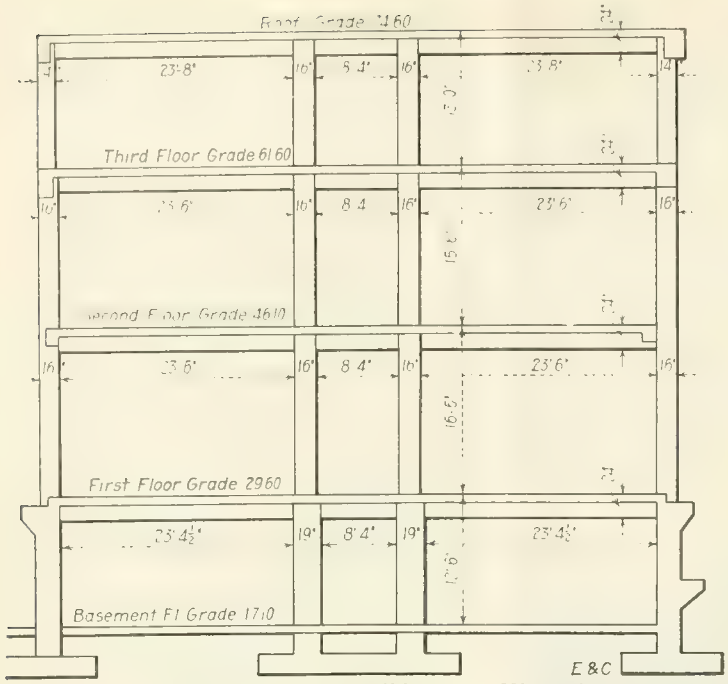


Fig. 6. Typical Cross Section of Buildings on Minor Courts—Three Bay Construction.

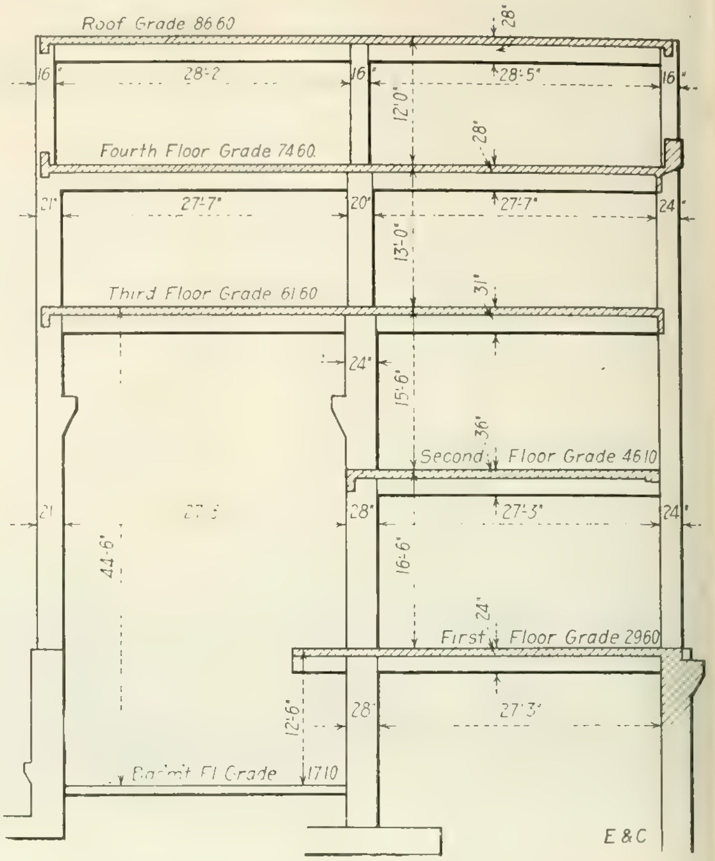


Fig. 7. Typical Cross Section of Buildings on Major and West Secondary Courts—Two-Bay Construction.

mittee on Concrete and Reinforced Concrete," were drawn up by the author, but only special features will be considered in this article.

UNIT STRESSES.

The following unit stresses were used in the design:

Item.	1:2:4 mix.	1:1½:3 mix.	1:1:2 mix.
	Stress, in lbs. per sq. in. for various concrete mixtures.		
Compressive strength of 8x16-in. concrete cylinders.	2,000	2,500	3,300
Compressive fiber stress:			
At center of beam.......	650	810	.....
At support	750	930	.....
Compressive stress.........	450	560	750
Shearing stress	120	150	.....
Bond stress	80	100	....
Steel tensile stress.........	18,000	18,000	18,000
Ratio of elasticities, n.....	15	12	10

TYPICAL BENDING MOMENTS.

In the layout of beams there is usually one short span between two long spans. This arrangement gives a series of class rooms on each side of a long corridor, with most of the beams in the partition. Figure 4 is a detail drawing illustrating this type of construction. In some cases the center span is 10 ft. and the two side spans each 25 ft.; in others the center span is 12 ft. and the two side spans each 24 ft.

Figure 5 shows the positions of live and dead loads for maximum bending moments at various points in the three spans of this type of construction. The formulas from which the bending moments were derived are rather complicated. Solutions were worked out for the different conditions and constants obtained by the use of which the general formulas were reduced to the two following formulas:

$$2M_2(l+nl)+M_4nl=-6\left[\frac{1}{l}\int_0^l m_{x1}x\,dx+\frac{1}{nl}\int_0^{nl} m_{x2}(nl-x)\,dx\right]\ldots\ldots.(1).$$

$$M_2nl+2M_4(nl+l)=-6\left[\frac{1}{nl}\int_0^{nl} m_{x2}x\,dx+\frac{1}{l}\int_0^l m_{x3}(l-x)\,dx\right]\ldots\ldots.\ (2).$$

Where

M_2 and M_4 bending moments at center supports.

m_{x1} and m_{x3} = static bending moment at any point in the respective end spans due to load in that span.

m_{x2} = static bending moment at any point in the center span due to load in that span.

s = ratio of end span to center span.

These formulas were solved, and constants were derived in terms of dead and live loads for different ratios of short span to long span and for different positions of the load. The bending moment coefficients given in Table I were thus obtained.

TABLE I.—BENDING MOMENT COEFFICIENTS FOR CONSTRUCTION CONSISTING OF SHORT SPAN BETWEEN TWO LONG SPANS.

	*Max. M₁.		*Max. M₂		*M₃		
						Live-load.	
Ratio of short to long span.	Dead load.	Live load.	Dead load.	Live load.	Dead load	Positive.	Negative.
0.3	0.084	0.085	—0.090	—0.101	—0.077	0.009	—0.086
0.4	0.087	0.089	—0.083	—0.096	—0.063	0.015	—0.078
0.5	0.087	0.092	—0.082	—0.095	—0.049	0.022	—0.072

*See Fig. 5.

As a result of these studies the following simple formulas were used in the design of the three-span continuous beam:

End spans:

$$\text{Center } M_1=\frac{1}{11}wl^2$$

$$\text{Support } M_2=-\frac{1}{11}wl^2$$

Center spans:

$$\text{Support } M_2=-\frac{1}{11}wl^2$$

$$\text{Middle}\begin{cases}M_3=\dfrac{1}{60}wl^2\\[2ex] M_3=-\dfrac{1}{18}wl^2\end{cases}$$

In the above formulas l is the length of the end span.

RELATIVE ECONOMY OF DIFFERENT ARRANGEMENTS OF BEAMS AND GIRDERS.

Before deciding on a flat slab layout with no intermediate beams, requiring 15x27-ft.

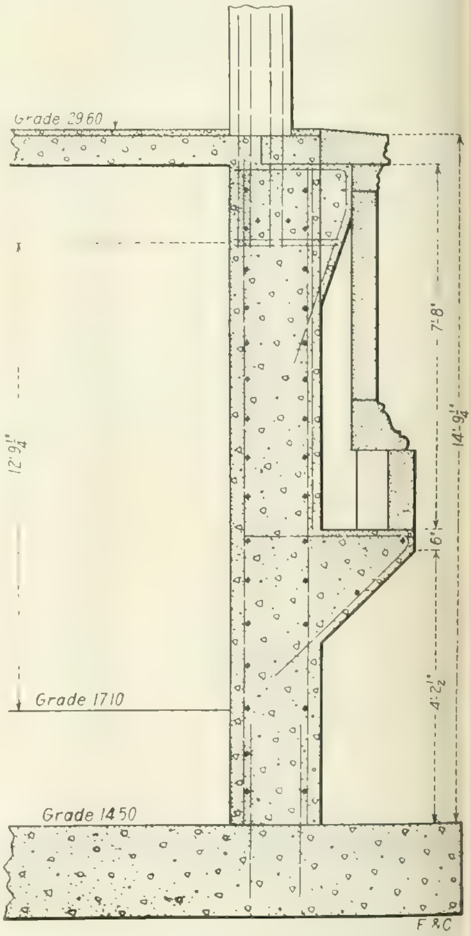


Fig. 8. Cross Section of Basement Wall of Massachusetts Institute of Technology Buildings.

slabs, studies were made of the relative costs of this construction compared with intermediate beam and tile construction. The long-span concrete slab construction proved most economical, however, when the total cost of concrete, steel, and making of forms was considered. Designs and estimates were made for the following cases:

Case I. Panel with no intermediate beam; slab 15 ft. 6 ins., solid concrete construction.

Case II. Panel with one intermediate beam; slab 7 ft. 9 ins.

Case III. Panel with no intermediate beam; slab 15 ft. 6 ins., with tile.

In Table II there is summed up the relative costs for the three cases. It is evident that the cost of forms is the important factor, completely upsetting the conclusions that would be drawn from the relative costs of the materials actually used in the slab.

BEAM REINFORCEMENT.

All beams are continuous, and negative moments were provided for in the design. The location of bends in steel was always selected so as to leave as much steel as was required for both tension and compression stresses. As a rule about three-eighths of the shear was considered to be carried by the bent bars in accordance with recent German tests. Typical reinforced beam and column construction is shown in Fig. 4. Figure 6 is a typical cross section of the three-panel type of construction, and Fig. 7 is a typical cross section of the two-panel construction (also see Fig. 2).

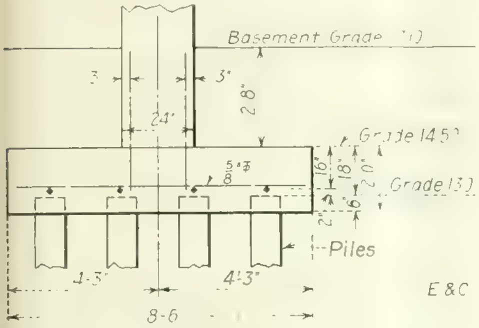


Fig. 9. Elevation of Interior Wall Footing of Massachusetts Institute of Technology Buildings.

Unusually long beams of special design were used in the construction of the pavilions in buildings Nos. 1, 2, 5 and 6, where it was desirable to have class rooms over 40 ft. square, with no inside columns. Four beams running at right angles to each other, two in each direction, divided the floor into four nearly square panels. The beams were 18x36 ins., and the reinforcement consisted of six 1-in. and six ⅞-in. bars at the center, and five 1-in. and two ⅞-in. bars at the ends. All bars were square twisted steel. The pavilion roof beams are also unusually large because of the architectural treatment. In building No. 17 there is a 48-ft. beam 24x60 ins. in section, reinforced with eighteen 1-in. bars at the center and twelve 1-in. bars at the end. In this case it was necessary to strengthen the support by haunches.

INTERIOR COLUMNS.

All interior columns are square, and are reinforced with vertical steel only. Bands were placed 12 ins. on centers to keep the steel in position during construction. The eccentricity of interior columns was neglected because the short beams were designed with sufficient steel to prevent bending in the column.

WALL COLUMNS.

In the design of wall columns account was taken of the bending moment produced by the rigidity of the connection between beam and column. The eccentricity in this case was computed carefully and enough steel provided to take care of it. To provide for the bending moment in the top story, however, it would have been necessary to use larger columns than the architectural treatment would permit. Therefore to prevent a bending moment in the columns it was decided to make a joint between the columns and roof beams and not to carry the outside reinforcement through the beam. Columns were then designed for the superimposed load placed on the column with an eccentricity of 0.4 the width of the column.

TABLE II.—RELATIVE COSTS OF DIFFERENT SLAB DESIGNS.

Item.	Unit cost.	Concrete slab; span, 15 ft. 6 ins. Amt.	Cost	Concrete slab; span, 7 ft. 9 ins; 1 intermediate beam. Amt.	Cost	Hollow tile; span, 15 ft. 6 ins. Amt.	Cost.	Page ref. "Concrete Costs."*
Concrete, per panel:								
Slab, cu. yds.		10.7		6.1		6.6		
Beam, cu. yds.		2.8		2.6		2.2		
Girder, cu. yds.		.		0.65		. .		
Total	[illegible]	13.5	$78.50	9.35	$55.00	8.8	$51.22	
Steel, per panel:								
Slab, lbs.		1,080		435		670		
Beams, lbs.		944		1,620		944		
Girder, lbs.				690		.....		
Total	.027	2,024	$55.60	2,745	$75.00	1,551	$41.88	
Tile, per panel:								
Slab, piece	[illegible]			.		286	$57.20	
Total cost of materials			$134.10		$130.00		$150.30	
Form lumber:								
Slab, 1¼-in. stock, ft. B. M.		1,772		1,435		1,772		617
Beam, 1¼-in. stock, ft. B. M.		496		680		429		619
Girder, 1¼-in. stock, ft. B. M.		.....		267		.....		619
Total for 4 floors		2,268		2,382		2,201		
Total per floor per panel	$30.00 per M.	567	$17.00	596	$17.86	550	$16.50	
Form labor:	Carpenter labor [illegible] cts. per hour Ordinary labor [illegible] cts. per hour							
Slab:								644
Make		$4.39		$3.78		$4.39		
Place and remove first floor		12.88		11.48		12.88		
Place and remove second floor		9.88		8.57		9.88		
Place and remove, third floor		11.02		9.31		11.02		
Place and remove, fourth floor		11.02		9.31		11.02		
Total cost 4 floors		$49.19		$42.45		$49.19		
Cost per panel per floor			$12.30		$10.61		$12.30	
Beams:								639
Make		$3.00		$2.10		$2.70		
Place and remove first floor		5.79		4.40		5.10		
Place and remove second floor		5.20		3.90		4.60		
Place and remove third floor		6.92		5.10		6.80		
Place and remove fourth floor		6.92		5.10		6.80		
Total cost per beam 4 floors		$27.83		$20.60		$26.00		
Cost per panel per floor			$6.95		$10.30		$6.40	
Girders:								641
Make		....		$2.30		. .		
Place and remove first floor		.....		4.80		.....		
Place and remove second floor		. .		4.10		.		
Place and remove third floor		. .		6.20				
Place and remove fourth floor				6.20		.		
Total cost 4 floors				$23.60		. . .		
Cost per panel per floor			. .		$9.50†		. .	
Total cost forms			$36.25		$48.27		$35.20	
Total cost			$170.35		$178.27		$185.50	

*Costs are from "Concrete Costs," by Taylor and Thompson as per page number noted.

†Multiply cost per panel per floor by 1.6 instead of 2.0 to allow for spandrel beams.

Notes.—Forms assumed to be used four times and remade once for a change in size of columns. Size of beam below slab, 12x19 ins.; size of girder below slab, 14x19 ins. Note that cost of forms and not cost of materials used in beams and slab determines relative cost of the three alternate designs.

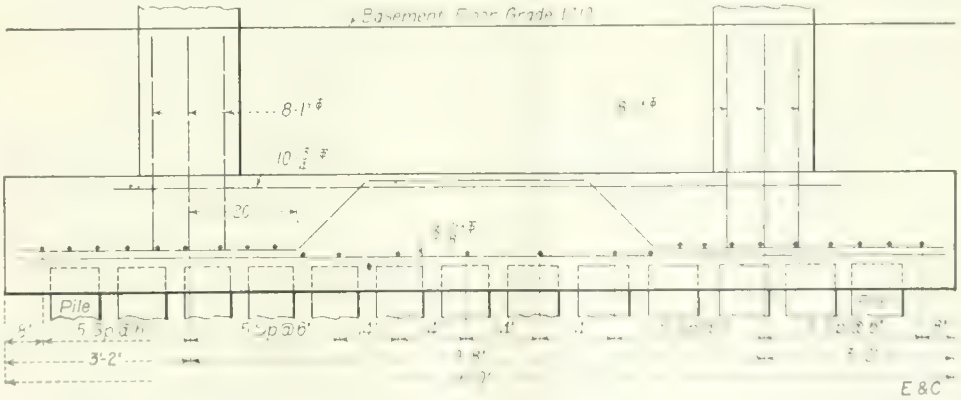


Fig. 10. Typical Bay of East Wall Footing of Massachusetts Institute of Technology Buildings.

SLABS.

The floor slabs which are continuous were designed for a bending moment of $\frac{wl^2}{12}$ at the support and the same moment in the center of the span. To prevent, as far as possible, cracks in the building short bars were placed at the top over each girder whenever the main slab reinforcement ran parallel to the girder, and, in fact, wherever there was danger of negative stresses.

WALLS

Retaining walls were cast monolithic with the wall columns, except on the outside wall. In the minor and major courts separate retaining walls were built about 3 ft. 9 ins. from the building line. Figure 8 is a typical cross section of the basement wall.

FOOTINGS.

The design of footings varies in different parts of the structure. In certain buildings the interior footings are continuous; in others individual footings are used, and in still others two interior columns are placed on one footing. All outside footings are continuous. The footings rest on wood piles of spruce or oak, depending upon the character of the ground as determined by thorough tests. Figures 9 and 10 give a general idea of the design and reinforcement of the footings.

FLOOR SURFACES.

Special studies of floors were made and several experimental slabs were built in order to find the method of placing that would result in minimum dusting and a satisfactory bond for the slab. The scum which always rises on the surface of base concrete was removed by brushing the slab with a wire brush just as it began to harden. The tests showed that dusting is best prevented by using coarse sand containing scarcely any dust and broken stone ranging from ¼ to ½ in. in size, these materials being mixed into a stiff mortar in the proportions 1:¾:1¼. As a result of laboratory tests stiff neat cement brushed into the set concrete was selected as the best bonding material between the base concrete and the granolithic.

PERSONNEL AND ACKNOWLEDGMENT.

William W. Bosworth is the architect for the Technology buildings, and the Stone & Webster Engineering Corporation the engineers and builders. The consulting engineers engaged in various capacities on this work are: Charles T. Main, on the footings; J. R. Worcester & Co., on the structural steel; Sanford E. Thompson, on the concrete superstructure, and Hollis French and Allen Hubbard, on the heating and ventilating system. The foregoing article contains the essential features of a paper by Sanford E. Thompson presented before the annual meeting of the American Concrete Institute at Chicago. We are indebted to Mr. Thompson for illustrations and data contained in this article.

Comment on "Cost of Quantity Surveys of Buildings and a Proposed Survey Guarantee."

To the Editors: The editorial in the April 21, 1915, issue of Engineering and Contracting on the subject of "Quantity Surveys" has attracted the writer's attention. As he has had some years of experience in formulating contracts for construction, both for municipal and other improvements, and in supervising construction work under the terms of such contracts, in the course of which he has acquired some rather definite notions and fixed convictions regarding this subject (now much discussed) of furnishing bills of quantities with plans and specifications for the convenience of prospective bidders, it has occurred to him that some points of this experience might be of interest and perhaps assist to some slight degree in the settlement of this mooted question.

In the engineering office of the writer's firm we have tried probably all of the various plans that have been proposed and discussed for construction contracts. We have come to realize from actual experience throughout many years in handling the bidding for important constructions that this question of furnishing the prospective contractor with a list of quantities is not the simple one it might seem to be if viewed without the light of hard experience. We have all sympathy with the contractor, and regret as much as any of the writers on the subject the apparently wasteful and unnecessary expense entailed by reason of all of the contractors having to figure the same quantities on a given job. We also would like to find a plan that would actually work out in practice by which this apparent "lack of efficiency," now so much talked of, could be overcome, but it has not been proved an easy thing to correct.

First, let us consider that, for present purposes, all contracts for construction ought to be classified as: (a) Flat Price General Contracts; and (b) Unit Price Contracts. By the first is meant such contracts as, for example, a municipal waterworks plant and system upon which it is desired to receive a fixed flat price bid for the entire construction, to be completed in accordance with plans and specifications furnished. By the second is meant such a contract as, for example, grading of more or less indefinite quantity, to be contracted at a certain price per yard, or a job of sewer construction upon which it is desired to receive bids on the basis of so much per linear foot for the various sizes.

Whatever the objections may be to the first form of contract, it is one which can scarcely be avoided in the case of certain classes of work; and it is found to be really best for those cases. Such cases are usually those of municipal constructions, such as when a city has voted a definite amount of bonds, and desires to spend the full amount of the bond issue, but cannot exceed the limits of the bond issue. In such cases, it is practically impossible to get a city council to be satisfied with any other form of bidding than that of the fixed flat price, or form (a) above. This form of contract may have added to it a schedule of unit prices, distinctly specified to be solely for possible additions and deductions, should any be ordered afterwards, thus making it possible for minor changes to be arranged between the city and the contractor, through the medium of the engineer, without raising any controversy as to the cost of such changes, or without giving the contractor, when once he has secured the contract, any opportunity to take advantage of the municipality, as might be done if no previous provision had been made concerning the terms for possible additions and deductions. Such a form of contract has been used many times by the writer's firm for this class of business, with entire satisfaction.

The second form of contract—the "Unit Price Contract"—is frequently employed by those larger cities which have their own engineering departments. This form is also sometimes employed by the smaller cities for extensions and betterments, and more frequently by private concerns. It is satisfactory to the engineer, but the contract fixes no minimum limit for the expenditure, and there is only the engineer's estimate as a guide for the client by which can be known the probable amount of expenditure. Such contract, while it may be more convenient for the engineer and more satisfactory to the contractor, is not generally acceptable for the smaller municipalities where the Council is always determined to know just what the job is going to cost.

Now, in the case of contracts of class (a), it may be argued that the engineer should furnish complete bills of materials, and this is frequently done; it has been tried repeatedly by the writer's firm. It has been found, however, that to furnish any kind of a bill of materials to the contractor, in connection with such a contract, is almost certain to cause some kind of confusion or controversy. It may be argued that this should not be so, but as a matter of fact experience shows that it is.

The plan has been tried of giving a bill of materials, carefully itemized, to prospective bidders, but with the announcement printed plainly thereon that this bill of material is *approximate* and is solely for the information, convenience and guidance of prospective bidders. It is stated that the actual bid is to be based upon the quantities required to execute the work, as shown and specified by the plans and specifications. But even this does not prove satisfactory for the contractor, as it is found that he inevitably will bid blindly on the quantity listed, and will pay little or no attention to the drawings and specifications, with the result that there remain innumerable small items of materials of such minor character that they cannot well be listed, for which he will demand extras, thereby causing trouble all out of proportion to the value of the items, both for the engineer and his client.

It may be argued that the engineer ought to be able to detail and itemize a bill of materials as thoroughly and carefully as a contractor. The answer is: Most engineers can do so, and when they attempt to prepare such a bill they do it much more thoroughly than the average bidder; but that is not all there is to the matter.

For one thing, it is not usual that an engineer can command sufficient fees to compensate him for working out a bill of materials in minute detail. He can prepare his estimate for his clients with sufficient exactness by his own methods of figuring, without itemizing every little article required to make the construction complete. Moreover, it is a fact that no two contractors "work" their materials in the same way, or make the same allowance for loss, breakage and shortage. If the engineer gives a bill of materials, based upon the actual amount of material which the finished work will figure, there are bound to be shortages, due to cutting to standard lengths, sizes and shapes, and to the usual loss and breakage. If the engineer attempts to make allowance for this, he will never make the allowance which any two contractors would agree is right. If he tells them plainly in the specifications to make their own allowances they never do it, but will figure on just what is displayed in the bill of materials, and will then complain about not having materials enough to finish the job.

Another, and possibly the most important consideration, is that in the case of a complete bid, as, for example, a municipal water and lighting plant for a small Western city to cost about $50,000, it is not best from any standpoint to attempt to specify details of construction with too great a degree of minuteness. It requires a great deal of judgment and much experience to prepare such specifications so as to express the engineer's ideas concerning essential requirements, and still leave the bidding open to various standard makes of machinery, equipment and supplies. It also is difficult to provide means for enabling the contractor to exercise some judgment as to the manner of carrying out the construction. If the specifications are made too exclusive, complaints will be heard that the engineer is favoring some certain make of engine or pump, or something of this kind, or the contractor will complain that if he were allowed to carry out his ideas about handling the work he could make important savings. Furthermore, too close specifications do actually limit and restrict competition greatly, thus affecting bids. This becomes serious, particularly in public work, where competition must be more open than in private undertakings. It is found best to specify type, size, character, performance, etc., for such a plant, and to show a sufficient number of detail drawings to fix the arrangement of equipment in the station (in the case of a power plant, for example), leaving the less unimportant details to the judgment, decision and experience of the contractor. Such a course will mean a saving to the client and a smoother and more satisfactory execution of the whole work. In fact, the general results will be more satisfactory.

Granted this, it is apparent, then, that the engineer cannot furnish a minutely itemized bill of material, for in no case would it be just that required by any certain bidder.

Therefore, after much experience with various forms of contracts, it has been definitely determined in the office of the writer's company that for contracts of the form (a), above referred to, no bills of materials shall be furnished. This may appear to be a hardship on the contractor, but as a matter of fact it is not nearly so much so as some writers would have us believe. These contractors have their own quick ways of figuring jobs, and they can do the work with comparatively small expense to themselves; in fact, they would not be satisfied with anyone else figuring for them. Of course, in many instances, especially on such municipal work as has been referred to, contractors get together and compare notes as to their quantities, and possibly, as it is sometimes claimed, "get together" too much for the good of the job. However, it is not believed that the average bidder cares to have anyone else figure his quantities, his costs, or his totals for him. He will blindly bid on the engineer's bill of materials, if one is given, because he can blame the engineer and can claim that *that* is what he was asked to bid on. On the other hand, if no bill of material is furnished by the engineer—only a set of clear-cut plans and specifications with proper "Instructions to Bidders"—the contractor will go ahead and figure out his proposal, and there will be no unsatisfactory after-results. It costs him something to do it, to be sure, but it also costs something to conduct every business, and this is the contractor's unavoidable burden.

It is not because the writer has desired to escape responsibility or blame that he has become settled in the practice above outlined, but because—in spite of preconceived ideas to the contrary—after many trials, he has found it to be the best plan in every way.

As to these "Quantity Survey" concerns, referred to in the editorial in question, the writer thinks they will have a hard time of it. Where will there be found a Western contractor (or any other) who will pay 1½ per cent to have his quantities figured, on, say, a $50,000 municipal electric light and water plant and system, such as the writer has had to handle through this office many times. Furthermore, if such concerns undertake to guarantee these quantities, it is the writer's belief that they will spend most of their time engaged in lawsuits, and ultimately will wind up in failure.

We, in the writer's office, shall welcome any plan to overcome the difficulty under discussion, but we believe that it is not so much a "lack of efficiency" after all, nor is it anything which will require the complete overhauling of tried engineering practice.

When it comes to contracts of the form (b), above referred to, there is no harm, and it may be useful and helpful to furnish approximate lists of quantities; but in the other form of contract, it is believed to be a wholly mistaken idea for the engineer to attempt to furnish bills of materials.

Very truly yours,
W. K. Palmer.

The W. K. Palmer Company,
919 Baltimore Ave., Kansas City, Mo.
April 23, 1915.

Ventilation Standards for Factories.

(Staff Abstract.)

The American Society of Heating and Ventilating Engineers, through a committee, has prepared a set of minimum ventilation requirements for public and semi-public buildings as a basis for legislation recommended by the Society. The committee having this work in charge consisted of: James D. Hoffman, professor of mechanical engineering, University of Nebraska; E. Vernon Hill, Department of Health, Chicago; and Frank T. Chapman, eastern manager Vento Department, American Radiator Co. The standards recommended for factories are as follows:

A minimum floor area of 25 sq. ft., and a minimum cubic space of 250 cu. ft. per occupant shall be provided in all work rooms, and no work room, of which occupancy is taken after the date of issuance of this provision, shall have less than a clear height of 10 ft.

A positive supply of outdoor air from an uncontaminated source shall be provided the work room at all times during working hours, and the quantity of this positive supply of outdoor air shall be based upon a minimum requirement of 1,500 cu. ft. per hour per occupant.

The distribution of the supplied outdoor air shall be so arranged as to maintain the temperature requirement without uncomfortable drafts, or any draft lower than 60° F. in occupied spaces. A test of proper air supply and distribution will be that the CO_2 content in any occupied part of a work room shall not at any time exceed 10 parts in 10,000 parts of air, based upon tests taken in a zone from 3 ft. to 6 ft. above the floor line.

The temperature of the air in the work room shall, at all times during working hours, be maintained throughout the actual working spaces, within the range of 60° to 72° F., depending upon the class of work and workers—except when the outside temperature is sufficiently high that artificial heating in the building is not required, or when the particular class of manufacture or work requires or makes desirable other temperatures that may be approved by the department of health. The temperature of the air in offices shall be maintained during occupancy within the range of 65° to 70° F.; in wash, dressing and locker rooms during working hours, 60° to 70° F., and in toilet rooms 55° to 68° F.

Accurate thermometers, properly protected by open wire shields, shall be provided, set and maintained at a height of 5 ft. from the floor of all work rooms, at least one thermometer for every 2,000 sq. ft. of floor area. In addition, there shall be provided one such thermometer in each office, wash room, toilet room and locker room.

If the opinion of the department of health the air supply to any building is deemed impure or especially dust laden, filters, air washers or other appliances, satisfactory to the department, may be required

WATER WORKS

Novel, Simple Method of Applying Liquid Chlorine Under Pressure.

Contributed by J. W. Ledoux, Chief Engineer,
American Pipe and Construction Co.,
Philadelphia, Pa.

There are a number of water plants in the United States using pressure filters in which it would be desirable to use chlorine or hypochlorite of calcium as an aid to render the filtered water safe.

As there has been no very satisfactory method heretofore for thus treating the filtered water under pressure with liquid chlorine, engineers have resorted to the plan of applying the chlorine solution to the raw water and, by using a considerable amount more than would be necessary otherwise, the bacterial purification of the filtered water can be maintained at the desired degree. However, this phase of water purification has been the principal reason why many engineers prefer open gravity filters to pressure filters, because with the former the chlorine solution can be discharged directly into the filtered effluent where it does the most effective work.

The following plan would seem to be satisfactory for acomplishing this result with pressure filters.

Assuming that we are using liquid chlorine instead of hypo-chlorite of calcium, the needle valve connecting the top of the liquid chlorine tank would be opened a sufficient amount to discharge the desired amount of chlorine gas per unit of time. This chlorine gas would be conducted up through 5 or 6 ft. of, say, 8 in. vertical pipe (concrete or terra cotta), filled with broken pumice stone. At the top of the tank is sprayed the purified water, which, passing down through the broken stone, takes the chlorine gas into solution and discharges into a small tank of, say, 20 gals. capacity. This tank is maintained at a constant level by means of a float valve which controls the sprayed supply of purified water. The solution from the small tank is then pumped into the discharge main beyond the pressure filters by means of a reciprocating pump operated by either a water motor, electric motor, or a link connection with the main pumping engine, where this handles the entire supply, and thus the solution will be proportional to the rate of pumpage.

In most cases for small plants, where the amount of chlorine is, say, from 1 to 4 lbs. per 1,000,000 gals., it is not important that the supply of chlorine be in direct ratio to the pumpage. It is only necessary that there be sufficient chlorine to sterilize properly the supply, so therefore, the needle valve is set so that a given amount of chlorine can be discharged in the unit of time, say one day, and this can be readily effected by a few trials. The strength of the solution recommended should be so weak, say 1 part in 10,000 or more, that the chlorine is all taken into solution, and hence will not materially injure the parts of the small pump.

Design Features of the New Water Works at South Orange, N. J.

(Staff Article.)

The new water works plant at South Orange, N. J., combines utility and attractiveness in design. For a period of 20 years this city had been supplied with water by a private company, though the city had always owned the water mains. Owing to inadequate pressure and unsatisfactory quality of the original supply the city decided to install the new municipally owned supply works here described. Mr. John J. Boyd, consulting engineer, 11 Broadway, New York City, was engaged to find the new supply and to design the supply works. The supply is now derived from wells and is pumped to a distributing reservoir at a high elevation which gives sufficient pressure at all parts of the city.

THE SUPPLY.

Seven wells are now in service. All are 8 ins. in internal diameter and range in depth from 275 to 400 ft. Three of the wells are 275 ft. deep, three 300 ft. and one 400 ft. The minimum yield is from the 400 ft. well and is 70,000 gals. per day on a test. The maximum yield of a single well on test was 350,000 gals. per day. The combined yield of the seven wells on test was 1,693,000 gals. per day.

The wells are through about 30 ft. of loam, clay and hardpan and then through 230 to 270 ft. of solid rock to the water bearing stratum. The well casings are sealed into the rock at the bottom of the well. Around the top of each well there is a block of concrete 8 ft. square and 15 ins. thick which cuts off any surface water that otherwise might follow down the casing. The wells are located in a tract of land of about 27 acres belonging to the city and purchased for this purpose. The grounds around the pumping station and wells form a fenced-in public park.

Air Lift Pumping.—The air lift pumping system is utilized to get the water out of the wells. A 5 in. pipe extends down into the 8 in. well casing for a distance of about 140 ft. A 4 in. pipe extends down for a nearly equal distance inside the 5 in. pipe. Air from the compressors in the pumping station is forced down between these inner tubes and the alternate pistons of air and water are forced up to the surface through the inside or eduction pipe. At the top of each eduction pipe a deflector turns the water into pipes through which it flows by gravity to a basin at the pumping station. Here the water is picked up by the high lift pumps and is pumped into the distributing reservoir whence it flows by gravity to the consumers.

Additional wells will be driven when the demand increases sufficiently to warrant extending the supply works. The well system can readily be extended to long distances from the power house.

The per capita consumption of water increased from 33 gals. per day in 1894 to 65 gals. in 1912. In the latter year the total daily consumption was 396,800 gals.

PUMPING STATION AND EQUIPMENT.

Building.—The pumping station building is a substantial tapestry brick structure on reinforced concrete foundations. The roof is covered with green tile. As shown in Fig. 1 the station building harmonizes well with the grounds in which it is located. The walls of the engine room are wainscoted, to a height of 8 ft., with white glazed brick. See Fig. 2. The interior of the plant is designed so as to invite good care and cleanliness from the operators. The smoke stack, 125 ft. high and 5 ft. in diameter at the top, is constructed of material matching the main building. A railroad siding brings coal to the pockets along one side of the boiler room.

About one-third of the floor space in the pumping station was left vacant to provide space for an electric plant for lighting the city streets. If such a plant is installed the generators will be run from the same boilers as the pumps, one being operated chiefly at night and the other in the daytime, or both together if necessary. There is space enough in the boiler room for an additional boiler should one be required.

Equipment.—The machinery is in duplicate throughout. Thus there are two boilers, two air compressors and two pumps so that there is always a complete reserve equipment. The water tube boilers are of 210 H. P. each. They carry a normal working pressure of 150 lbs., although they can be operated at pressures up to 190 lbs. if desired. These boilers were manufactured by the Murray Iron Works of Burlington, Ia.

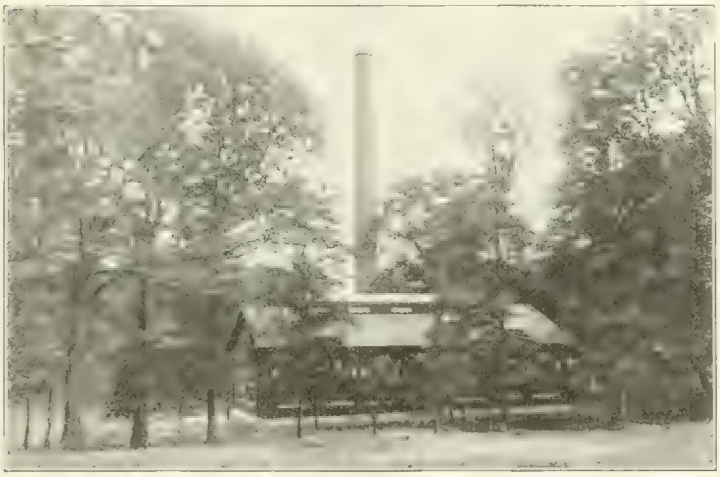


Fig. 1. View of Water Works Pumping Station at South Orange, N. J.

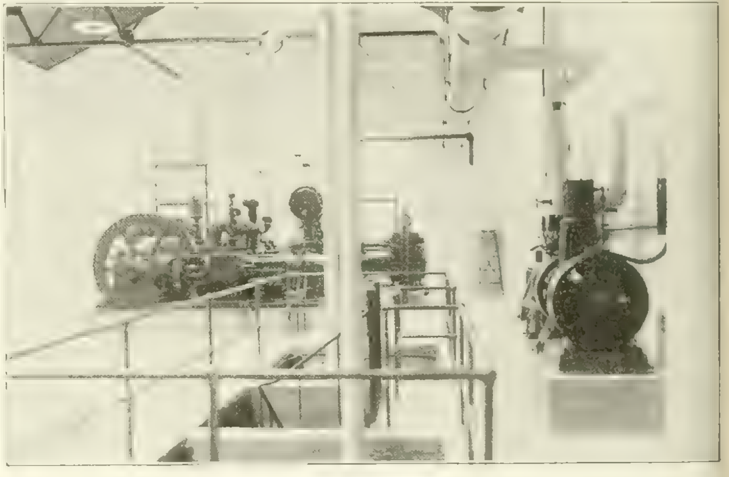


Fig. 2. View of Pump Room of New Water Works at South Orange, N. J.

The air compressors are of Laidlow-Dunn-Gordon manufacture with Meyer valve gear on the steam ends. They are of the cross compound, two stage type. Their principal dimensions are as follows:

	Ins.
High pressure steam cylinder, diameter	11
Low pressure steam cylinder, diameter	20
Intake air cylinder, diameter	20
Compression air cylinder, diameter	13
Stroke, length	12

The capacity of each compressor, with the present well system, is about 1,300,000 gals. per day.

The pumps are of Epping Carpenter Co. manufacture. They are of the triple expansion type of guaranteed duty of 80,000,000 ft.-lbs. per 1,000 lbs. of commercially dry steam. The principal dimensions are as follows:

	Ins.
High pressure steam cylinder, diameter	8
Intermediate pressure steam cylinder, diam.	12
Low pressure steam cylinder, diameter	30
Water cylinder, diameter	9½
Length of stroke	16

The normal capacity of each pump is from 800 to 900 gals. per minute, but in emergency this could be increased to 1,000 gals. per minute or 1,440,000 gals. per 24 hours. Both pumps and compressors will operate condensing the water for this purpose being taken from the Rahway River and returned thereto.

The boiler room is well fitted out with auxiliary machinery. There are two independent jet condensers, each of sufficient capacity to condense the steam from one compressor and one pump. These are of the Blake and Knowles manufacture. There are two Henry R. Worthington boiler feed pumps. The single feed water heater is so proportioned as to take the exhaust steam from the condenser pump and the boiler feed pump to heat the water fed to the boilers to a temperature of 190 to 210° F.

PLAN OF OPERATION.

The plant is designed so that one boiler will operate one compressor and one pump. The units can, of course, both be operated at the same time if desired, as long as the rate of supply is sufficient. It is not necessary to pump continuously at present. That would require extra labor and add to the operation charges. The capacity of wells and pumps is such that enough water can be raised in an ordinary working day to supply the city for 24 hours. The reservoir capacity is 2,000,000 gals. and the ordinary daily requirement is only about 400,000 gals. The reservoir is filled and after the daylight run of the pumps will keep the supply up to the demand. The 12-in. main from the pumps to the reservoir is also connected directly to the distribution system so that the reservoir acts as an equalizer. The system is valved so as to permit cutting out either the pumps or the reservoir when desired.

The power plant includes a dynamo for lighting the building and grounds and there is a storage battery for lighting when the boilers are shut down. There is an air tank and fire whistle for sounding alarms, the latter being connected with the fire-alarm system of the city and actuated from the boxes, the police headquarters or the fire department building.

THE DISTRIBUTION RESERVOIR.

The reservoir is trapezoidal in plan being 255 ft. long, 90 ft. wide at one end and 20 ft. at the other, and 23 ft. 9 ins. deep, the shape conforming to the topography of the site. It is divided into two sections either of which can be cut off for cleaning, leaving the other in service. Its elevation gives a pressure of 117 lbs. at the city hall. If houses should be built near the top of the mountain, too high to be served from the reservoir, they can be supplied from a small standpipe set on land owned by the city, at a higher elevation than the reservoir. This small standpipe would be filled by an electrically driven pump operated from the power house. A conduit for electric wires for telephone, lighting and power has been laid over the 12 in. main connecting the main pumping station and the present distribution reservoir. The present reservoir was made by excavating rock from the mountain side and by lining the excavation with walls and floor of reinforced concrete. The reservoir has a reinforced concrete roof supported by steel columns encased in concrete. The roof is covered with earth and seeded in grass.

COST.

The cost of the works here described was approximately as follows:

Real estate (36 acres)	$ 70,369.84
Wells	10,697.47
Pumping station, machinery, etc.	65,465.89
Reservoir	46,694.09
Pipe lines	9,111.93
Engineering, inspection, etc.	9,223.96
Interest	6,082.00
Grading roadway, etc.	2,284.30
Miscellaneous	1,820.02
	$221,749.50

The earnings of the department are sufficient to meet all charges for operation, interest and sinking fund.

The information from which this article was prepared was furnished by Mr. Edwin S. Allen, 75 Church St., New York City. Mr. Allen was chairman of the water committee at the time this new plant was constructed. We are also indebted to him for the photographs of the pumping station shown herewith.

Methods and Cost of Pneumatic Calking of Lead Wool Joints in Large Gas Mains in Chicago.

(Staff Abstract.)

The present article describes the methods employed in pneumatic calking with lead wool the joints in several large cast iron gas mains in Chicago in recent years. Special reference is made to a 36 in. main 13.3 miles long. Numerous unit cost and time data are given and construction plant and methods are described.

A 36-IN. MAIN 13.3 MILES LONG.

Lead wool was decided upon as a jointing material for this 36-in. main because cast lead and cement joints had made a poor showing in the past in preventing joint leaks. A series of tests were made of lead wool joints by the engineers of the People's Gas Light and Coke Co., for whom all the work here described was performed, and these laboratory tests distinctly indicated the superiority of lead wool over other materials for jointing purposes in gas mains, both from the mechanical and electrolytic standpoint.

PNEUMATIC CALKING.

Because of the cost of hand calking on lead wool joints, due to the necessity of using a full set of tools on each ring of lead, this method was not to be thought of in connection with the 13-mile line of 36-in. pipe. Pneumatic calking was adopted as the only available method productive of economy.

DIRECTION OF WORK AND FORMATION OF GANGS.

The installation of this main was done under the direction of the General Superintendent of the Street Department, the Assistant General Superintendent and the Superintendent of Mains of the People's Gas Light and Coke Co. of Chicago. In actual charge of the work were the Superintendent of the Division and his assistant in those divisions through which the main was laid. An engineer was placed in charge of the engineering details of the whole route whose duty it was to see that proper grades were maintained and that obstacles in the line were removed or arrangements made for clearing them. In addition, it was his duty to keep a profile and location of the line and to make any necessary field sketches.

Four gangs were organized to accomplish the work, estimated to take from April 15 to October, 1912, since the route decided upon traversed thickly settled manufacturing districts, residence districts and prairie land.

The organization of each gang was as follows: foreman in charge of the gang, apprentice engineer, foreman of calkers, or inspector of joints, machinist in charge of the compressor, time keeper, tool keeper, various straw bosses as necessary, each gang averaged 130 men and had about ten calkers.

The duty of the foreman was to direct and be responsible for each gang. The apprentice engineer's work was to maintain the grades for the main, keep records on the calking and in addition was to make himself generally useful. The duty of the foreman of calkers or inspector of joints was to see that the calkers were supplied with lead wool and yarn and that the proper amounts were used. He also assigned the joints to the calkers and was held responsible for the condition of the joints after they were made. The machinist in charge of the compressor, in addition to the usual duties of the position, made the necessary repairs, where possible, on the pneumatic tools to maintain them in good condition. The work of the timekeeper and the toolkeeper is obvious, but in addition to their regular duties they were expected to roll up and weigh the strands of lead wool for the calkers and were also to arrange the yarn for introduction into the joint.

INSTRUCTION OF CALKERS.

After deciding upon the formation of the gangs, it became necessary to provide the means for instructing those men who would be directly in charge of the work and those who were actually to use the hammers. For this purpose, a "Course of Instruction for Street Men" was started at the South Shop in March, 1912. The apparatus for this purpose was the same as that used in the later work on the street, with this exception, that instead of a gasoline engine, a 15 hp. steam engine was used to drive the compressor. (All apparatus will be further dealt with and described.)

In order to provide a convenient means for conducting this training, and to give the men involved experience as nearly approaching actual conditions as possible, a 36-in. joint was used, made of a short bell and a short spigot piece of pipe. The bell piece was cut into two parts, the cuts being diametrically opposite to each other, and the two halves then held together by bands running around the pipe and fastened by heavy bolts. When a joint was calked, the bell piece was then separated, thus exposing the yarn and lead and immediately disclosing the character of the work. Each pair of calkers was required to calk two or three joints in one visit to the shop, and returned again for further practice in two or three weeks. From March 11 until April 12, 53 men received instruction and training in this method of calking, during which time 76 joints were calked and four or five tons of lead wool used. A close record was maintained of the performance of each man, both regarding the time of operation and the material used, and by this method a fair comparison of the relative merits of the operators was made possible. To determine the correct amount of calking material which should be used, other 36-in. joints were made up with both lead wool and cast lead, driven up with pneumatic tools and also by hand. After the joints were completed the bells were broken, the quality of the joint noted and samples taken in order that specific gravity tests might be conducted. From the report of the testing laboratory four samples thus taken showed the following:

Sample	Sp. gr. of section as calked	Sp. gr. of ring as calked	True sp. gr. [illegible]
Lead wool, hand calked.	10.79	10.61	11.30
Lead wool, pneumatic calked	11.11	11.26	11.[illegible]
Cast lead, hand-calked..	10.84	11.15	11.36
Cast lead, pneumatic calked	11.[illegible]9	11.09	11.[illegible]

As will be noted from the above table, the samples of joints which are pneumatically calked are uniformly more dense and their specific gravities nearer to the true specific gravities than are the hand-calked samples. It is also to be commented upon that the gravity of the ring of lead wool back of the recess in the bell is more dense and its specific gravity nearer to the true specific gravity than is a like sample from the cast lead joint. Therefore, this test tends to show that the best and most uniform results are obtained from lead wool, calked with pneumatic hammers. Similar tests, made from samples taken from bells which split after calking during the installation of the main, were a means to determine whether this standard was being maintained.

APPARATUS AND MATERIALS USED IN WORK

After the test joints at the South Shop had been carefully examined, it was decided that the 5-in. joint on 36-in. pipe should be made as follows: Three inches of yarn was to be first inserted and calked by the pneumatic hammers, the weight varying as the size of the joint varied, averaging, however, about 6 or 7 lbs. The remainder of the joint, 2 ins., was to be filled with lead wool, weighting about 75 lbs., this weight also depending upon the size of the joint. The equipment of each gang working on the 36-in. main was practically the same, so that a description of one will suffice. The portable compressor outfit consisted of a 15 hp. Otto gasoline engine, 225 rpm., directly geared to an N. E.-1 Ingersoll-Rand compressor, 170 rpm., with a cylinder size of 8 ins. by 8 ins. and delivering 76 cu. ft. of free air per minute at a pressure of 80 to 100 lbs. Mounted on the frame with the engine and compressor was an auxiliary compression tank 18 ins. by 6 ft., and all other accessories, the whole having a shipping weight of 7,200 lbs. In connection with each outfit a storage tank 3 ft. by 6 ft. was provided, so that from 6 to 8 pneumatic hammers could be used at the same time by each gang, since without this tank only 5 hammers could be used simultaneously.

The calkers worked in pairs, each man being equipped with a 15-53 H. Ingersoll-Rand Crown valve pneumatic hammer, having a 1⅛-in. bore and a 3-in. stroke, and delivering approximately 1,800 blows per minute. In addition to the 8 hammers used on each gang there were seven additional ones supplied so that a defective hammer could be replaced without causing any time to be lost. In addition to the pneumatic hammer, each calker was given a set of 8 calking tools and each pair of calkers was provided with a pail containing a hammer wrench, a 10-in. Stillson wrench, an oil can, 3 cold chisels and 1 hand calking hammer.

The air was carried through a 2-in. steel line laid beside the trench for a distance of about 600 ft. either way from the compressor and joined by Dart unions every two lengths. At every 20 ft. a branch was taken off this line, this branch being divided to supply two air hose. Each of these two latter branches was equipped with a valve and had attached to it 25 ft. of ½-in. hose, directly connected to the hammers. By this means it was possible to calk a large number of joints without moving the compressor and no appreciable loss in pressure was encountered by this arrangement, nor did it require long leads of hose. Each gang was also supplied with diamond points and half rounds for cutting and tapping pipe with special pneumatic hammers, some of this work being attempted, in the latter case with somewhat indifferent results.

At the beginning of the work, some difficulty was experienced with the pneumatic hammers, this being in many instances due to lack of experience on the part of the operators. Among these troubles may be mentioned the loosening of barrels, handles splitting where the barrels were screwed into them, breaks at the inlet of the air, the loosening of bolts, etc. Practically all of these troubles were directly traceable to the fault of not holding the calking blank tight against the hammer. This allowed the piston to hit against the shoulder of the barrel, the force of the blow being entirely taken up by the hammer itself instead of being received by the calking blank. With increased experience serious hammer trouble disappeared, the minor repairs and the replacement of worn out parts being taken care of by the machinist in charge of the compressor. This man was provided with a work bench, equipped with soft jawed vise, etc., and was supplied with duplicate parts, so that the hammers were maintained at a high state of efficiency, and the cost of repairs reduced to a minimum. After each day's work the hammers were carefully cleaned and immersed in a bath of kerosene, in which they remained all night. The compressor outfit gave practically no trouble, so that it might be stated that the whole equipment gave perfect satisfaction after the men became familiar with its operation.

METHOD FOLLOWED IN "LAYING UP" JOINTS

The preliminary work in connection with the calking of these joints was conducted thoroughly, and it is to this work that some credit should be given for the success of the undertaking. The bell and spigot of the pipe was cleaned before laying and extreme care was used to carry the pipe home. The centering and blocking were carefully done so that an even joint would be insured at all quarters of the pipe. After this was accomplished, a piece of yarn especially prepared for the purpose was tucked into the joint to exclude dirt, this yarn remaining in place until the calkers were ready to begin work on the joint.

The yarn used in calking the joint was prepared at the "camp" and fastened in bundles of various weights, this weight ranging around 7 lbs. The lead wool was shipped to the gang in sacks of 100 lbs. each, at which place it was rolled into suitable lengths for inserting into the joint, and definite amounts weighed out. The amount weighed out varied as the diametrical thickness of the joints varied, and it was the endeavor to provide as little over the actual amount of lead wool needed as possible in order to reduce the waste to a minimum, therefore if the joints were averaging 70 lbs., 75 lbs. was provided; if they were averaging 75 lbs., 80 lbs. was provided, etc. This definite amount was then put into a box, especially provided for this purpose. This box was numbered and the weight of the lead wool noted on a record card. When the calkers were ready to work on the joint, they indicated to the foreman of calkers the size of the joint and whether a small or a large amount of lead wool and yarn was required. The suitable bundle of yarn and the box containing the nearly correct amount of lead wool, was then taken to the joint, the number of the joint, the box of lead and the bundle of yarn being credited to the pair of calkers.

The first step in the joint work consisted in removing the yarn which was tucked into the joint at the time it was laid. After this was done, and as a means of additional precaution against dirt remaining in the joint, the air hose was used to blow out any which might have been admitted before the joint was protected by the yarn.

The thickness of the calking tools was as follows:

No. of tool.	Thickness ins.	No. of tool.	Thickness ins.
1	¼	[illegible]	9/16
2.	⅜	6.	[illegible]
3.	7/16	[illegible]	11/16
4.	½	8.	[illegible]

The first yarn, consisting of about six strands, was then pushed into the joint, tool No. 1 being used for this purpose. After this was in place, and any excess length cut off, it was calked by tool No. 3 in the pneumatic hammers, each man starting at the bottom and working to the top without stopping in order to insure an even distance being maintained on this first, and the subsequent yarns. After this first was tightly driven, another yarn was inserted, which consisted of 8 or 9 strands. Tools No. 3 and 5 were used to calk this yarn, the same procedure being followed as in the first case. This method was carried out until the yarn came to within the required 2 ins. of the face of the bell, at which point the lead wool was to be started. Slack places in the yarning were taken care of by doubling back any extra length instead of cutting it off.

Before using the lead wool a shallow galvanized iron pan was placed under the joint to catch any waste that might drop during the calking. When work on the line was first started it was customary to calk separately the first two strands of lead wool inserted in the joint. It was found, however, that this method allowed the lead to crawl around the joint, so it was deemed expedient to calk the first two strands together. Consequently two strands were introduced all around the joint, the calkers working from the bottom upward and continuing to the top. When these strands were driven up and even, a third strand was inserted, and so placed as to break joints with the first rings calked. This ring was calked in the same manner as the previous ones; this method being carried out until the face of the bell was reached, when the joint was finished off. A full set of tools was used on each joint, save possibly No. 7, the larger sizes and special tools being used when the joint was especially large.

After the joint was finished, the lead wool and yarn which remained, together with the waste lead in the tray under the joint, was gathered up and returned to the "camp" where it was weighed. Thus the amount of material used was accurately determined and charged to the pair of calkers who worked on the joints. The time spent in yarning and calking the joint was also noted. After sufficient length of main to warrant testing was completed, a test was made, the compressor providing the air. After 15 lbs. was reached, each joint was carefully gone over with soap and water. Since the number of the joint was recorded in the name of the men who did the work, it was easily seen which men were negligent if the joint failed to hold. As a matter of fact, except for the first joints calked, few were found leaking under the test, and owing to the newness of the work, the first few leaking ones were not unexpected.

Since the number of joints possible to calk in one day was dependent upon the number of feet of pipe laid, and since this latter was directly dependent upon the character of the sub-soil encountered a statement of the number of joints daily calked would be of no value. It was necessary, however, that each gang calk on an average 10 joints per day in order to finish the work on schedule time. There were times, however, under favorable conditions, where a pair of calkers finished 5 or 6 joints in a 9-hour day, but there were also times when it was possible to lay only three of four lengths of pine in one day, so consequently only one joint was calked by each pair. As a general average for all the joints in the line, calked by this method, the time of yarning was 43 minutes and that of calking 1 hour and 14 minutes.

In conducting the work on this line, it was found advisable not to use any lead wool that had become wet, therefore a canvas cover was provided for each bell hole for protecting the men and the lead during a slight fall of rain, and also to provide a shelter for the calkers from the sun during the heat of the day. Rainy days were used to test the line laid, if this were possible, and on this phase of the work some interesting figures were obtained. It required two compressors 2 hours and 45 minutes to fill 2,568 ft. of main and one compressor 4 hours and 30 minutes to fill 2,028 ft. of main with air at a pressure of 15 lbs.

REPORTS AND FIGURES ON WORK.

In order to keep accurate records for this work daily reports on each gang were filled out by the apprentice engineer. These reports were two in number and consisted of a "Report of Calkers" and a "Daily Report" containing in detail, the work of each gang. One copy of the "Report of Calkers" was filled out for each pair of calkers, and contained all the information pertinent to the operations connected with each joint. The "Daily Report" presented a comprehensive outline of the daily work of each job. The two reports were then assembled at the general office, and an assembled copy given to the General Superintendent, who then had an accurate indication of the whole work. In addition to these reports, there was compiled a "Daily Average of Calkers" which gave the cost average for calking and the average material used by each man to date, and this record, coupled with that maintained at the gang concerning the holding of the joint under test, determined the fitness of the man for an increase in rate of pay. On this basis this determination absolutely rested. A daily blotter was maintained showing the number of feet of pipe laid the previous day, the total laid and the total to be laid. A progress map was also posted daily which presented in graphical form the exact amount of work done and also the amount of pipe strung on the street. Sketches of street intersection, etc., were also sent in by the engineer to form part of the record. The total number of joints calked by means of the methods above described was 5,917. The average cost per joint was $7.46, divided into $1.04 for labor and $6.42 for material. The average weight of the material used in each joint was 6.2 lbs. of yarn and 72.4 lbs. of lead wool. The total number of feet of pipe laid was 69,553, at an average cost of $7.09 per foot. The cost figures are actual shop costs determined from the daily reports and do not contain any overhead expenses.

After this main was finished and gas at 5 lbs. pressure put into it, everyone connected with the work waited with an air of expectancy for complaints of leaking joints. Past experience had been that within a short time after installing a main these complaints started, and it was with incredulity and finally with amazement that it was seen that the main was holding tight, at least from all external appearances. One break developed, but beyond this, no other trouble was reported and none has been experienced up to November, 1914. Several stretches of this line have been exposed through other main operations; in all about 150 joints have been uncovered at different points, and they are without a fault. While it may be too soon for congratulations on this line, it seems at least an indication that the work was well done and that the material used was of the highest quality that could be obtained.

METHOD PURSUED IN FOLLOWING YEARS

No mention has previously been made as to the kind of lead wool used on this line for the reason that it is desired to make this the connecting statement between the description of the installation of the 36-in. main, and the outline of later work since a change in this product is the most important difference between the work of 1912 and that of the following years.

Practically the entire 36-in. main was laid with lead wool furnished by the New York Lead Wool Co., only enough of the product of the United Lead Co. being used for experiment. The product of each of these companies was entirely satisfactory, there being little choice between them. Specific gravity tests showed that each was composed of lead of a high grade of purity, and when calked closely approached the true specific gravity of the fused metal. The change from the use of lead wool furnished by the New York Lead Wool Co., to that of the United Lead Co., for the later work was entirely due to the fact that the product of the latter company was supplied in continuous strands, coiled on reels. This aided in eliminating waste, and provided an easier means for transportation and handling at the gang.

Except for the above change subsequent work has been conducted along the same lines as it was during 1912. A minor change has been made in the compressor outfit, in connecting the auxiliary storage tank to the compressor by means of a metallic hose, thus eliminating the transmission of vibration from the engine to the tank. Air is maintained at 100 lbs. pressure in the tank, the outlet being equipped with a reducing valve, which cuts this pressure to 75 lbs. By this means it has been proven that a more uniform supply could be provided when all of the hammers were operating, in addition to obtaining a better calked joint with the latter pressure than with the former. The same calking tools are being used on this year's work as were used on the 36-in. main, the arc of the tools having been changed to fit 24-in., 16-in. and 12-in. pipe.

The same records being maintained, it is possible to give some results on the pneumatic calking of lead wool on smaller sized pipes. On 443 joints of 12-in. main, the total cost per joint has been $1.76, divided into $.27 for labor and $1.49 for material. On 1,922 joints of 16-in. main a total cost per joint has been $2.31, $.32 for labor and $1.99 for material. On 400 joints of 24-in. main, the total cost per joint has been $4.37, $.78 for labor and $3.59 for material.

As a means of determining the time consumed in yarning and calking joints on these sizes of mains, and also to find out the weight of the lead wool and yarn used, 100 joints were averaged, the results showing the following.

Size.	Time of yarning, min.	Time of calking, min.	Weight of lead wool, lbs.	Weight of yarn, lbs.
12-in......	25	27	16.5	1.6
16-in......	10	21	23.4	2.5
24-in......	22	33	42.7	6.3

In laying the 12-in. main only one calker works on a joint, but on the 16-in. and 24-in. mains there are two men on each. The figures on the 12-in. main are those made by men inexperienced in the use of pneumatic hammers, this accounting somewhat for the slow time as indicated.

ACKNOWLEDGMENT.

The foregoing matter is from a paper before the Illinois Gas Association by C. E. Reinicker of the engineering department of the People's Gas Light and Coke Co., of Chicago.

Standard Fittings for Water Meters.

(Staff Abstract.)

At the 1913 annual convention of the American Water Works Association a committee on standard fittings for water meters was appointed, and was instructed to report on a revision of the standards of meter lengths and meter connections. The committee, of which Chester R. McFarland, general manager of the Tampa Water Works Co. of Tampa, Fla., is chairman, has acted in conjunction with representatives of the meter manufacturers in its deliberations. Such a conference was held at the Cincinnati meeting recently and we publish herewith the gist of the conclusions reached.

The committee did not arrive at a standard for all the meters but did so for the smaller sizes. It was thought to be unnecessary to fix a standard for ½, ⅝ or 1¼ in. meters although some of the latter are used.

The effort made was to find some standard that would not interfere with present conditions, either of the manufacturers or the users of these meters.

LENGTH OF METERS.

In fixing these sizes for lengths, which was the first matter to come up and in going over the different lengths, the committee concluded that the length of the ⅝ in. meter from end of spud should be 7⅜ ins., but some of the manufacturers objected to this, and one manufacturer believed that it would be necessary to change his pattern to do this. This matter has not been fully investigated, and if it would be necessary for him to change his pattern, then 7½ ins. would probably be the length to be adopted.

In the ¾ in. meter, they universally agreed that 9 ins. was the proper length.

On the 1 in. there was an agreement reached on 10¾ ins.

THREADS FOR METERS AND COUPLINGS.

It was agreed that what was known as the "Briggs Standard Straight Thread" would probably be more nearly universal than anything that the committee could establish to conform with what is being used. It was the opinion of the committee that Briggs Standard Straight Thread should be used in the next size larger than the size of the meter. For instance, with a ¾ in. meter, it is necessary to use Briggs 1 in. thread, which is practically what is being used today. That is as far as the committee went into this matter.

LARGER METERS.

In regard to the larger meter, the question arose as to whether they should be thread meters, with either male or female connections, or flange connections.

The committee found in discussing the matter with the manufacturers that the larger percentage of the 1½ in., and the 2 in. meters that they sell, are sold with female threads, while the opinion of the committee was that it would prefer to have a standard flange coupling, a 2-bolt coupling.

However, it is not the intention of the committee to interfere with the present conditions any more than is necessary, but to arrive at some fixed standard on which all can agree to operate water plants. It is the intention of the committee to proceed further with this matter and to prepare a standard set of specifications for these meters, or to adopt two different lengths, one for male connections and the other for flange connections. The objection raised by the manufacturers as to the adoption of the flange connections was that in making the flange on a meter they had to make it so heavy that it might be a burden on the producer of the meter. The trouble is that if these flanges are brought up parallel to each other a like flange on the meter can be used, but if the meter should be a little out of line the workman applies a wrench on the bolt and away goes the flange on the meter, and the bottom of that meter is lost. Therefore, the reason the manufacturers think it would be better to use on the 1½ in. and 2 in. meters a female coupling rather than a flange coupling is clear.

In reference to the lengths of the larger meters the committee has not changed its recommendations made last year.

ACKNOWLEDGMENT.

The foregoing is an abstract of the 1915 report of the Committee, of the American Water Works Association, on Standard Fittings for Water Meters. The Committee has been continued and will report further progress next year.

Notes on Water Supplies from Wells in Gravel.

(Staff Abstract.)

Satisfactory methods of drawing water from wells in gravel were described by several water works operators in a discussion at the recent convention of the American Water Works Association. In connection with the article in our issue of May 19, on the gravel well water supply at Delaware, O., the accounts given here furnish a very useful group of solutions of an oftentimes troublesome operation problem.

Mr. W. J. Haddow of Frankfort, Ontario, states that his city derives its water supply from a gravel bar soil. The supply works consist of a long collecting gallery made of perforated tile pipe laid according to the contour of the adjacent river, and the water flows down through that gallery into a large concrete well. In case of low water, water is admitted from the river and flows to the central well from which it is distributed into the different sections so that it will again fall into the collecting gallery. The low water difficulty is thus obviated.

Mr. W. E. Haseltine, manager of the Ripon, Wis., Water Co., states that his company also derives its supply from gravel wells. The wells are not over 15 to 18 ft. deep. An excavation was dug to this depth and a collecting gallery was there constructed. The gallery walls are laid with rock and are reinforced with a concrete cap. The gallery leads to the collecting well, which is also located in the gravel, and the water is pumped from that.

Mr. John W. Moore, Consulting Engineer, Indianapolis, Ind., describes the procedure in vogue in Indiana as follows:

In Indiana we put in what we call a combination well. We get the water from the gravel as well as stone. We put in a pipe of a size larger than the size of the strainer that we are going to use. We drive pipe to the bottom of the water bearing gravel or to the stone, then pass a strainer, smaller pipe, down after drilling in it five holes about ⅝ in. in diameter. The outer edge of the holes is beveled to about 1 in. Around this pipe there is a perforated sheet of brass, the perforations being cut to suit the size of gravel traversed. The entire pipe is then put in, which brings the strainer opposite the water bearing gravel, when the outside pipe is removed by a hydraulic jack. If more water is desired, or if submergence is desired, the well driller goes down into the rock with a smaller size hole. In this way we get water from the gravel as well as the rock. This makes a very good well where large quantities of water are desired.

Mr. H. Hymmen, superintendent of water works at Berlin, Ontario, states that his city has a system of about 15 wells in gravel. Some of them are pumped by compressed air. He has started to use turbine pumps, direct connected, electric drive, and they are giving very good results. When the compressed air system of pumping was installed it pumped out sand and filled up the conduits. A small turbine pump, 3-in., was then installed. The other wells are being changed over from air lift to turbine pumps.

ACKNOWLEIGMENT.

The foregoing matter is from the discussion of the paper by Mr. C. W. Wiles of Delaware, O., before the recent annual meeting of the American Water Works Association. His paper was published in this journal of May 19, 1915.

Some Experiences in Packing Valves.

(Staff Abstract.)

On Superintendents' Day, at the recent annual meeting of the American Water Works Association, there was a topical discussion on the care of valves with special reference to the methods and materials used in packing them.

Mr. M. L. Worrell, General Manager of the Meridian, Miss., water works, stated that he has found lead wool to be the most satisfactory material for packing valves. Once the valve is properly packed with this material, present indications are that the job will last "forever"; failure will occur at some point other than in the packing. Mr. Worrell has used lead wool for this purpose ever since it has been on the market and has never had occasion to repack a valve in which this material was used. In some cases he has used graphite or other lubricant in connection with the lead wool, and in other cases the lead wool has been used alone. The addition of the lubricant does not seem to add anything of value. Mr. Worrell has not tried lead wool on fire hydrants. He first used it because, on one occasion, it was necessary to pack a valve out on the job and nothing else than lead wool was handy, so he decided to give it a trial. At the present time his engineer at the pumping station is using it with satisfactory results. It is used on all valves at Meridian, both large and small.

Mr. A. A. Reimer, Superintendent of Water Works at East Orange, N. J., feels that a sufficiently long period has not elapsed since lead wool was placed on the market, to warrant calling its durability "everlasting" for the purpose here under consideration. At East Orange, Mr. Reimer specifies high grade Italian hemp packing laid in tallow. He has had a 25-year test of that material without repacking, except for examination, and on examination the tallow is shown still to possess lubricating value. Recently he has been using a little graphite mixed with the tallow, but regards the addition of the graphite as unnecessary.

Mr. H. C. Hodgkins, civil engineer, Syracuse, N. Y., stated that in 1907 he took out about 475 valves from 6 to 12 ins. in size, in which the box packing had been lubricated with tallow and graphite. He has examined the valves and the packing occasionally and it seems to be in as good condition, apparently, as when first placed. The valves have been operated only at intervals as necessary.

Secretary J. M. Diven, of Troy, N. Y., raised a question as to whether a new valve, as received from the factory, is packed as it should be with a durable form of packing, or whether the valve should be repacked before being placed in service. In this connection Mr. Raymond W. Carlin stated that in one water plant, of which he had charge, he found it necessary to repack all the new valves. The quality of that particular water supply was such that corrosion took place on all the valve stems and the packing, placed by the valve manufacturer, was soon eaten up. They were repacked with graphite and a few were packed with lead in the form of washers. As repacked the valves rendered good service.

Another Paying Publicity Measure Employed by the Terre Haute Water Works Co.

(Staff Abstract.)

The giving of souvenir lead pencils to those who pay water bills when due is one of the paying publicity measures employed by the Terre Haute Water Works Co. The procedure in this connection is here described by Mr. Dow R. Gwinn, President and Manager of the company.

There is a method of publicity which we use that I think brings good results: Our annual bills are payable quarterly and at the beginning of each quarter, for a period of ten days, we have a notice in the paper to the effect that "Water bills are now due and payable. Pencils to First Comers." We buy 50 gross of lead pencils at one time at $3 per gross, or a trifle over 2 cts. a piece. They are first class lead pencils, coated with white enamel, with gilt top and rubber and inscribed in gilt letters, "Compliments Terre Haute Water Works Co." "Pure Filtered Water—Low Rates." These pencils are distinctive and when one takes out a white pencil, practically everyone present knows that it is one of the Water Works pencils, and an expression frequently heard is, "I see you have paid your water bill." The beautiful white enamel is suggestive of the purity of the water, while the gilt letters suggest that the water is as good as gold.

As these pencils are given out from the 1st to the 11th of the month, at the time the quarterly payments are due, the people have learned that it is better to pay their bills promptly and get a pencil. When bills are not paid promptly, we must send a notice by mail with a 2 ct. stamp and envelope, making the cost equal to the cost of a lead pencil. Hence, we believe that outside of the value as an advertising medium, we are getting a good return on the investment.

Notes on the Use of Lead Wool Joints in Cast Iron Mains.

(Staff Abstract.)

The comparative merits of lead wool and cast lead joints in cast iron mains, particularly on small jobs and on dry as well as wet joints, were discussed on Superintendents' Day at the recent annual meeting of the American Water Works Association. The advantages of lead wool where only a few joints are to be made are especially pronounced.

Mr. John M. Diven, superintendent of water works at Troy, N. Y., stated that he has found the use of lead wool so satisfactory that, in small jobs, such as in setting fire hydrants where there are only four or five joints to make, he has not used a fire for years. He called attention to the fact that the time required to get the fire started and to get the melting apparatus in position, in the case of a small job, is a large percentage of the time required for the entire job, and is correspondingly expensive. On one large job he stipulated with the contractor that a half mile of pipe be laid with lead wool and hand caulked joints and a mile with air pressure joints. A careful record of the leaks in both types of joints was to have been kept, but the contractor's caulkers refused to do the work and the test was given up.

On another occasion Mr. Diven states that he had laid an 8-in. cast iron pipe line through swampy land. One-half of this line was caulked with lead wool and the other half with cast lead joints. Seven or eight months after the work was done there had been no leaks in the lead wool joints but all of the cast lead joints had developed leaks. The joints were all very deep and were from ½ to ¾ in. thick, and the lead wool held where the cast lead did not.

Mr. Oscar Bulkeley, engineer of the Rockford, Ill., water department, stated that in his department lead wool was used on a line of pipe 8 and 10 ins. in diameter, but the use of the material was abandoned because the caulkers refused to do the work. When caulked by hand it is a long and tedious job. The only way lead wool can be used to advantage, on big jobs, is in connection with pneumatic caulking.

Michigan County Surveyors Aided by New Legislation.—An act of the last Michigan Legislature put the office of county surveyor in that State on a higher level than it has been heretofore. Formerly the county surveyor received $4 a day for his services and he was not allowed his expenses. The chief provisions of the new law are as follows: County surveyors are elected, at the general election, for a term of two years. To be eligible to the office one must be either a graduate from an engineering course in the University of Michigan, the Michigan Agricultural College or the Michigan College of Mines; or a graduate from an engineering course of some other college or university of equal standard with those named; or a person who has completed all the prescribed courses in surveying of an engineering course in some reputable college or university, and has had at least two years' experience in the active practice of surveying or engineering; or a person who has had at least five years' experience in active practice of civil engineering or surveying within the State of Michigan.

The county surveyor and his deputies are entitled, under the provisions of the new law, to receive a compensation of not more than $6 a day for their respective services. This includes the time of traveling to and from the place of making the survey. All necessary expenses incurred in the discharge of duty are allowed. Provision is also made for the payment, by the person for whom the services are rendered, of a fee of 25 cts. for recording each description, and 25 cts. for each certificate or copy of description.

CONSTRUCTION PLANT

MACHINES DEVICES MATERIALS

An Electrically Controlled Automatic Sewage Ejector System.

In the sewerage of buildings with deep basements and of cities of flat topography, at a small elevation above the natural water course into which all drainage must ultimately discharge, it is frequently desirable to install some form of sewage ejector system which will operate automatically. These ejectors lift the collected matter to sewers draining by gravity to the main sewer outfall. The present article describes and illustrates the design of the Beggs Sewage Ejector System which is manufactured by James Beggs & Co., 36 Warren St., New York City. This system, with or without modification, can be used for handling any liquid accumulated in tanks at low levels and which must be lifted to higher levels. Figure 1 shows the arrangement and essentials of a complete installation which is made up as follows:

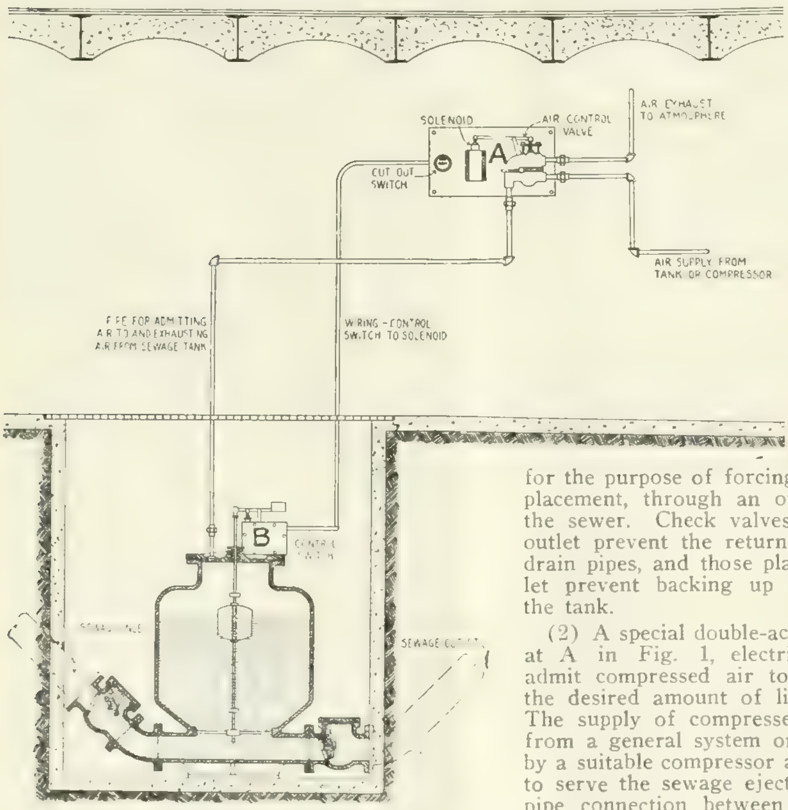

SOLENOID
AIR CONTROL VALVE
A
AIR EXHAUST TO ATMOSPHERE
CUT OUT SWITCH
AIR SUPPLY FROM TANK OR COMPRESSOR
PIPE FOR ADMITTING AIR TO AND EXHAUSTING AIR FROM SEWAGE TANK
WIRING - CONTROL SWITCH TO SOLENOID
B
CONTROL SWITCH
SEWAGE INLET
SEWAGE OUTLET

Fig. 1. Arrangement of Essential Features of a Complete Installation of the Beggs Sewage Ejector System.

(1) A receiving tank into which the sewage gravitates from the drain pipes, and which is designed to leave a space above the sewage in which compressed air is admitted for the purpose of forcing the sewage, by displacement, through an outlet connected with the sewer. Check valves placed in the tank outlet prevent the return of sewage into the drain pipes, and those placed in the tank outlet prevent backing up of the sewage into the tank.

(2) A special double-acting air valve, shown at A in Fig. 1, electrically controlled to admit compressed air to displace and expel the desired amount of liquid from the tank. The supply of compressed air may be taken from a general system or may be maintained by a suitable compressor and receiver installed to serve the sewage ejector exclusively. One pipe connection between this valve and the tank described above alternately serves the purpose of an inlet to the tank for compressed air, and an outlet for the exhaust of the air to the atmosphere after the sewage has been ejected and the tank is refilling.

(3) A float, rising and falling between stops according to the level of the sewage in the tank, automatically operates the control switch, shown at B in Fig. 1, mounted on the top of the tank. This control switch opens and closes the electric circuit through a solenoid mounted on the same base as the air valve, described above.

The solenoid, by which the air valve is operated, is designed for any voltage which may be required to meet local conditions, and is mounted on the same basis as the air-control valve and cut-out switch for throwing the entire system in or out of operation.

In operation the vertical rod connecting at its top to the switch lever, passes through the float, is guided near its upper end by a stuffing box in the cover of the tank, at its lower end by a suitable bearing, and is provided with two limiting stops.

The float, rising with the level of the liquid, strikes the upper stop and lifts the rod, which closes the switch, completes the electric circuit to the solenoid, which through its plunger and lever, closes the upper valve, admitting compressed air for the discharge of the sewage. Then the float descending with the level of the sewage in the tank strikes the lower stop, carries the rod down, opens the control switch, breaks the circuit to the solenoid, thus permitting the spring to close the lower valve and open the upper, relieving the air pressure through the vent to the atmosphere. This completes the cycle, and sewage then collects for the next discharging operation.

There are very few parts in the system and those are of simple nature. The operation of each part is distinct in itself, and if any difficulties should arise they can be readily traced and remedied.

This ejector is claimed by its makers to be sewage, gas and air tight. The sewage inlet and outlet are always sealed. Piping connections are reduced to a minimum. Practically no oiling or cleaning is required.

An Air Compressor of High Efficiency.

(Contributed.)

The constant demand for higher efficiency and greater economy, and the increasing tendency towards the use of higher steam pressures has led to the development by the Ingersoll-Rand Co. of the small steam-driven high-speed air compressor illutrated here. This machine is designed along the same lines as the company's former small steam-driven type, but embodies improvements which give it a higher efficiency in the air end and a considerably lower steam consumption. These improvements are:

Ingersoll-Rogler Air Valves.—These valves allow of high speeds, give high compression efficiency, are almost silent in operation and are independent of any operating mechanism. Before adopting this valve a thorough test was conducted to determine the life. This test consisted in running a 12-in. stroke compressor 400 revolutions per minute over a period of one year, during which time no valves were broken nor any adjustments required, and in the two years in which this type of valve has been on the market practically no breakage has resulted.

Small Steam-Driven High-Speed Air Compressor.

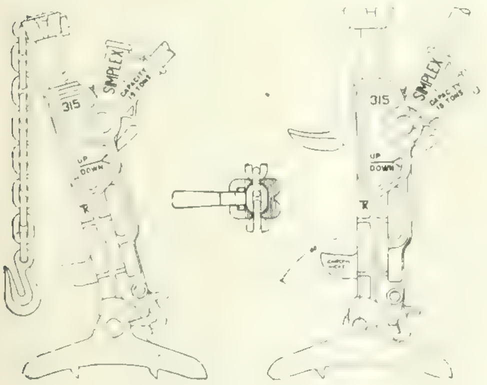
Balanced Piston Steam Valves.—This type of valve was adopted after extensive research. It is designed after the most successful European practice, permits of higher speeds, high steam pressures and the use of superheated steam, at the same time giving a higher efficiency under ordinary low pressure steam conditions.

Automatic Cut-Off Control.—This control gives steam economy under conditions of varying load or varying steam pressures. It is regulated by a centrifugal fly wheel governor which acts to shorten or lengthen the stroke of the piston valve, thus changing the cut-off.

The machine as a whole is designed and constructed with great thoroughneess of detail. Materials are disposed with special attention to great rigidity without excess weight; bearing surfaces are large and carefully finished. Special provision has been made for ready adjustment of all parts, without loss of time.

A Lifting Jack With Wide Range of Action.

The emergency jack shown in the accompanying illustration should prove a very useful tool for contractors. It combines the qualities of a crane and a jack and the wide range of its effective working angle enables it to be operated in difficult positions and under conditions which preclude the use of jacks of ordinary type. Equipped with an auxiliary shoe it may be operated at an angle of 60° from the vertical; with a chain the angle of operation may be increased to 90°.



Emergency Lifting Jack.

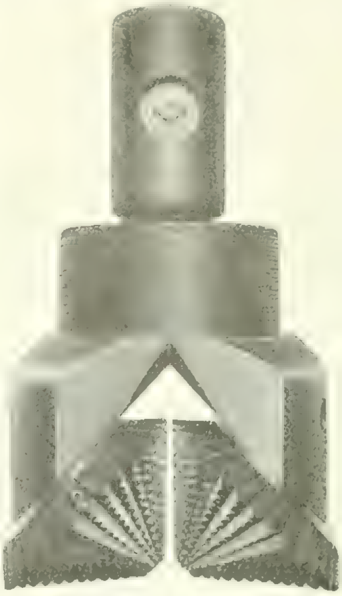
The standard or frame is a heavy malleable iron casting, ribbed for stress in every direction. The circular bottom of the frame rests with a machine fit upon two circular shoulders, which are a part of the large, well proportioned base. In this way the base takes the load and the steel pin acts to hold the frame in position. The rack bar and cap are heavy drop forgings. The top of the cap is recessed for the chain, which is a part of the equipment. The double socket of crucible steel makes it possible to handle a load with the jack at any angle. A very heavy trunnion bearing supports the socket. The trip at the back of the base either holds the frame in a rigid vertical position or releases it to pivot on the base. Five feet of chain and a five foot steel lever bar comprise the accessory equipment.

This jack is manufactured by Templeton, Kenly & Co., Ltd., 1028 So. Central Avenue, Chicago, Ill.

A New Bit for Rotary Drilling.

A new bit which is claimed to broaden the field of rotary drilling and to possess unusual efficiency is illustrated here. This bit is intended to replace the older fish-tail form of bit. Its cutting parts are two toothed rotating cones of hard steel and the cutting action is a process of chipping. Except for the bit the drilling operations conform to usual practice. A record of cone bit work is given by H. R. Hughes in the March Bulletin of the American Institute of Mining Engineers as follows:

Day crew—	
4 men, $3 per day, 6 days	$ 72.00
1 driller, $200 per month, 6 days	40.00
Night crew—	
4 men, $3 per day, 6 days	72.00
1 night driller, $5 per day, 6 days	30.00
Steam and water, 6 days, at $10	60.00
Rental of bit for 30 days	50.00
3 sets of cones, at $45	135.00
Total cost of 72 ft. of 9-in. hole	$459.00
Average cost per foot	6.38

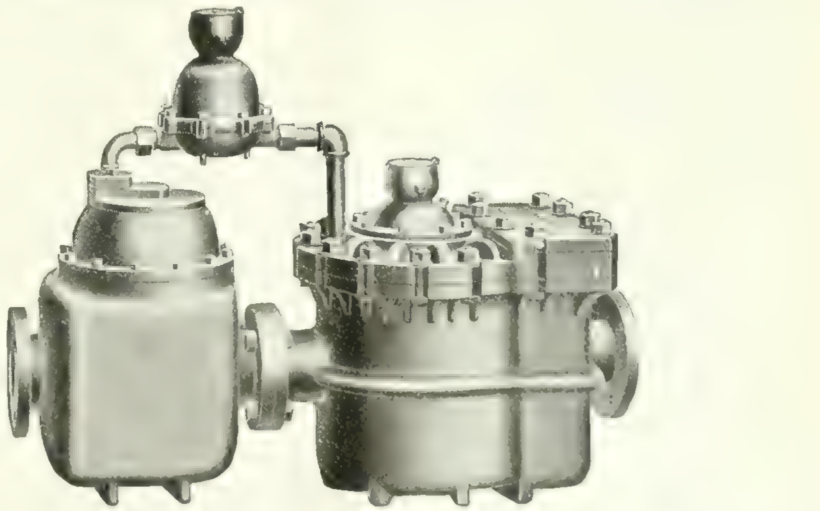


Cone Bit for Rotary Drilling.

A Compound Water Meter for Accurate Measurement of Large and Small Flows.

There are many situations, in water works practice, in which the flow of water varies between such wide limits that neither a large nor a small meter, alone, is satisfactory for measuring it. This condition prompted the Union Water Meter Co. of Worcester, Mass., to bring out its Nilo Compound meter which is arranged so that it measures both large and small flows, it is claimed, with equal accuracy. The new compound meter is a combination of the Nilo meter, a high duty meter of large capacity, and the King small flow disk meter, together with an automatic double differential vertical valve, guided and united by a central stem. The compound meter is illustrated herewith.

The combined valve area is equal to twice the capacity of the inlet pipe and gives an unrestricted passage for the flow of water. The valves and seats are made of bronze composition, ground to a watertight joint to eliminate leakage. The lower valve is adjustable and is easily removed from the chamber when desired.



The "Nilo" Compound Water Meter for Accurate Registration of Large and Small Flows.

The Nilo Compound is so constructed that it can be attached to any Nilo meter of its size, or to any other meter. The operation is such that the valve opens or closes according to whether the amount of water drawn is large or small. When water is drawn in quantities, such as the high duty meter can correctly register, the water passes through both the Nilo and the King disk meter, though on large flows the amount passing through the low duty meter is small, each meter registering separately the amount of water passing through it. When the flow is such that the high duty meter cannot correctly record the amount, the automatic differential valve closes and the water passes through and is registered by the low duty meter only. The combined reading of the two meters is the amount of water drawn. In no case is the water registered twice.

A Large Capacity Sand and Gravel Washing Plant.

(Contributed.)

The large sand and gravel washing plant of the Akron Gravel & Sand Co., Akron, O., has recently been completed and put in operation. The size and capacity of this plant exceed any other land operated plant so far constructed. The daily 10-hour capacity is 100 cars of washed material.

The material is excavated by Marion steam shovels and brought to the plant by two locomotives each handling two 30-yd. dump cars. One car of each set dumps from the bottom and the other cars dump from both sides. The tracks from the pit are elevated and pass over a large concrete hopper holding about seven carloads.

The material is drawn from the hopper through an opening in the bottom onto an apron feeder 48 ins. wide. This feeder is operated by a variable speed motor, geared direct to an oil immersed worm gear drive. This construction is novel and is arranged in this manner to govern the capacity of the plant. The speed of the feeder regulates the output of the plant.

Large Sand and Gravel Washing Plant at Akron, Ohio.

The material from the feeder is delivered into a large stone screen 60 ins. in diameter, which separates the stone to be crushed from the aggregate. The material which passes through the stone screen is delivered direct to the main elevating belt and the over-size from the screen goes to the large steel crusher elevator. This elevator is not an ordinary elevator by any means. The chains are built up of 4½x⅝-in. open hearth steel bars and the chain pins and bushings are chrome nickel steel. The chain rollers are steel and the sprocket wheels on the head and foot shafts have renewable manganese steel teeth. The buckets are of the continuous type 36 ins. wide and reinforced by heavy steel lips.

The material from the elevator is discharged onto a bar grizzly which divides the large stone for a No. 6 Gates gyratory crusher and the remainder goes to a 48-in. Symons Brothers' disc crusher. The product from each crusher is delivered onto a 30-in. belt conveyor which carries the crushed stone back to the stone screen for rescreening.

The main belt is 36 ins. wide and has a Goodrich six-ply rubber conveyor belt with ⅛-in. extra rubber cover on the carrying side. The troughing idlers are of the Link-Belt Co. type, with five pulleys each. The main conveyor is 270 ft. long and the conveyor gallery is enclosed for protection from wind and storm.

The gravel washing equipment consists of 16 Dull type inclined washing screens mounted four in a row with provision for two more rows or 24 screens in all. The sand is separated by eight 72-in. conical sand separators with provision for four more. These tanks work automatically and present a very interesting sight to anyone who can observe the operation of four tanks working in unison.

The screens and tanks make five grades of material which are delivered into seven large bins. The sand bins are arranged at both ends of the plant and contain fine sand for plastering and brick laying and coarse sand for concrete work. The bins are 144 ft. long and 26 ft. wide and the height of the plant at the center is 90 ft.

Loading tracks go on both sides of the plant and segmental type gates are used for gravel and slide gates of a special design for the sand bins. The bins are built by cribbing the plank and are stiffened by steel rails vertically with the rods running through the bins. This construction is unusual but very satisfactory.

A center tunnel runs through the center of the plant in order to facilitate getting from one side to the other.

The washing water is pumped to the plant by an 8-in. American, two-stage centrifugal pump direct connected to a 100 HP. motor. The water distribution is novel and very elaborate and quite effective. The material is given a preliminary washing in a stone box and the water jets do the distributing for the four different sets of washing screens. Bypasses for taking out the great volume of sand are also provided as well as a rinsing system while loading and when delivering from screens.

The plant is electrically driven throughout by individual motors and each half of the plant can be run independent of the other. Westinghouse motors are used and power is furnished by the Northern Ohio Light & Traction Co.

This plant on account of its large capacity is designed for low cost of production, yet nothing was spared to insure against liability of breakdown. The machinery is designed unusually heavy and strong and all supports are also very heavy. The plant was designed and engineered by The Raymond W. Dull Co., 1910 Conway Building, Chicago, Ill.

Device for Detecting Imperfections in Steel.—An instrument for testing steel has been invented by Ethan I. Dodds, director and chief engineer of the American Flexible Bolt Co. of Pittsburgh, which is said to accurately test the internal structure of iron and steel. It is of simple construction, consisting of two small magnets and ordinary telephone apparatus. The hand piece is moved over the surface and a light magnetic current is driven through the steel to be tested. So long as the metal is of uniform character and density, the current passes through at a uniform rate of resistance. When the current strikes an air space, however, the resistance is increased, and the consequent fluctuation in the current easily records itself. Telephone receivers are strapped on each ear of the operator and the uniform flow of the magnetic current through the solid and perfect steel is recorded by the constant and uniform sound of a buzzer. The fluctuation of the magnetic current, when it strikes an imperfect place, is recorded by a fluctuation in the sound of the buzzer. At the same time an indicating apparatus points out with a hand the extent of the current variation, hence the extent of the flaw causing the variation. The device for marking down on paper the extent of the flaw and its location is not yet a part of the machine that is now in use, the patent for this feature still pending. The machine with the other parts, however, is being used in a series of tests by the union Switch and Signal Company.

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Engineering Meetings in San Francisco.—The twenty-eighth general meeting of the American Electrochemical Society will be held in San Francisco Sept. 16 to 18. The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers expect to hold their meetings at the same time and arrangements are under way for joint sessions with some of these societies. The holding of this meeting immediately before the date for the International Engineering Congress, Sept. 20 to 25, will also enable the members to attend the sessions of the Congress. All inquiries in regard to transportation should be addressed to J. M. Muir, 239 West 39th St., New York, chairman of the transportation committee.

CURRENT NEWS

The Doings of the Week.

Business made progress during the past week. The possibility of international complications, of course, caused considerable caution in commercial affairs, but there was nevertheless an improvement in the industrial situation. The outstanding development of the week as concerns industry and finance was the decision in the Steel Corporation case. The ruling of the District Court that the Corporation is not a trust and not amenable to the Sherman law will have a wide spread effect on many lines of trade. The effect on financial sentiment will be decidedly favorable. The peaceable settlement of the threatened labor troubles in Chicago now seems probable. Building construction shows an improvement. According to Bradstreet's Review there will be an increase of national building construction for June over the same month of last year. Based on incomplete reports received to date, the figures show a net gain of more than $10,000,000 for large cities. In the general construction field activities have been well sustained. Municipal work, especially water works and sewerage improvements, are not quite up to the mark, but in other lines there are a considerable number of contracts ready to be figured on. Highway construction, street paving and bridge building continue to furnish many construction opportunities. Kansas City, Mo., authorized a $4,560,000 bond issue for municipal improvements, and New York City shortly will offer for public subscription $50,000,000 of 4½ per cent bonds. In the Iron and Steel markets the bar situation is stronger and there is more buying of basic iron. It is stated that the recent meeting of the American Iron and Steel Institute was a clearing house for more favorable sentiment than has come out at a similar meeting in two years. Rail orders placed recently have been for small tonnages. The Pennsylvania R. R. has issued new specifications for its 138,000 tons of rails and it probably will be some weeks before the order is given out. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending June 2 were as follows:

Finished Iron and Steel.	June 2	May 26.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia	[illegible]	1.17½
Iron bars, Pittsburgh.........	1.25	1.20
Iron bars, Chicago............	1.20	1.15
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York.......	[illegible]	1.369
Tank plates, Pittsburgh..	[illegible]	1.15
Tank plates, New York .	[illegible]	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York.......	1.369	1.369
Skelp, grooved steel, P'gh. ..	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh.......	1.25	1.25
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh.	[illegible]	1.75
Galv. sheets, No. 28, P'gh	[illegible]	3.75
Wire nails, Pittsburgh	[illegible]	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh.	[illegible]	1.35
Barb wire, galv., P'gh........	2.20	2.10

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—There have been no construction developments in the railway field during the past week. No one expected there would be for that matter. Progress is being made with the preliminary work for the Philadelphia subways and there are prospects that some contracts will be let this summer. The Union Depot Co. of St. Paul, Minn., it is now announced, will award contracts about June 14 for the river changes at St. Paul, the first work in connection with the $15,000,000 union terminal in that city. Bids on the changes, which involve dredge and steam shovel work and retaining wall construction, were opened several weeks ago.

Roads and Streets.—A considerable number of street paving contracts reached the call for bids stage during the past week. State and county highway improvements also are numerous. Illinois is calling for bids on several sections of state highway; Maryland opens bids June 22 on four contracts. Volusia County, Florida, is asking proposals for the construction of 53 miles of highway. Street paving work advertised by smaller cities includes 38,000 sq. yds. for Wellington, Kan.; 34,600 sq. yds. for Elma, Wash.; 24,000 sq. yds. for Atlantic, Ia.; 22,000 sq. yds. for Clarksville, Tex. Grinnell, Iowa, has awarded a $213,000 paving contract; Macon, Ga., opened bids on paving work to cost $120,000; Indianapolis, Ind., awarded a good sized contract for surfacing Parkway Blvd.; Corpus Christi, Tex., let a $259,000 paving job. California and New York opened bids on large state and highway lettings.

Bridges.—Quite a few smaller bridge opportunities are being advertised. Larger structures include a Strauss trunnion bascule bridge for San Francisco, bids for which will be opened June 23. Toronto, Ont., is asking tenders for concrete substructure and steel superstructure of Strachan Ave. bridge. The Union Station Co., Chicago, awarded contracts for trunnion bascule bridge to be erected over Chicago River at West Monroe St., Chicago. Calcasieu Parish, Louisiana, let the contract for a $72,000 reinforced concrete bridge; contract for concrete viaduct approach to the bridge was let at $52,000. Board of Public Utilities of Los Angeles, Cal., will submit plans to City Council for four viaducts to span the Los Angeles River and to cost about $3,500,000. Buffalo, N. Y., probably will let contract to American Bridge Co. at $185,000 for reconstruction of Chicago St. viaduct. City Council of New Haven, Conn., has taken steps to provide $250,000 toward the proposed $400,000 reinforced concrete bridge to be erected over the Quinnipoc River.

Drainage and Irrigation.—No particularly large jobs in either the drainage or irrigation fields appear to have come up for advertising during the past week. The Seadrift Drainage District No. 3 of Port Lavaca, Tex., opens bids June 22 for construction of 45 miles of ditches requiring 325,000 cu. yds. earth excavation. The U. S. Reclamation Service is asking bids for construction of canals and structures for the Sun River Project, Montana, involving about 455,000 cu. yds. of excavation and about 4,290 cu. yds. of reinforced concrete, 4,560 lin. ft. of concrete pipe and 265 M ft. B. M. of lumber.

Waterworks.—No especialy large water works projects reached the call for bids stage during the past week. Cincinnati, O., opens proposals June 16 for laying 36-in. water main; Board of Water Supply of New York City is calling for proposals for construction of a coagulating plant at Mt. Pleasant, N. Y.; Hydro-Electric Commission of Ontario, is asking tenders on a 500,000-gal. elevated water tower to be erected at Stratford, Ont. Bids are being asked for furnishing a considerable amount of pipe, pumps and water meters.

Sewerage.—A considerable amount of sewerage work came up for advertising during the past week. Winston-Salem, N. C., is asking bids on reinforced concrete sewage disposal plant and 2½ miles 24-in. and 30-in. sewers; Burlington, Ont., is calling for tenders on storm sewers and sewage disposal works; Greenwich, Conn., opens bids June 14 on constructing 22,500 ft. of sewers; Lake Mills, Ia., is asking bids for sanitary sewers and disposal plant; the Sanitary District of Chicago is calling for proposals for contract No. 3 of the Calumet intercepting sewer; Washington, D. C., opens bids June 10 on 3,000 ft. of 4½ ft. by 5 ft. trunk sewer.

Minimum Wage Law.

The minimum wage law at Portland, Ore., for municipal contracts does not appear to be working out the way its sponsors intended it should. Last winter the City Council passed an ordinance providing that contractors must pay not less than the city's scale to workmen employed on contracts for the city. This meant that a minimum wage of $3 must be paid. It is claimed this requirement, instead of providing a $3 a day wage, has resulted in many laborers being thrown out of work entirely. This has been due to the entrance of Syrians and Italians into the contracting field. These aliens have formed co-operative firms whereby each laborer is a party to the contract, or in other words is a contractor. No workmen are employed as the contractors do the work themselves and divide the profits. As a consequence the foreigners have no minimum wage scale of $3 to pay and naturally can underbid the regular contractors. The wage scale went into effect on March 26 and since that time all but two or three of the small sewer contracts let by the city have been secured by these co-operative concerns. That no regular contractor had a chance in competing for this work is shown by the statement that on some of the jobs the Syrians have netted less than 75 cts. per day per man. An ordinance is now before the City Council of Portland, proposing to exempt from the minimum wage act the men engaged in street and sewer work. It is probable also that a court decision will be obtained on the validity of last winter's ordinance. This action will be taken on the grounds that the City Council is merely acting as the agent for the property owners and has no right to make a contractor pay more than the going wage to his workmen. This contention opens up an interesting point. If a city increases the cost of an improvement by requiring the payment of high wages will it have to pay back the difference to the property owners?

Market for Municipal Bonds.

A large number of construction undertakings proposed for this spring have been held in abeyance because the interested cities could not dispose of their securities. The demand for municipal bonds during the first five months of the year has been disappointing. There is good reason to believe, however, that there will soon be an improvement in the bond situation. In fact the municipal bond sales for May, including state and county issues, amounted to $36,467,000, an increase of over $4,000,000 over the sales during April. In May last year, the sales totaled $30,990,000. Evidence of a better demand for the securities of cities also is indicated by the fact that New York City shortly will offer probably $50,000,000 4¼s to public subscription. So large an offering would not be made without first sounding out the market. It is understood the city officials were advised by bankers that there was a large amount of idle capital seeking investment and that city bonds could be marketed advantageously at this time. A better demand for bonds means the taking up of a lot of improvements.

Road Work in Multnomah County.

There is nothing slow about Multnomah County, Oregon. A few weeks ago it voted a $1,250,000 bond issue for improving its roads; today it opens bids on the work. This improvement, one of the largest city or county paving contracts that has come up for letting so far this year, provides for the surfacing of 73 miles of highway, the total yardage being 742,000. An undertaking of this size usually is in the preliminary stages for months. Law suits over the bond issue and wrangles over the roads to be improved and the kinds of improvement commonly delay matters. The dispatch with which the project of this Oregon County has been advanced to the construction stage is worthy of note.

The Lighter Side of Engineering and Contracting

UNCLE HENRY COOLEY, for many years walking boss for S. R. Carter, can catch a fish more skillfully and lie more gracefully about its weight than any known disciple of Izaak Walton, now out of captivity. All of his stories, however, are not about the fish that escaped. For instance, there is the famous tale of the big trout. This is the way Uncle Henry tells it: "Once I caught a trout, a regular hell buster, mor'n 2 ft. long he was. When I got him up on the bank he looked at me so beseeching like that I didn't have the heart to break his back. So I took him home and put him in the watering trough. That was one grateful trout. My wife named him Henery. That fish became the pet of the family. He was so darn bright that he could tell my step and when I came near the trough he would hop right out of it, knowing of course that I would put him back again. This little trick of his set me to thinking. 'By Jing,' I said to myself, 'fishes always live in water because they never tried living on land. It's just a habit with them.' So I began to experiment on Henery. Each day I'd let out a bit of water from the trough, and I'd observe how the fish acted. He didn't seem to notice at all. Finally there was just water enough so the trout's back fin showed. Next day I lowered it a bit more, and so on until the basin was dry. And that fish never minded it a bit. I'd just got him accustomed to going without water. After the fish had got used to it, I took him out, and would you believe it he followed me around just as though he was a dog. He would flop along on his fins and kick away with his tail so that he got along quite rapidly. He used to come into the kitchen and get under the stove. If the old dog or cat was there he would slap them in the face with his tail and if that didn't start them he would snap at them. Then he would coil up and go to sleep. Henery was some fighter, you bet; he would pitch into the old rooster and he'd even pull the feathers out of the turkey. A remarkable animal was Henery, a remarkable animal." Here Uncle Henry always paused, wiped away an imaginary tear and reached for your tobacco pouch. While he filled his pipe you were supposed to ask, "And what became of Henery?" Uncle Henry would wait until he had smoke coming out of his nose and mouth and then he would again take up his narrative. "What became of that trout? Why, one day Henery came tagging after me. I told him to go home, but he insisted on following. I had to cross a bridge and Henery plugging along after me stubbed his tail on a loose board and fell into the creek and got drowned."

Strike! Strike! Strike!

When the world is growing steady,
  When we've met the staggering blow,
When the panic is averted,
  And the wheels begin to go;
When bankers cease from trembling
  And business tries to grow—
Then doth the festive Union call a strike!

When the contract is awarded
  And you find your bid is "low";
When you figure up your profits—
  You will make it now, you know,
When plant and men are busy
  And with hope your heart's aglow—
O, then the pesky Union calls a strike.

When "full time" is recorded
  And you hear the whistles blow.
When the dinner pail is heavy
  And you think you'll save some dough,
When wife and kiddies get new shoes
  and see the jitney show—
Why then the dad-blamed Union calls a strike.

◆

COL. GEORGE B. INMAN, who for several years was actively engaged in educating the people of various small western cities on the advantages of sewerage systems and disposal plants, used to tell this story when recounting his experiences:

"I had addressed a mass meeting of the citizens of one of these municipalities with respect to the aid and comfort they might reasonably expect to derive from a public sewerage system. I told of the requisite character of the projected construction, gave an idea of its probable cost and explained clearly, as I thought, the modus operandi of the sewerage system. I then called for questions which were answered concisely and in simple language. Everything seemed to be progressing nicely until one of the leading business men of the community arose in his place and spoke as follows: 'I am much interested in the gentleman's statement. There is just one thing that bothers me about it all. You know our young women have all been trained to do their work as their mothers did before them. After they wash the dishes they open the back door and throw the dish-water out into the back yard. Now it is going to come hard to these girls to have to go out into the street, take off the cover of the sewer manhole and pour the dish-water into the sewer."

◆

LITTLE drops of water, little grains of sand,
Make the contractor swear to beat the band.

IN THE good old days before the war (the Yanko-Spanko one), when there was some real railroad building, John Henry was the butcher for the commissary department of a construction outfit working on a contract in the Indian Territory. One day when the fresh meat was running low, John Henry went out to round up a new supply. Little Big Foot, an Indian, had some stock, so the butcher drove out to his place. Here he found a fat steer that just filled the bill. "How much?" inquired John Henry. The noble red man held up both hands. "Ten?" inquired the butcher, and he counted out ten silver dollars. Little Big Foot carried the money into the house, and then came out again and gravely watched John Henry kill and dress the animal. When the steer was neatly quartered, the Indian came over and pointing a finger at one of the hind quarters, grunted, "How much?" "Eleven dollars," said the butcher promptly. Little Big Foot fished up a buckskin bag and handed out eleven coins. John Henry loaded the remainder of the beef into the wagon and drove away rejoicing.

◆

WHAT'S in a name? Luck and wealth seemingly for the contractor. If this is not so the newspapers are base prevaricators. And the great general public that obtains its ideas, opinions and information from the press has been given the wrong impression of a very useful profession. For it is seldom indeed that a contractor has his name in print without the qualifying words lucky or wealthy. It is always the "lucky" bidder that gets the contract or the "wealthy" builder that gains an unexpected son-in-law by way of the elopement route. Why, no contractor can get a divorce or even die without being classed with the undesirable rich. The average reporter looks upon a letting as something of a lottery. The bidders write their guesses on slips of paper and the man whose total is the least gets the job. He is the "lucky" bidder; fortunate in guessing a lower number than his competitors, doubly fortunate in securing a chance to make a bit of money. Some contractors are lucky, and some are wealthy, but the press makes no distinction. To it all contractors are blessed with luck or wealth.

◆

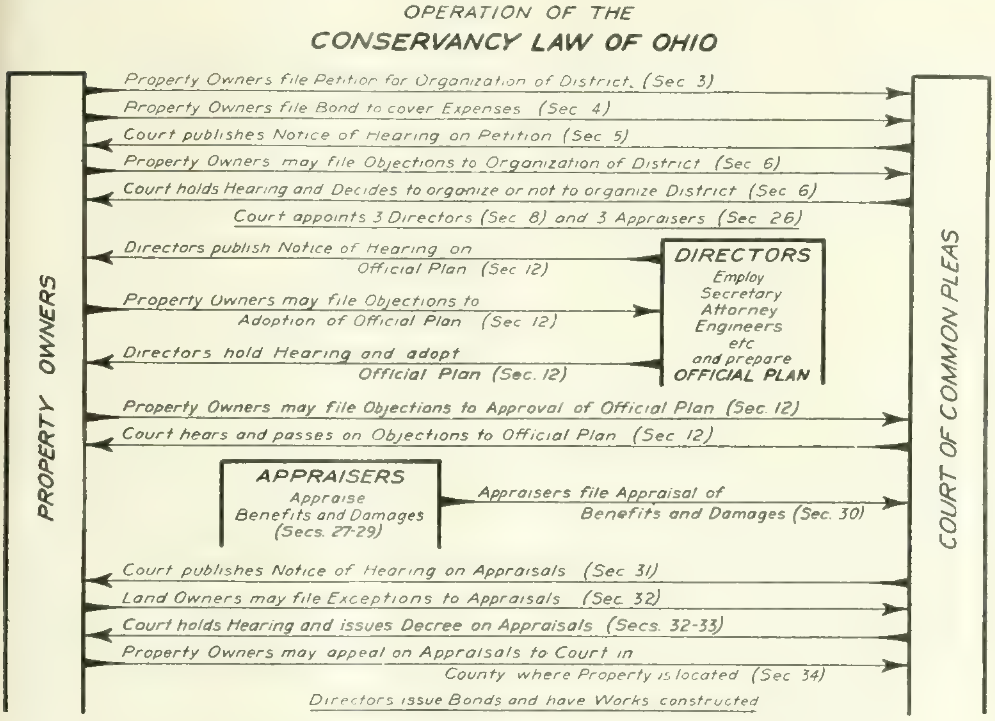
Skinner Mulvey says: There's alwus two sides to every dispute—your own side and the wrong side. Johnny Conners got a contract for puttin' down submarine piles; he's goin' to drive 'em with a flock of hammerheaded sharks.

FLOOD PREVENTION UNDERTAKINGS IN OHIO.

Proceedings Under New Conservancy Law.

Present Status of Miami Valley Project.

A vast amount of construction work will be undertaken in Ohio under the provisions of the new conservancy law of this State. One of the largest of these projects is the Miami Flood Prevention works for Dayton and other cities in the Miami valley. This project is now waiting on the organization of a conservancy district to carry out the work. Progress at present is pending a decision from the Supreme Court of the State of Ohio on a technical question as to whether the legal procedure towards organizing the district has so far been correct. The engineering plans are progressing rapidly and satisfactorily and this work is now several months in advance of legal developments.


OPERATION OF THE
CONSERVANCY LAW OF OHIO
PROPERTY OWNERS
COURT OF COMMON PLEAS
Property Owners file Petition for Organization of District. (Sec 3)
Property Owners file Bond to cover Expenses (Sec 4)
Court publishes Notice of Hearing on Petition (Sec 5)
Property Owners may file Objections to Organization of District (Sec 6)
Court holds Hearing and Decides to organize or not to organize District (Sec 6)
Court appoints 3 Directors (Sec 8) and 3 Appraisers (Sec 26)
Directors publish Notice of Hearing on Official Plan (Sec 12)
Property Owners may file Objections to Adoption of Official Plan (Sec 12)
Directors hold Hearing and adopt Official Plan (Sec. 12)
DIRECTORS
Employ
Secretary
Attorney
Engineers
etc
and prepare
OFFICIAL PLAN
Property Owners may file Objections to Approval of Official Plan (Sec. 12)
Court hears and passes on Objections to Official Plan (Sec 12)
APPRAISERS
Appraise
Benefits and Damages
(Secs. 27-29)
Appraisers file Appraisal of Benefits and Damages (Sec. 30)
Court publishes Notice of Hearing on Appraisals (Sec 31)
Land Owners may file Exceptions to Appraisals (Sec 32)
Court holds Hearing and issues Decree on Appraisals (Secs. 32-33)
Property Owners may appeal on Appraisals to Court in County where Property is located (Sec 34)
Directors issue Bonds and have Works constructed

Method of Procedure Under the Conservancy Law of Ohio.

In view of the many flood protection projects in Ohio that will be carried out in the next few years under the new conservancy act the accompanying diagram is of particular interest. It was prepared by the Morgan Engineering Co., Dayton, O., the engineers for the Miami Flood Protection Project. It shows the successive steps taken under this law from the time the petition for the organization of the district is filed until the construction of the work is begun.

In the diagram the arrows in each case start at the party taking the action and point to the party with whom the action is taken. For example—beginning at the upper left hand part of the diagram, and following the first two arrows from left to right, it will be seen that action under the law is started by the property owners filing a petition and bond with the court. Following the third arrow from right to left it will be seen that the court then publishes notice of a hearing on the petition. Thereupon, following the fourth arrow from left to right, the property owners may file objections with the court to the organization of the district, and so on.

A brief inspection of a diagram will show that the fundamental principles involved in the law are few and simple. The Court of Common Pleas exercises the most important functions in the proceeding. Certain matters of procedure are handled for the court by the directors who act as the business managers of the district, and by the appraisers. Both the directors and appraisers are appointed by the court and their principal acts are subject to the approval of the court.

Wharf and Sea Wall Construction at Woods Hole, Mass.

A small wharf and sea wall job for the U. S. War Department is being advertised by the U. S. Engineer at Newport, R. I. The work provides for rebuilding wharves and building new sea wall and coal house at U. S. Bureau of Fisheries Station at Woods Hole, Mass. The main works at the station were built between 1879 and 1887 and have been extensively repaired since the latter date, but the wharves are in a dilapidated condition, badly decayed and are in need of reconstruction.

The work to be done under this contract involves the following items: (1) removal of present east, south, west and cross wharves, including the pile foundations; (2) removal of the coal wharf, coal wharf extension and all its foundations; (3) reconstruction of timber wharves around the east, south and west sides of the granite basin, also the coal wharf and foundation for coal house; (4) construction of about 314 lin. ft. of coursed masonry sea wall on riprap foundation, including removal of existing walls where necessary; (5) removal of present coal house and construction of new coal house upon the pile and timber foundation; (6) construction of a new coal tipple. The approximate quantities required for the new wharves include the following:

520 piles, North Carolina pine, creosoted
32,000 ft. B. M. North Carolina pine timber, creosoted
76,000 ft. B. M. Georgia heart pine timber
1,200 ft. B. M. Georgia heart pine planking
16,806 lbs. wrought iron.

The approximate quantities for the sea wall are:

315 tons riprap in pieces of from 20 lbs. to 150 lbs. each
206 cu. yds. coursed rubble masonry
57 cu. yds. coping

Bids for the above work will be received until noon, June 12, by Col. John Willis, U. S. Engineer, Newport, R. I.

The steamship H. C. Henry, passing through the canal on April 20, carried a cargo of 5000 tons of creosote, shipped at London and Middlesboro for discharge at lumber yards at Seattle and along the Columbia River. This is the first whole cargo of this preservative to have passed through the canal.

Water Works and Sewerage to Cost $240,000 for Small Cities in New York.

A considerable amount of water works and sewerage construction for smaller cities in New York state will be advertised for bids in the next two or three months. Among the projects that will be ready for proposals the latter part of this month or early in July are public improvements for Brockport, Ilion, Manchester and Wellsville, four small places in the northern part of the state and all within a radius of perhaps 200 miles of each other.

The development at Brockport calls for a sewage disposal plant. This will consist of a 2-story settling tank and sprinkling filters. It will have a daily capacity of 515,000 gals. The estimated cost is $27,000. Contracts probably will be let in July.

At Ilion, N. Y., a filtration system will be installed and a pipe line laid. This latter will consist of 3½ miles of 10 in. cast iron mains, the average depth of trench being 5 ft. There will be a reinforced concrete reservoir of 1,000,000 gals. capacity, and a slow sand filtration plant, ⅓ acre in size, of reinforced concrete construction. The total estimated cost is $76,500. Contract probably will be let on June 20.

The water works development at Manchester is estimated to cost $33,000. It will include 3½ miles 4 in. to 10 in. cast iron mains, a pump well 40 ft. in diameter, a stand pipe, and electric driven pumps. Contract will be let probably next month.

At Wellsville water works to cost $104,000 will be constructed. This improvement will include 6 to 7 miles of 4 in. to 14 in. cast iron mains and ⅔ mile of 16 in. wood stave intake pipe line. There will be one pump well, 10 ft. in diameter, a 3,000,000-gal reinforced concrete reservoir, and a 500,000-gal. roofed reinforced concrete reservoir. There also will be a slow sand filtration plant of 750,000 gals. daily capacity, an intake dam and an intake. Contracts may be let in July.

Charles G. Hopkins, Rochester, N. Y., is consulting engineer for the improvements at Brockport, Manchester and Wellsville, and for the filtration plant at Ilion.

$1,600,000 Proposed for Water Storage Project in Pennsylvania.

The Pymatuning Swamp water storage project, described in our issue of Nov. 4, 1914, has been brought a step nearer the actual construction stage by the recent action of the legislature of Pennsylvania in passing a bill providing $1,600,000 for the work. This project in general provides for the conversion of a portion of the swamp and adjacent areas into a storage reservoir the main object of which will be to regulate the flow of the Beaver and Shenango Rivers.

The main feature of the development will be an earthen dam constructed across the valley of the Shenango near Turnerville about 3 miles north of the Crawford-Mercer county line. This structure will have a length of about 2,910 ft. and an average height of 27 ft. It will have a concrete spillway, 250 ft. in length, founded on rock, with its crest about 10 ft. below the top of the dam. There also will be two regulating gates each 20 ft. wide and a 96 in. blow off and regulating pipe. The estimated cost of the earthen dam is $366,000; the spillway and regulating works will cost about $150,000, according to the preliminary estimate.

The work, if carried out as originally planned, will involve the relocation or elevation of about 11 miles of highway and the elevation of the tracks of the Erie and Pittsburgh division of the Pennsylvania R. R., for a distance of about 9,000 ft. These features of the development were estimated to cost in the neighborhood of $352,000.

The construction will be in charge of the Water Supply Commission of Pennsylvania, of which Farley Gannett is engineer. The commission has its headquarters in the Telegraph Bldg., Harrisburg, Pa.

A $683,000 SEWER CONTRACT.

Bids Asked for Constructing 14 Miles of Brick Sewers.

System for Norwood Park and Edison Park Sections of Chicago.

A $683,000 sewer undertaking is being advertised for bids by the Board of Local Improvements of Chicago, Ill. The official name of this improvement is the Argyle Street Sewer System. It is designed to drain all that part of the city of Chicago lying north of Wilson Ave. and south of the Chicago River. Within this territory are the communities known as Jefferson Park, Norwood Park and Edison Park.

Edison Park for some years has had a sewer system which terminated in a ditch at the city limits at 72nd Ave., just north of Ibsen Ave. From this point the sewage flowed in an open ditch across country to the village of Niles into the north branch of the Chicago River. The Norwood Park sewer system terminated in a ditch located at the southerly side of the Chicago & Northwestern Ry. tracks near Ardmore Ave. and thence flowed across the country about 1½ miles to the Chicago River. These open ditches containing sewage were a source of a good deal of complaint from the people living and driving through this section of the city. In addition, the village of Edison Park, before annexation, had been served with a notice by the village of Niles to alleviate the nuisance and to stop the flow of sewage through this village. This fact brought about the annexation of Edison Park to Chicago. This newly annexed territory will be served by the new sewer system.

The area of the territory drained by this sewer system is approximately 5,000 acres. The length of the system is 14 miles and it varies in size from a 2½-ft. brick sewer to a 9-ft. brick sewer. Several special features in connection with the system are of interest. These include the overflow chambers at Forest Glen Ave. and Catalpa Ave. and at Foster Ave. and Tripp Ave. The sewer discharging into the chamber has an internal diameter of 9 ft. and at these points it is enlarged to an internal diameter of 10 ft. Across the chamber in the plan in the shape of a Z there is a weir. On the upstream side of the weir is a channel by means of which the dry weather flow is diverted to a dry weather flow sewer leading from the overflow chamber. These connected pipes were computed as acting as short tubes, and in one case the internal diameter is 24 ins. and in the other it is 27 ins.

The crest of the weir in each case is 3 ft. above the bottom of the chamber. On the downstream side of the weir the sewer decreases in size by means of 16-ft. sections to the proper size of the outlet sewer, which in the case of the Forest Glen sewer is 6 ft., and in the case of the Foster Ave. sewer is 6½ ft. The paramount principle in this design has been to eliminate as far as possible all pollution from the North Branch of the Chicago River. The dry weather flow will in all cases, except in the case of excessive storms, flow through the connecting pipes into the overflow chamber and in the dry weather overflow chambers, eventually emptying in the North Shore Channel of the Sanitary District located at Argyle St. and the Sanitary Canal.

The work is divided into two sections. The first section comprises the portion of the system between the outfall and Argyle St. and the overflow chamber at Forest Glen Ave. and Catalpa Ave. Section 1 covers the construction of sewers in the following streets and avenues, the approximate lengths, diameters and average depths being as indicated:

Laid in.	Length, ft.	Int. diameter, ft.	Av. depth, ft.
Argyle St.	2,630	6*	18
Argyle St	710	6*	13½
Argyle St.	3,360	5½*	18½
Argyle St.	1,670	5*	21½
Tripp Ave	1,230	5*	21½
Foster Ave.	940	6½†	9
Foster Ave.	3,690	9†	21
Foster Ave.	1,030	7¾†	22
Foster Ave.	2,980	5½*	14
Foster Ave.	1,140	5*	15
Milwaukee Ave.	170	5*	19
Milwaukee Ave.	1,100	3*	15½
Norwood Park Ave.	910	5*	16
Foster Ave.	2,440	5*	16
N. Cicero Ave.	2,660	4*	18
N. Cicero Ave.	680	3*	16
N. Cicero Ave.	680	2½	15½
N. Cicero Ave.	680	2*	12
Maynard Ave.	980	5*	18
Elston Ave.	680	4½*	21½
Elston Ave.	400	1	12½
N. Lawler Ave.	1,290	4½*	18½
N. Catalpa Ave	450	4½*	18½

*2-ring. †3-ring.

The other work in Section 1 includes 121 manholes, 286 standard catch basins, 2 large catch basins, and a concrete bulkhead at Foster Ave. and Chicago River, and a similar structure at Argyle St. and the North Shore Channel. There also will be the special brick overflow at Foster Ave. and Tripp Ave.

Section 2 covers the portion of the sewer lying westerly of the Forest Glen outfall. It includes the construction of sewers in the following streets:

Laid in.	Length, ft.	Int. diameter, ft.	Av. depth, ft.
Forest Glen Ave.	1,430	6*	22
Forest Glen Ave.	1,100	1	12
N. Leclaire Ave.	950	9†	17
Elston Ave.	2,130	9†	15
Lynch Ave.	200	8½†	14
Catalpa Ave.	3,060	8½†	16½
Milwaukee Ave.	850	8¼†	22
Bryn Mawr Ave.	1,040	8¼†	21½
Bryn Mawr Ave.	1,160	8†	21
Norwood Park Ave.	1,850	8†	21½
Norwood Park Ave.	1,340	4*	17½
Nagle Ave.	2,130	6½†	19
Naples Ave.	1,290	6*	16½
Raven St.	100	6*	15½
Natoma Ave	1,340	6*	15
Nieman Ave	1,770	4½*	12
Newark Ave.	710	4½*	12
Imlay Ave.	1,130	4½*	14
Isham Ave.	1,080	4½*	19
Harlem Ave.	3,140	4½*	16½
Harlem Ave.	2,840	4*	16
Harlem Ave.	1,520	3½*	16
Peterson Ave.	850	2½*	13
Ibsen Ave.	1,910	4*	13½
Olcott Ave.	680	3½*	13½
Pratt Ave.	220	3½*	13½
Oliphant Ave.	1,000	3½*	16½
Ardmore Ave.	1,460	3*	13
Newark Ave.	660	3*	14
Maynard Ave.	1,330	3½*	19
Maynard Ave.	1,330	3*	18½

*2-ring. †3-ring.

The other work in Section 2 includes 184 manholes, 342 standard catch basins, 8 large catch basins, two concrete bulkheads and the special brick overflow at Forest Glen Ave. and Catalpa Ave.

The sewers will be laid on the center line of the streets except for comparatively short distances. Some of the streets in which the sewers are to be laid are paved with country road macadam or country road macadam surfaced with asphalt. There are also street car tracks in Milwaukee Ave. between Edmunds St. and Foster Ave., a distance of about 1,270 ft. These tracks will be removed wherever necessary. The through street car track in Milwaukee Ave., between Bryn Mawr, Ave. and Catalpa Ave., will be left in place. Sewers will be constructed under steam railroad tracks near eight intersections. At three of these the tracks will be timbered at the expense of the railroads; at the others they will be tunnelled at the expense of the contractor.

The system will cross or run along several important paved thoroughfares, such as Cicero Ave., Elston Ave., Leclaire Ave., Forest Glen Ave., Milwaukee Ave., Raven St., and Norwood Park Ave. The contractor must use special effort to maintain traffic in such streets, and must in each case refill the trench and restore the street surface so that it is usable for traffic as soon as possible, and in any event before the next important thoroughfare is opened.

The order of procedure will be as follows: The contractor will begin work on the Argyle St. portion of Section 1 within 20 days after the award of the contract. The masonry east of Central Park Ave. must be completed before Sept. 15, 1915, and the masonry in Argyle St. and Tripp Ave. completed before Nov. 15, 1915. The masonry of all that portion of Section 1 between the overflow chamber at Leclaire Ave. and Catalpa Ave. and the outfall in Foster Ave. (except Cicero Ave.) must be completed before Aug. 1, 1916. The sewer in Cicero Ave., including the restoration of the street, must be completed before Oct. 15, 1916, and the entire work completed before Dec. 1, 1916. For Section 2 work must be started on the Forest Glen portion within 20 days after the award of the contract. The sewer, including the restoration of the street, east of Milwaukee Ave., must be completed before Dec. 15, 1915. The sewer connecting the existing sewer at Heyden Ave. and Newark Ave. with the proposed sewer in Norwood Park Ave. at Nagle Ave. will be constructed before or concurrently with the construction of the sewer in Nagle Ave. north of Norwood Park Ave. This connecting sewer must be completed before Aug. 1, 1916. The existing sewer at Isben Ave. and Olcott Ave. must be connected with the proposed sewer before Dec. 1, 1916. All of the work included in Section 2 must be completed before Aug. 1, 1917.

The engineer's estimate of the cost of this sewer system is $683,000. The work is in a territory which makes the use of excavating machinery the ideal method of construction. The soil is almost entirely of blue glacial clay and it is believed that steam shovels are the economical method for handling the work.

Contractors may bid either on the contract as a whole, or upon separate sections. The bids will be received by the Board of Local Improvements, City Hall, Chicago, Ill., until 11 a. m., June 18. C. D. Hill is Chief Engineer and Geo. C. D. Lenth is Assistant Chief Engineer of Sewers.

Power House for Dam 29, Ohio River.

The U. S. War Department is asking bids for the construction of a power house at Dam No. 29, Ohio River. The site is in front of Clyffeside, near Ashland, Boyd County, Kentucky. The lock grounds are about ¼ mile distant from the Chesapeake & Ohio Ry., and a switch track owned by the Ashland Coal & Iron Ry. extends to the U. S. property on which the building is to be built. An electric car line adjoining the Chesapeake & Ohio Ry. provides regular and frequent communication with Ashland, Ky., and Huntington, W. Va. The principal items of a permanent character include the following: brickwork, terra cotta trimmings, reinforced and other concrete floors, iron or steel roof trusses, beams, struts or purlins, tile roof covering, coffee gutters, flashings and downspouts, chimney stack, iron and concrete stairways, iron and wood doors, etc.

The foundation walls in general with their footing courses will be plain concrete. This material also will be used for the foundation for front steps, rear area walls, air compressors and boiler foundation and chimney stack foundation. The terra cotta trimmings will include the lower and upper plinths, outside flat arches for exterior doors, and for windows in main and second story. The outside facing brick will be of the variety usually designated as "iron spot" or "fire flashed."

Bids for building the power house will be received until 2 p. m., June 15, by Lt. Col. H. Jervey, U. S. Engineer, Cincinanti, O.

$442,000 for Water System Improvement at Philadelphia.

An ordinance has been reported favorably to the Councils of Philadelphia, Pa., appropriating $442,000 for equipment, improvements and alterations to the water supply system. The items provided for are as follows:

Cold storage, stoker equipment and appliances for Queen Lane pumping station	$ 80,000
Renewal and replacement of pumping station equipment and motor truck	195,000
Locomotive crane and improvements at Lardner's Point pumping station	17,000
Protecting water main under tracks of P. R. R.	25,000
Improvements at Torresdale filters	20,000
Replacing wooden trestles under water mains with permanent structures	15,000
Laying mains in Tenth and other streets	75,000
Retaining wall at Torresdale	5,000

Progress on New Union Station, Chicago.

A considerable amount of construction work is now underway on the $65,000,000 Union depot and terminal in Chicago, which is being built for the Pennsylvania R. R. and other lines. Contracts already have been let for the foundations of the new freight house and work is now well advanced. The Blome-Sinek Co., Chicago, has the contract, which involves some 45,000 cu. yds. of concrete. The contract for sewer construction in Canal, Monroe and Clinton Sts. and for retaining walls and curb walls was awarded early last month to the W. J. Newman Co., Chicago. Work on this also is underway. Contracts for the trunnion bascule bridge to be erected over the south branch of the Chicago River at West Monroe St. were awarded on June 1 to the following Chicago firms: Dredging, pile driving and substructure, Fitzsimons & Connell Dredge & Dock Co.; steel work and erection, Kettler-Elliott Erection Co.; electrical work, Pierce Electrical Co.

A small grading contract involving about 8,000 to 10,000 cu. yds. of fill for streets in the vicinity of the station will be let in a few days. Practically all of the architect's plans for the passenger terminal are stated to be now completed. It probably will be several months, however, before some of the details are worked out.

Kansas City, Mo., Will Spend $4,560,000 for Municipal Improvements.

Bond issues amounting to $4,560,000 were authorized by a vote of 9 to 1 by the citizens of Kansas City, Mo., at an election on June 1. Practically all kinds of public improvements, except water works developments, are provided for by the issues. Of the total amount voted $900,000 will be applied for sewer construction, $300,000 for garbage disposal, $700,000 for traffic approaches to the Union Station and $450,000 for bridges and viaducts. The remainder will go for traffic ways, buildings and other municipal improvements. The 19 projects and the amounts authorized for each are as follows:

Grading Station Hill Park	$100,000
Fire stations and fire equipment	125,000
General hospital improvements	125,000
Municipal farm improvements	125,000
Sixth St. traffic way	450,000
Sewer system extension	400,000
Bridges and viaducts	450,000
Traffic approaches to Union Station	700,000
Garbage disposal	300,000
Police stations	125,000
Traffic approaches to 12th St. viaduct	200,000
Improving Swope Park and other public parks	450,000
Public comfort stations	40,000
Constructing 23rd St. traffic way	300,000
Constructing Chestnut Ave. traffic way	25,000
23rd St. subway under Robert Gilham Road	15,000
Widening New Brook St.	30,000
Constructing Blue Valley sewer	500,000
Improving channel and banks of Blue River	100,000

Curtis Hill is city engineer of Kansas City.

Merger of New York, Westchester & Boston Ry.

A railway merger that makes probable the undertaking of a considerable amount of construction work was approved last week by the New York upstate Public Service Commission. The commission gave its approval to the corporate merger of the New York, Westchester & Boston Ry. and the Westchester Northern R. R. The first mentioned railroad at present operates over the Harlem River & Port Chester tracks from Harlem River to 174th St., New York City, and thence over its own tracks to North Ave., New Rochelle. It also operates its own branch from Mount Vernon to White Plains and is to construct its road to Port Chester. The Westchester Northern is to be built from the terminus of the New York, Westchester & Boston at White Plains, forming a continuous line of road through Westchester County to Danbury, Conn., with a branch to Brewster, Putnam County. The consolidated road will connect with the New York, New Haven & Hartford lines at various points, including a connection with the Poughkeepsie bridge route, thus affording the New Haven & New York tidewater point for coal, and will open up for commutation travel new sections of northern Westchester County. The consolidation proceedings were started in 1912.

A $250,000 Dredging Job in Florida.—A good sized contract for dredging in the St. Johns River, Florida, will be advertised during the coming season by the U. S. Engineer, Masonic Temple, Jacksonville, Fla. The work calls for dredging and rock removal in the St. Johns River between Jacksonville and the ocean. The material will be disposed of in river parallel to cut or on prescribed dumping ground. The probable consideration of contract is $250,000, and the approximate date of opening bids is July 15.

Organization of the Engineering Foundation.—There was held on May 25 the first regular meeting of the Engineering Foundation, at which rules of administration were adopted and the following officers elected: Chairman, Gano Dunn; vice-chairman, Edward D. Adams; secretary, F. R. Hutton; treasurer, Joseph Struthers. This is a professional engineering trust organized along the lines of the Cleveland, Carnegie, Rockefeller and Sage Foundation by the United Engineering Society representing jointly the national organizations of electrical, mining and mechanical engineers, with the co-operation of the national organization of civil engineers, combining about 30,000 members. The Foundation is the first of its kind devoted to engineering interests.

The Engineering Foundation was made possible through the generosity of a distinguished engineer, Ambrose Swasey, of Cleveland, who made the initial gift of a quarter of a million dollars to be devoted to the benefit of mankind through fostering engineering research. The board administering this trust consists of Mr. Edward D. Adams, banker; Mr. Gano Dunn, president The J. G. White Engineering Corporation; Mr. Howard Elliott, president New York, New Haven & Hartford R. R.; Dr. Alexander C. Humphreys, president Stevens Institute of Technology; Dr. Charles Warren Hunt, secretary American Society of Civil Engineers; Dr. A. R. Ledoux, past president American Institute of Mining Engineers; Dr. M. I. Pupin, professor electromechanics, Columbia University; Mr. Charles E. Scribner, chief engineer Western Electric Co.; Mr. J. Waldo Smith, chief engineer, Board of Water Supply, Gas and Electricity, city of New York; Mr. Jesse M. Smith, past president American Society of Mechanical Engineers, and Mr. Benjamin B. Thayer, president Anaconda Copper Co.

Applications for the use of funds were received in large numbers and a committee was appointed to consider them, consisting of Dr. A. R. Ledoux, chairman; Mr. J. Waldo Smith, Dr. M. I. Pupin and Dr. Alexander C. Humphreys. Most of the applications were in such form that they could not be considered, and the committee is preparing a schedule of requirements with which applications will have to comply.

"Good Roads Day" in Pennsylvania.—Preliminary reports received at the State Highway Department, at Harrisburg, indicate that despite unfavorable weather conditions generally throughout the State, the Pennsylvania "State-wide Good Roads Day" was a success. With 15 counties to hear from, reports showed that 41,000 men worked on 3,900 miles of roads. There were 8,804 teams at work and 1,223 drags in the 49 counties included in this preliminary report. Nearly every county in the northeastern part of the state reported rainy conditions. In Blair county 50 carloads of cinders were used on the roads and 3 carloads of stone

PERSONALS

Mr. I. A. Baum has been elected city engineer of Texarkana, Ark.-Tex.

Mr. Henry A. Varney has been appointed town engineer of Brookline, Mass., succeeding the late A. H. French. Mr. Varney has been first assistant enginer since 1901 and has been acting town engineer during the illness of Mr. French.

Mr. D. L. Struthers has been appointed city engineer of Wilmington, N. C. Mr. Struthers was formerly superintendent of construction in the Chadbourn, N. C., Drainage District. During the year 1911 he was in general engineering practice and since 1911 has been assistant city engineer of Wilmington.

Mr. William T. Crowley has opened an office at 31 W. Main St., Lock Haven, Pa., for private civil engineering practice. Mr. Crowley was engaged in railway work for several years prior to 1911, when he became connected with the Pennsylvania State Highway Department, with which he has held various positions. He was also for a time in the city engineering department of Lock Haven.

Mr. C. W. Anderson has been appointed city engineer of Centralia, Wash., succeeding Mr. Stanley Macomber, resigned. Mr. Anderson graduated in civil engineering from the University of Washington in 1912. Prior to graduation he had spent one summer with the U. S. Geological Survey on topographical work; one in charge of construction of irrigating plant at Wenatchee, Wash., and the summer of 1911 in surveys at Vancouver, B. C. Since graduation he has been assistant city engineer of Centralia.

Mr. S. D. Clinton has been appointed assistant field engineer of the Interstate Commerce Commission, Division of Valuation, with headquarters in the Wells Fargo building, San Francisco, Cal. Mr. Clinton will be in charge of Party No. 7, engaged on valuation work in northern Montana. He has been assistant engineer for the Idaho State Highway Commission since 1912. Mr. Clinton is a graduate of the University of Nebraska, class of 1902. His first engineering work was in the railway field, first as resident engineer for the Western Maryland Railway at Cumberland, Md., and then for the Tidewater Railway at Norfolk, Va., in 1905-6. In 1907 he opened an office in Twin Falls, Idaho, for private practice, which he maintained until receiving his appointment to the State Highway Commission in 1913. During 1909-10-11 he was chief engineer on a large irrigation project at Downey, Idaho.

Messrs. Joseph W. Ellms, George P. Smith and Clifford N. Miller have organized the firm of Smith, Ellms & Miller, consulting civil, hydraulic and sanitary engineers, 2807 Union Central Building, Cincinnati, Ohio. Mr. Smith was in the engineering department of the Burlington & Missouri from 1886 to 1896. For six months following he was with the Lassig Bridge & Iron Works, Chicago. He then became chief engineer for the St. Joseph & Grand Island Railway, St. Joseph, Mo., where he remained until November, 1900, when he was appointed first assistant engineer for the Lake Shore & Michigan Southern. In April, 1902, Mr. Smith was appointed engineer maintenance of way for the Indiana, Illinois & Iowa Railway at Kankakee, Ill., and from 1905 to 1909 was chief engineer for the Lake Erie & Western. In January, 1909, he became chief engineer for the Big Four, and retained that position until February last. He is now consulting engineer for that company.

Mr. Joseph Ellms has been superintendent of the Cincinnati filtration plant since it was started in 1907. He has also for the past two years carried on a consulting engineering practice along lines of water works improvement, specializing in problems relating to water purification, sewage disposal, trade wastes, refuse and garbage disposal and general engineering. He is a member of the American Society of Civil Engineers, American Chemical Society, New England Water

Works Associaton, the Indiana Water Supply and Sanitary Association and the American Public Health Association. Mr. Ellms is widely known, and has been called in as consultant by many large cities in connection with water supply or sewerage problems.

Mr. Clifford N. Miller has been associated with Mr. Ellms since December, 1913. He is a graduate of the University of Cincinnati, a member of the American Water Works Association, and an associate member of the American Society of Civil Engineers. For a short time he was connected with the U. S. Engineer Office at Cincinnati. From 1897 to 1909 he was assistant engineer in charge of the engineering office of the Commissioners of Water Works, Cincinnati. From October, 1909, to July, 1911, he was assistant engineer on water works design with Mr. Wynkoop Kierstad of Kansas City, Mo. During year following he was for a time assistant engineer in the Kansas City water department, and from September, 1912, to May, 1913, he was chief engineer of that department.

Mr. David R. Cooper announces that he has reopened his office at 39 Cortlandt St., New York City, for the practice of hydraulic engineering, specializing in stream flow studies and reports on hydro-electric power projects. Mr. Cooper's early experience was attained in Ohio, where he was connected with the engineering department of the Springfield, Troy & Piqua Railway Co., Central Construction Co. of Toledo, the Cincinnati, Dayton & Ft. Wayne Railroad, the Cincinnati Northern Railroad, and the Toledo & Ohio Central Extension Railroad. He was city engineer of Springfield, Ohio, and later of Dayton, Ohio. For one year he was employed on design of the Cincinnati filtration plant, and one year was in the office of the chief engineer of the New York Central. He entered his present line of work when he was employed by the New York State Water Supply Commission, for 3½ years, investigating flow of stream and water power possibilities of the state. For one year he was engineer-secretary to the commission. Since that time Mr. Cooper has been employed on many large water-power projects, including that of the Salmon River Power Co., in New York state, on which he was assistant to the chief engineer; the Columbia Mills plant at Minetto, N. Y., as chief engineer; the 40,000-H. P. plant at Grace, Idaho, and a 30,000 H. P. plant at Oneida, Idaho. He has been frequently retained as hydraulic expert to make reports and give testimony in stream flow litigations in New York state.

Contractors.

The John F. Casey Co., Oliver Building, Pittsburgh, Pa., was recently awarded the contract for six miles of main sewer for the city of Canton, Ohio. This firm is composed of John F. Casey and Ottomar Stange, and has handled some of the largest contracts in their line, through Ohio and Pennsylvania. Among these were the Cleveland Filtration plant, West Side, for $1,000,000; the Cleveland pumping station and chemical house, $400,000, both in 1914; raising the Pennsylvania main line tracks from Pittsburgh, Pa., to Braddock, Pa., and a 700,000,000-gal. reservoir at Pittsburgh, $705,000, in 1913-14. The present contract at Canton calls for 4,500 lin. ft. of double 30-in. Lock Joint Pipe Company's concrete pipe, the rest of the sewer being 39-in. segment block. The firm was also awarded the contract for the construction of the two intercepting sewers at Milwaukee. The company's bid was $305,305 for the sewer on the east side of the river and $193,423 for the west side job. The two contracts call for the following approximate quantities: 7,927 ft. brick and concrete sewer, 30 in. to 51 in. in diameter, in open cut; 3,992 ft. brick and concrete sewer, 30 in. to 51 in. in diameter, in tunnel; 3,884 ft. terra cotta pipe sewer, 10 in. to 24 in. in diameter; 1,762 ft. of manholes and pile and timber foundations; 8,480 ft. brick and concrete sewer, 30 in. to 48 in. in diameter, in open cut; 2,340 ft. terra cotta pipe sewer, 10 in. to 18 in. diameter, and 1,105 ft. of manholes and pile and timber foundations.

OBITUARIES

Joseph S. Mundy, mechanical engineer and inventor and manufacturer of the friction drum hoisting engine, died at his home in Newark, N. J., May 26, aged 68.

William P. Adams, contractor of Louisville, Ky., died in that city May 24, aged 70. Mr. Adams built the Shelbyville railroad extension, the old trotting track at Douglas Park, and the Jacob Park boulevard, in Louisville.

NEW CATALOGUES

Slope Chart.—Paper, 6x9 ins.; 4 pp. Keuffel & Esser Co., 127 Fulton St., New York City.

Describes the Brunton Slope chart, and gives directions for its use. Illustrated.

Leadite.—Paper, 2 folders, The Leadite Co., Land Title Bldg., Philadelphia, Pa.

Describes the use of "Leadite" for jointing cast iron water mains without caulking. Illustrated.

Standpipe Paints.—Paper, 5½x8½ ins.; 16 pp. Joseph Dixon Crucible Co., Jersey City, N. J.

Consists of views of standpipes painted with Dixon's Silica Graphite Paint, and giving details as to conditions, service, etc.

Valves.—Paper, 6¾x10 ins.; 32 pp. H. Mueller Mfg. Co., Decatur, Ill.

Catalogue No. 5, describing Mueller reducing and regulating valves. Gives details of construction, installation and operation, proper sizes, etc., and shows half-tone views and sectional diagrams.

Graphite Products.—Paper, 6x9 ins.; 104 pp. Joseph Dixon Crucible Co., Jersey City, N. J.

Catalogue of Dixon's graphite productions from air brake and triple valve grease to yacht plumbago, and including crucibles, nozzles, many kinds of lubricants, paints, electrical specialties, pencils, etc. Illustrated.

Coagulant and Sterilizing Apparatus.—Paper, 6x9 ins.; 14 pp. Pittsburgh Filter Manufacturing Co., Pittsburgh, Pa.

Bulletin C. & S. 6, describing coagulation and sterilization methods, and illustrating different arrangements and design of apparatus for feeding coagulant to the water, treating of chloride of lime solution, and the liquid chlorine gas.

Lead Wool.—Paper, 3½x6 ins.; two 12-page pamphlets. United Lead Co., 111 Broadway, New York.

Ulco lead rope, an emergency material for plumbers, gas fitters, steam fitters, etc., to repair leaks in pipes or masonry, is described in one of these pamphlets. The other is devoted to "Ulcoloy," a copper-lead metal for bearings, bushings, metallic packing, etc. Both illustrated.

CATALOGUE REVIEWS

Pumping Machinery.—Paper, 6x9 ins.; 104 pp. The Hill Machine Co., Anderson, Ind.

The 1915 catalogue, "A," describing Hill pumping machinery, shows a number of improvements and additions to the line, and is in addition a useful hand-book of data and general information on pumping machinery.

The first few pages are devoted to pumping data and engineering information. These are followed by a section on Hill deep well steam pumping engines. Section "D," describes Hill power and electric deep well pumping heads; Section "E," power and electric house pumps; Section "F," double-acting power and electric pumps; Section "G," single and double-acting cylinders, valves and well parts.

Photographs, drawings and dimensional tables supplement the text and altogether comprise a complete and convenient reference book for users of pumping equipment.

Though the preface states that the publishers have "somewhat sacrificed the beauty of the book by inserting drawings and dimensions for prompt reference and study," we personally find it an attratcive and unusually well-arranged catalogue, typographically excellent in all particulars. One feature we like well is the insertion of blank pages headed "Data" after each section. We believe that the arrangement and this convenience for inserting notes will induce the recipient to keep this catalogue on file, which after all is the object of a catalogue.

INDUSTRIAL NOTES

MacArthur Concrete Pile and Foundation Co., 11 Pine Street, New York City, has been awarded a contract for the pile foundations of the Y. W. C. A. building, San Jose, Cal. Morrison Bros., Santa Clara, general contractors. Julia Morgan, architect.

The Sterling Wheelbarrow Co., West Allis, Milwaukee, Wis., report a record month's business in May. This company last fall completed a 7,500-sq. ft. enlargement to its plant, and the increase of business since then has been such as to necessitate a second enlargement of the same size. This will be started at once.

FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409 U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should be made to the file numbers.

Concrete Mixers, Etc.—Business man in Chile desires catalogues of small concrete mixers. He also desires to receive plans and specifications for small concrete buildings, together with catalogues, etc., of materials and forms to be used; also catalogues and full information relative to metal ceilings and facings for walls. No. 17045. [For address see first paragraph.]

Portable Houses.—An American consular officer in Greece desires catalogues, specifications, and full information relative to portable houses, especially those which may be used as isolation hospitals. No. 17093. [For address see first paragraph.]

Dynamos.—Firm in Greece is in market for dynamos and electrical supplies. No. 17094. [For address see first paragraph.]

Pipe, Pumps, Etc.—Firm in Greece may be induced to purchase iron beams or girders, iron pipe and pumps. No. 17098. [For address see first paragraph.]

Machinery, Etc.—American firm contemplates installing marble plant in Italy and one of the directors wishes to obtain catalogues from American manufacturers of marble machinery and power equipment. This firm may also be interested in purchasing patented window sashes and skylights as well as other modern devices for concrete buildings. No. 17124. [For address see first paragraph.]

Building Timber.—Firm in Greece desires to place an order for pine and fir building timber, sawn or hewed, also hewed satin walnut. No. 17136. [For address see first paragraph.]

Mining and Pumping Machinery.—Representative of a Russian society is in New York City for the purpose of establishing commercial relations with American manufacturers of mining, pumping, printing, and refrigerating machinery, and exporters of paints, fertilizers, and various other lines. No. 17090. [For address see first paragraph.]

Motor Trucks.—Company in Honduras wishes to purchase two 5-ton trucks for freighting purposes. The motors should be geared to fore as well as rear wheels. No. 17072. [For address see first paragraph.]

Engineering and Contracting

Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction

EDITORS

H. P. Gillette | C. S. Hill | C. T. Murray | S. C. Hadden | C. W. Malcolm | C. R. Thomas

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Engineering Research and Progress.

The Mazda lamp—that remarkable product of the research laboratories of the General Electric Co.—will form the text of many a sermon on the profitableness of scientific research. In this issue we reprint a splendid paper on research by Mr. W. R. Whitney, and we ask our readers to note particularly his arguments in favor of investigations in the realm of pure science.

Engineering is applied science, but we should not forget that it is the principles of *pure* science that we apply. A chemical engineer said to the writer not long ago:

"Few business men seem to realize that almost every process of industrial chemistry was once a laboratory experiment."

Much the same criticism may be leveled at the business heads of railways and other public utility plants. They usually fail to understand the true value of scientific tests and studies, unless they can see an immediate and profitable application. Consider for a moment the possibilities of reducing the resistance of trains, and then review the meager array of test data on rolling friction, air friction, etc. Is it too much to say that train resistances might be reduced 20 per cent without greatly adding to the investment in railway plant? We think not.

It is well known that at high velocities more than half the resistance that a train encounters is "head resistance." Who has ever conducted experiments to reduce this "head resistance"? May it not be that a light car in advance of the locomotive could be so designed as to eliminate, say, half the head resistance? There is certainly nothing fantastic in the idea, for it is known that an elongated pear-shaped body offers but a fraction of the resistance to the air offered by a cubical body.

Take the whole subject of frictional resistance, a subject that daily concerns engineers in their designs, and attempt to harmonize the published facts about it. Instead of any apparent harmony, one seems to see infinite varieties of discord. Here we find coefficients of sliding friction decreasing with increased unit pressure; there we find the converse, but for no apparent reason. Rolling friction shows equally perplexing inconsistencies. Yet we are certain that experiment can be made to disclose all the laws of friction, and thus enable us to overcome or utilize friction in the most economic manner.

There is a tendency to regard civil engineering as being far less susceptible of improvement than electrical engineering, for example. May it not be that this tacit belief has sprung from the comparative lack of experimental research in the civil engineering field? May it not be that we civil engineers have, in a measure, failed to realize our own opportunities to hasten progress by research? Employed by municipalities and states whose executives are not spurred by the hope of profit, have we not also fallen somewhat into a lethargic state? Do we habitually regard our designs as merely crude attempts to achieve economic results? Does it occur frequently to us that these cities for whom we work are themselves woefully designed as economic plants? Are we not habituated to accept things as they are, making slight improvements here and there, when the real need is for entire abandonment of much that now seems as established as the tides?

Recently the writer stated that he would not be surprised to see railways almost entirely superseded as carriers of freight. By what? By automobiles? By flying machines? By water ways? By pneumatic tubes? Such were the questions to which the writer replied that he did not know, but that he fancied that something quite different from these devices would eventually displace railways as freight carriers.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

"But if the freight carrier is to travel neither on roads, nor on rails, nor on water, nor on air, what is left to travel upon?"

"On swings or pendulums perhaps."

Let the engineer reflect that in the pendulum he has a transporting device unequalled for mechanical efficiency, at fair high velocities, and he may well hesitate to believe that the wheel and axle will always remain supreme as an instrument of over land transportation of freight. A series of towers with mechanism for synchronizing the swinging of dependent cars, and for the automatic gripping of a car by a "pendulum" an instant before it is released at the end of its swing by the preceding "pendulum," forms a combination not only conceivable but calculable with considerable accuracy. It can turn curves, or rather corners, without shock. It can surmount grades. It can be operated like a conveyor but without the wear and tear of a conveyor. Bridges and culverts it would eliminate, and noise would be unknown in its operation. It might enter a city over the tops of buildings, and it certainly would cross farms without measurable injury to the land.

All this may be a dream, but rest assured that progress, as well as men, is "of such stuff as dreams are made of."

We shall move on to new wonders in the world of engineering, but our rate of progress will depend largely upon our ability to conceive achievements that border on the fantastic. Research will give us the data in such co-ordinated form that we may design more marvellous things than the talking towers of Marconi that whisper across the sea and are heard.

The Widest Tunnel in the World.

The first tunnels for commercial transportation were canal tunnels. In the eighteenth century canal tunnels multiplied rapidly in France and England and the United States. In France alone in 1850 there were over twenty canal tunnels with an aggregate length of some 18 miles and in England in 1856 there were 45 canal tunnels with an aggregate length of some 45 miles. America's record was much smaller, scarcely over a round half-dozen tunnels were built on canals and these were all quite short. Of the three countries named, which led in the early construction of canal tunnels, only France continued to develop her canals and canal tunnel work after the advent of the steam railway. France has in recent years enlarged, rebuilt and otherwise improved many of her old canal tunnels and as noted on another page France is building now a canal tunnel which has, we believe, the largest section of any tunnel in the world.

The early canal tunnels were not of large section. A modern double track railway tunnel is considerably wider and higher. In fact the first direct influence of the railway on tunnel construction was to increase sectional profiles. Tunnels for two tracks were built as wide as 30 ft. and generally ranged from 25 to 28 ft. in width. The widest of the early canal tunnels was about 20 ft. and some were as narrow as 9 ft. The next step in the increase of tunnel sections generally, came with the building of urban underground railways and of street tunnels.

The three-track New York City tunnels built a few years ago for the Pennsylvania R. R. had in places a clear width of 39 ft. At stations some of the Paris underground railways had widths of 45 ft. Greatest tunnel widths have, however, to be credited to street tunnels. One of the Roman boulevards was carried under the Quirinal a few years ago, as we recall, by means of a tunnel 15 m. (49 ft.) wide, and in our issue of Feb. 3, 1915, full description was published of the Stockton St. tunnel in San Francisco having a clear span of 50 ft. and a length of 911 ft. All of these sections appear nearly insignificant beside the section 72 ft. wide and 47 ft. high of the new tunnel of the Marseilles-Rhone Canal in France. This tunnel, too, is long enough—3¾ miles—to rank among the great tunnels of the world were it of only ordinary sectional dimensions.

Information available concerning the new French canal tunnel is yet rather meager in detail, but the article in another column gives the main structural and construction details. Roughly the excavation amounts to about 285 cu. m. per meter of tunnel or say 95 cu. yds. per lineal foot. This figure gives the tunnel engineer most clearly of all perhaps the size of the excavation task that confronts the contractor, Mr. Leon Chagnaud, of the Rove Tunnel.

The Isolation of the Average Water Department.

The average water works operator isolates himself from his contemporaries and thereby imposes a severe handicap upon his efforts. The truth of this statement is very well borne out by a brief consideration of Wisconsin conditions relative to membership by water works operators in the two large associations of water works men.

In 1914 only 6 of the 26 privately owned water works in Wisconsin were represented by membership in the American Water Works Association; of the 163 municipally owned plants only 9 were so represented. There are only six members of the New England Water Works Association in Wisconsin and of these only one is connected with water works operation. These figures are truly remarkable.

While the short tenure of office of officials in municipally owned plants no doubt accounts, in part, for the failure of such officials to take advantage of the privilege of membership in the organizations named, what can be said in extenuation of the failure of officers of privately owned water works to identify themselves with these associations? The figures above quoted are distinctly favorable to the alertness of the latter class, comparatively speaking, but their 23 per cent is a pretty poor showing when one considers the general enlightenment of Wisconsin citizens. Wherein lies the difficulty?

We are convinced that the point has been reached in the development of the American Water Works Association at which it must do more missionary work among prospective members. Those who are slow to seek membership are the ones most likely to benefit from it. Inertia, alone, probably stands in the way of extending the sphere of the association's influence—inertia on the part of individual operators. For this reason, or in this belief, we have urged and shall probably urge again that the association take up some form of publicity work which will attract the attention of the large number of water works operators who are now ignorant of or indifferent to the association.

This is a matter of first importance to the water works interests of the country, to water consumers and to tax payers. Many cities need better service, and a much larger number need more economical water works operation than they now have. Operators need the knowledge and the stimulus that membership in the association will give and we hope the association and its members will make every effort financially possible to secure new members among water works operators.

Water Meterage and Human Rights.

As long ago as the first of January, 1913, we published an article which demonstrated conclusively that the general introduction of water meters in Chicago would work to the economic advantage of the individual householder. The article was the result of long and close study by one of the city's engineers and in speaking in favor of a meter on every service he voiced the opinion of his professional colleagues in the city's service. Near the end of his fifth term former Mayor Harrison began to see virtue in a limited extension of the meterage system in this city for the curtailment of the excessive water waste. The new mayor, however, who has a tendency to protest overmuch his passion for the weal of the plain people, admits that he is glad Chicago has lots of water to waste, for this makes for a cleaner and more healthful city. We are wondering how many terms Mayor Thompson will have to serve before he sees the fallacy in his present views on the subjects of water waste and meterage.

The city council has long halted between two opinions on the meterage problem. The individual alderman is inclined to favor the installation of meters in every ward but his own. Now that women are voting here the council will be less likely than formerly to pass a meter ordinance, for women in organizations and as individuals are opposed to meterage on the grounds of the classic fallacy which always springs into renewed life when this subject is under discussion.

A few days ago at a meeting of the City Club City Engineer John Ericson and Prof. E. W. Bemis recommended the installation of meters as the best solution of the water waste problem. Mr. Ericson asserted that 75 per cent of the city's pumpage is wasted.

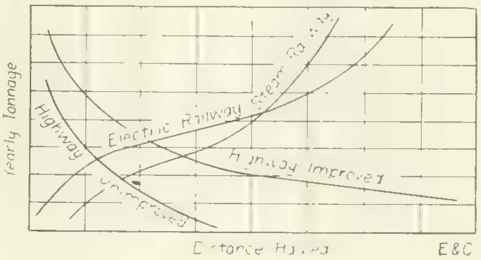
The zeal with which some of the women's organizations are opposing meterage is well illustrated by the following quotation from the statement of the spokeswoman for the Human Rights Party of Cook County:

> Seventy-five per cent of the water wasted! It is my opinion and the opinion of most of the women in Chicago that water is never wasted. There cannot be too much used. There is a big lake, plenty of water and if poor women, in the more congested districts, are forced to use less water—well, there will be more disease and more horrible conditions than now exist. Two years ago the aldermen of the city tried to pass such an ordinance, but it was defeated, largely through the work of Mary Miller, then president of the Human Rights Party of Cook County. She is dead now, but her work will go on just the same. I will take the matter up with the Woman's Rights Club and the Chicago Woman's Club.

There you have it, men! The women are down on the water meter in Chicago, and in view of this fact the fear of meterage will be put into the hearts of the new city council. While, in the premises, we naturally sympathize with the new aldermen, we hope they will speedily enact a meter ordinance. Experience in Chicago indicates that women voters are, after all, very much like old-style voters, and soon forget. By the time another aldermanic election comes they may be bent on safeguarding the freedom of our institutions from some other line of attack than the intrusion of the water meter.

The Economic Elements Involved in Transportation and Communication Problems on Country Roads.

There are three generally used means of transportation and communication: railway, highway and river or canal. These are to a greater or less degree competitive. Intensity of competition varies with the relative cost, rapidity and convenience. Highways serve as branches or feeders for railroads in the transportation of goods to be shipped beyond a certain distance. The proportion of highway tonnage eventually hauled by the railroads varies with the character of goods and the intensity of settlement of the region. Hence it seems a feasible proposition that adequate data having been secured, by plotting the yearly tonnage passing over a road against the distance hauled a set of curves may be derived of the nature shown in the figure that will indicate the economic hauling distance from the standpoint of cost. By careful observation convenience and speed—important factors not considered—may be evaluated and used to modify these curves.



Vehicles generally have their power supplied by horses, or gasoline or steam motors. Relative economy depends upon the cost of transportation, the type of road surface, distance, convenience and speed of transportation. The tonnage per vehicle or wagon train is affected by the capacity of the vehicles, the resistance to traction due to the road surface and friction grades and is indirectly influenced by the distance and type of goods transported. The average tonnage per vehicle may be determined directly by observation.

Transportation over country roads may be roughly divided into: transportation of farm produce and farm supplies, goods transportation between towns, and passenger transportation. Farm produce and farm supplies are hauled from or to numerous scattered points included within a freight area, or traffic area. Such an area is frequently triangular in shape, the total freight tonnage and passenger traffic passing through one apex of the triangle. Goods hauling between towns varies with the occupations of the people, and hence the type of freight hauled, railway and water competition, distance, economic types of vehicles for existing road surfaces and grades. Passenger traffic is divided into pleasure traffic, social intercourse and business communication. Pleasure traffic involves personal comfort, the value of which varies with the individual. Social intercourse involves health considerations, communication with schools and churches and the control of labor. Business communication concerns stage lines, the transportation of farm labor and commercial representatives and business matters relative to marketing and purchasing.

From an economic standpoint distance is a function of time as well as length. Speed of travel is affected by traffic intensity and direction, road surface, grades and curvature and by the economic speed of the vehicle. The economic speed of the vehicle varies with the power and size of loads hauled.

Convenience of travel is affected by economic conditions peculiar to each road user. In general, nearness to main roads, vehicles used for general purposes other than road hauling and the type of freight hauled are important factors.

Reliability and safety of travel are affected by the permanence of waterways, railroad grade crossings, condition of the road location and surface, involving maintenance, curves, grades and crown.

It is concluded, therefore, that the degree of importance of country roads is but a single factor in determining the profitable expenditure for hauling. Country roads are essentially a monopoly when beyond the influence of railway and water competition. It is held that in determining the profitable expenditure for transportation and communication in a community it is necessary to determine (a) the type of vehicle economical under existing conditions; (b) the type of vehicle operated at minimum cost of various grades and road surfaces; and (c) the type of road surface adapted to the economic type of vehicle.

The Pacific Highway Interstate Bridge Over the Columbia River.

The building of a number of trunk-line railroads to the Pacific coast has necessitated the construction of many important railroad bridges over our Western rivers. In general, the engineering problems connected with the design and construction of these bridges have been trying, due mainly to the difficulty of securing adequate foundations at a reasonable cost. With the development of our Western cities, creating in turn a demand for main highways connecting them, engineers have again been confronted with the difficult problem of bridging these rivers. The obstacles presented in the case of highway bridges are even greater than those met in the construction of railways, due mainly to the difficulty of raising adequate funds—the problem of financing generally being a local one. Of the four great Western rivers of North America, namely, the Yukon, the Fraser, the Columbia and the Colorado, only one of them has its lower portion spanned by a bridge devoted exclusively to highway traffic. The Frazer River constitutes this exception, this Canadian river being spanned, at New Westminster, B. C., by an important highway structure. It is of interest to note that construction is under way on the second important highway bridge over the lower portion of one of these rivers. This bridge, which is to span the Columbia River between Vancouver, Wash., and Portland, Ore., will form a part of the "Pacific Highway," which soon will extend from Vancouver, B. C., to San Diego, Cal. In addition to the general highway traffic this structure will provide for street car traffic, and in this respect it differs from the bridge at New Westminster.

The Pacific Highway Interstate Bridge, as the latest structure is commonly termed, will, with its approaches, extend from the city limits of Vancouver to those of Portland, a distance of about 3¼ miles. The project includes embankment approaches and two smaller bridges in addition to the main bridge over the Columbia River. The entire improvement, the cost of which will be about $1,750,000, was financed by the two counties in which its termini lie, Multnomah County issuing $1,250,000 of bonds and Clarke County $500,000. The main structure, which is of the riveted through type with curved upper chords, includes three 275-ft. spans, ten 265-

ft. spans, and one small girder span at the Vancouver end, giving a total length of about 3,531 ft. Navigation on the Columbia River is provided for by making the central 275-ft. span a vertical lift span, thus providing a 250-ft. channel with a vertical clearance above ordinary high water of 150 ft.

This important structure embodies certain original features which merit special attention. Investigations made at the bridge site disclosed the fact that the main part of the river bed consists of sand, with only a small amount of gravel, to a depth of over 100 ft. A satisfactory and economical solution of the foundation problem was secured by a scheme which includes the placing of the piers on timber cribs filled with concrete, in the lower portions of which are to be embedded exceptionally long wood piles, which will be driven deeply into the subsoil. These piles, which will have a length of about 120 ft., are to be embedded in the concrete within the cribs to a depth of 20 ft., and thus will be made integral parts of the piers. The great penetration of the piles—about 105 ft. below low water—and the rigidity of their upper connection, will result in safe construction even though there should be some scour at the bases of the cribs. To decrease the weight and cost of the substructures each concrete pier is to be built in the form of two cylindrical shafts connected by a vertical reinforced concrete diaphragm and by an oval reinforced concrete coping. The arrangement of the beams in the floor system and of the concrete floor slab is original with the designers. The floor system, as designed, contains longtiudinal stringers between the usual floorbeams, the spacing of stringers being about 9 ft. on centers. On top of the stringers, however, extending across the roadway, there are 8-in. I-beams spaced about 33 ins. apart. These cross beams are bent to conform to the crown of the roadway and support the reinforced concrete floor slab. The rails of the street car tracks rest directly on the cross beams, being fastened to them by clips. By means of a special arrangement of rail heading it is possible for the tracks to be removed without damage to the roadway slab. Other details of this important structure are given in the "Bridges" section of this issue. Due to the rapid development of trunk-line highways in this country we may expect a commensurate improvement in long-span highway bridges; we have already seen rapid advances made in the construction of highway spans of ordinary lengths.

WATER WORKS

Design Details of the Cincinnati High Pressure Fire System.

(Staff Article.)

Construction work on the high pressure fire system for Cincinnati was begun in 1914 and will be finished, according to the present outlook, in 1916. The present article describes and illustrates the design details of this system.

THE SUPPLY

When the study of the design was taken up consideration was given to the relative economic advantages of pumping raw water from the Ohio River and the use of filtered water. The chief argument in favor of using raw water was the avoidance of using expensive filtered water for fire protection purposes. On the other hand, the use of raw water would have required the construction of a river pumping station. The river has a variation in stage of 70 ft. and during times of flood the river pumping station could have been reached only by boats. Moreover, such a station would have had to pump against a head exceeding by 60 ft. the head pumped against in using filtered water for fire fighting purposes.

The choice finally rested with the filtered supply which reaches the high pressure pumping station at an initial pressure of 55 lbs., while a suction lift would have been necessary using the raw water supply.

TABLE II.—DIMENSIONS OF FLANGE PIPE SHOWN IN FIG. 2.

D.—Nominal diameter.	T.—Thickness.	H.—Flange diameter.	A.—Diameter of bolt circle.	Number of bolts.	Diameter of bolts.	B.	C.	E.	F.	G.	Weight of one flange.	Weight per ft., exclusive of flanges.
8	.80	15.50	13.50	12	⅞	10.63	10.69	.25	.19	1⅜	54.51	69.11
10	.92	18.00	15.75	16	⅞	12.75	12.81	.25	.19	1½	72.11	98.62
12	1.04	20.25	18.00	16	1	15.25	15.31	.25	.19	1¾	94.37	133.14
16	1.27	25.00	22.50	20	1	18.50	18.56	.25	.19	2	139.28	215.31
20	1.51	30.25	27.50	24	1¼	23.00	23.06	.25	.19	2⅜	217.00	318.85
24	1.88	35.50	32.50	28	1⅜	27.80	27.86	.25	.19	2¾	311.33	477.64

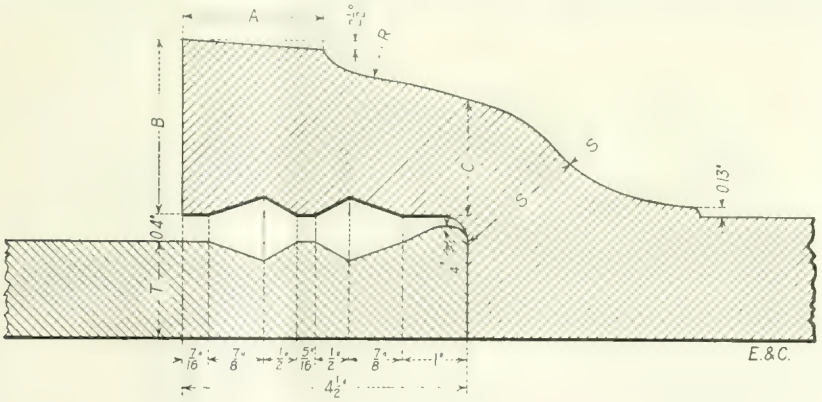


Fig. 1—Detail of Standard Hub and Spigot Joint, Cincinnati High Pressure Fire System. See Table I.

TABLE I.—DIMENSIONS OF HUB AND SPIGOT JOINT SHOWN IN FIG. 1.

Nominal diameter, ins.	T.—Thickness, ins.	Outside diameter, ins.	Diameter of hub, ins.	A. Ins.	B. Ins.	C. Ins.	R. Ins.	S. Ins.	Weight of hub, lbs.	Weight of barrel per ft., lbs.	Weight of 12-ft. length, lbs.
10	0.92	11.84	12.64	1.75	2.05	1.05	2.00	1.45	106	98.62	1,289
12	1.04	14.08	14.88	1.75	2.20	1.20	2.00	1.60	138	133.14	1,736
16	1.27	18.54	19.34	2.00	2.55	1.45	2.00	1.85	226	215.31	2,810
20	1.51	23.02	23.82	2.25	2.85	1.75	2.00	2.15	329	318.85	4,155
24	1.88	27.76	28.56	2.25	3.15	1.95	2.00	2.35	404	477.64	6,136

PIPES AND HYDRANTS

All the pipe employed as street mains is cast iron with the special form of grooved bell and spigot joints shown in Fig. 1, or with flanges. Table I gives the dimensions of the joint parts for the various sizes of pipe having bell and spigot ends. The details of the flange pipe are shown in Fig. 2 and Table II. The special castings, shown herewith, are of semi-steel with flange ends machined for tongue and groove joints.

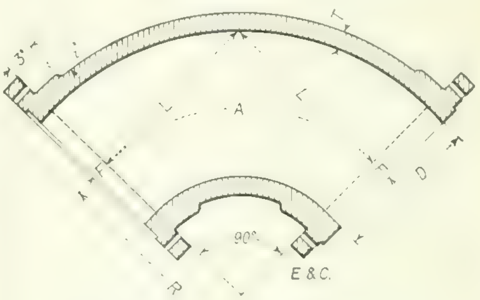


Fig. 3—Detail of Quarter Bends, Cincinnati H. P. F. S. See Table III.

TABLE III.—DIMENSIONS OF QUARTER BEND SHOWN IN FIG. 3.

Dimensions in inches.						Weight
D.	R.	L.	F.	A.	T.	in lbs.
8	16	16	1.375	25.13	.80	269.6
10	16	16	1.50	25.13	.92	375.4
12	16	16	1.75	25.13	1.04	506.4
16	24	24	2.00	37.70	1.27	1,026.8
20	24	24	2.375	37.70	1.51	1,561.9
24	30	30	2.75	47.12	1.88	2,717.1

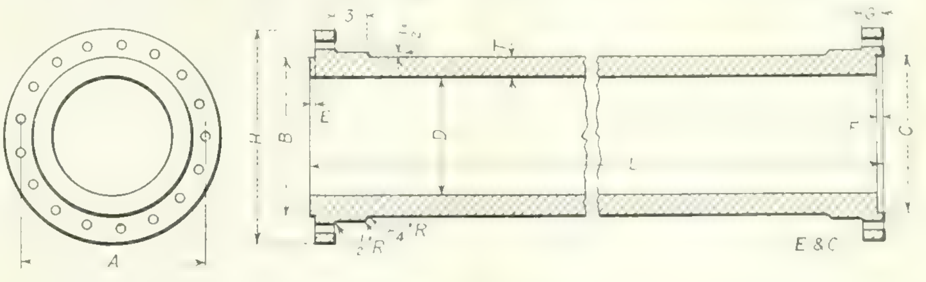


Fig. 2—Detail of Flange Pipe, Cincinnati H. P. F. S. See Table II.

The hydrants are of the flush type with portable heads of Ross manufacture. In general the hydrants are placed between the street car tracks. This location was decided upon for two reasons: (1) The space between the car tracks is always the first portion of the street from which snow is removed. This, of course, is done by the street railway forces. (2) Hydrants in the middle of the streets are less likely to be broken or rendered inaccessible by falling walls than they would be if located at or inside of the curb line.

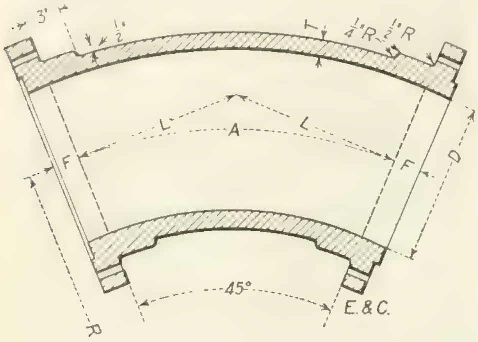


Fig. 4—Detail of Eighth Bends, Cincinnati H. P. F. S. See Table IV.

TABLE IV.—DIMENSIONS OF EIGHTH BEND SHOWN IN FIG. 4.

Dimensions in inches.						Weight
D.	R.	L.	F.	A.	T.	in lbs.
8....	24	9.94	1.375	18.85	.80	233.4
10....	24	9.94	1.50	18.85	.92	323.8
12....	24	9.94	1.75	18.85	1.04	436.7
16....	36	14.91	2.00	28.27	1.27	857.6
20....	48	19.88	2.375	37.70	1.51	1,561.9
24....	60	24.85	2.75	47.12	1.88	2,717.1

MATERIALS.

In the manufacture of the semi-steel selected new pig iron is used, and the mild steel is added thereto so as to make the castings tough, even-grained, and suitable for machining. It is required to develop a tensile strength of 30,000 lbs. per square inch. Nickel steel must be annealed and have from 21 to 24 per cent of pure nickel, and not over .04 of 1 per cent of sulphur or phosphorus. Tensile strength 70,000 lbs., yield point 35,000 lbs. and elongation 20 per cent in 2 ins. Manganese bronze must satisfy the same strength tests as nickel steel. The requirements for rolled Tobin bronze are: tensile strength, 60,000 lbs.; yield point, 30,000 lbs.; elongation, not less than 20 per cent in 2 ins. All alloys are made from new metals of the purest commercial quality. All bronze must show a tensile strength of 30,000 lbs. or over. Wrought iron must be genuine and show tensile strength of 48,000 lbs. or over and a yield point of 24,000 lbs. or over. Phosphorus and sulphur content of steel must not exceed 0.04 of 1 per cent. Tensile strength of steel must lie between 60,000 and 68,000 lbs., a yield point not less than half the ultimate strength and elongation of not less than 25 per cent in 2 ins. Babbitt metal is made of the following composition by weight: lead 70 per cent + or — 2 per cent; antimony, 20 per cent + or — 1 per cent; tin, 10 per cent + or — 1 per cent. The cast iron pipe is delivered by manufacturer to city pipe yard. All cast pipe is marked in 2 in. raised letters to show manufacturer's name, year of manufacture, serial number of casting, and distinctive initial marking for Cincinnati high pressure fire system. The pipe is coated inside and out with coal-tar pitch varnish. Both pipe and varnish are heated to 300° F. before dipping. The coated pipe is subjected to a hammer inspection and to a hydrostatic test pressure of 600 lbs.

TABLE V.—DIMENSIONS OF SIXTEENTH BEND SHOWN IN FIG. 5.

Dimensions in inches.						Weight
D.	R.	L.	F.	A.	T.	in lbs.
8....	48	9.55	1.375	18.85	.80	233.4
10....	48	9.55	1.50	18.85	.92	323.8
12....	48	9.55	1.75	18.85	1.04	436.7
16....	72	14.32	2.00	28.27	1.27	857.6
20....	96	19.09	2.375	37.70	1.51	1,561.9
24...	120	23.87	2.75	47.12	1.88	2,717.1

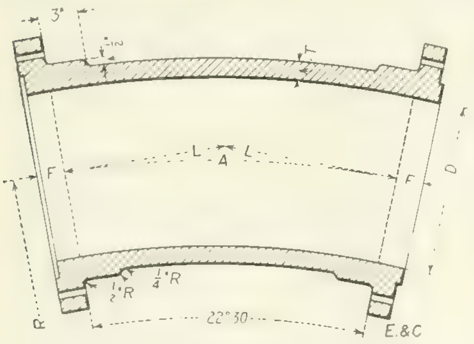


Fig. 5—Detail of Sixteenth Bends, Cincinnati H. P. F. S. See Table V.

TABLE VI.—DIMENSIONS OF TEES AND CROSSES SHOWN IN FIG. 7.

Diam		—Dimensions in inches.—				Weight	Weight
A.	B.	T_1.	T_2.	H	I.	of tee.	of cross.
10	8	0.92	0.80	12.00	12.00	443	545
10	10	0.92	0.92	12.00	12.00	463	584
12	8	1.04	0.80	13.00	13.00	579	681
12	10	1.04	0.92	13.00	13.00	599	720
12	12	1.04	1.04	13.00	13.00	638	799
16	8	1.27	0.80	15.00	15.00	918	1,020
16	10	1.27	0.92	15.00	15.00	938	1,059
16	12	1.27	1.04	16.00	16.00	1,024	1,195
16	16	1.27	1.27	16.00	16.00	1,109	1,366
20	8	1.51	0.80	17.00	17.00	1,440	1,541
20	10	1.51	0.92	17.00	17.00	1,459	1,580
20	12	1.51	1.04	18.50	18.50	1,591	1,766
20	16	1.51	1.27	18.50	18.50	1,686	1,955
20	20	1.51	1.51	18.50	18.50	1,826	2,234

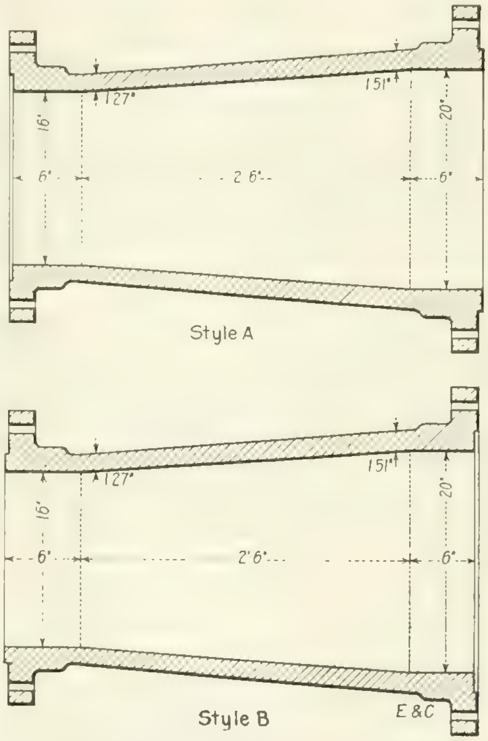


Fig. 6—Detail of Standard 20x16 In. Reducers, Cincinnati H. P. F. S.

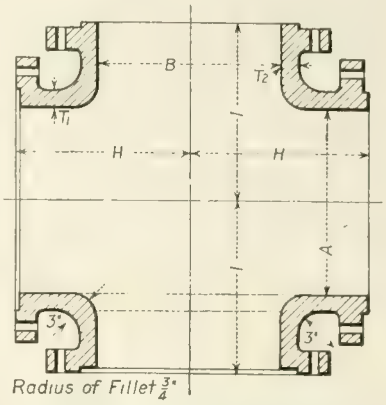
Special Castings.—The special castings consist chiefly of bends, reducers, tees and crosses, hydrant tees, sleeves, and filler pieces. The quarter, eighth and sixteenth bends are shown in Figs. 3, 4 and 5 and Tables III, IV and V. Two styles of the standard 20x16 in. reducers are shown in Fig. 6. The standard tees and crosses are shown in Fig. 7 and Table VI. The standard hydrant tee is shown in Fig. 8 and Table VII. Standard sleeves are shown in Fig. 9 and Table VIII. Standard filler pieces are shown in Fig. 10 and Table IX. Squarely cut filler pieces are used where sleeves are placed. The pipe in these cases is laid so as to make a tight fit when the filler pieces are inserted. All special castings are of semi-steel.

Miscellaneous Castings.—The miscellaneous castings are of cast iron and consist of valve chamber curbs and covers. Figure 11 shows the curb for 16 in. valve chambers; Fig. 12 the curb for hydrant and valve chambers; Fig. 13 the hydrant chamber cover, and Fig. 14 the valve chamber cover.

High Pressure Valves.—All valves used are of the solid wedge type. All except those on by-passes are of the inside screw type. Designs are for a working pressure of 300 lbs. Valves over 12 ins. are geared. Valves of 16 in. diameter or under are vertical with spur gears; those over 16 in. are horizontal with bevel gears. All valves over 12 in. have 3 in. by-passes. The valves open by turning to the right. The power required to open the valves with 300 lbs. pressure on one side and atmospheric pressure on the other side is as follows:

8 and 12-in. valves—1 man on 20-in. lever.
16 and 20-in. valves—2 men on 20-in. lever.
24-in. valves—2 men on 24-in. lever.

The valve stems are packed with lead or lead wool. Valves are given a shop hydrostatic test of 600 lbs. After installation there is a field test of 400 lbs. Valves are given two shop coats of the best asphaltum paint.



Radius of Fillet 3/4"

Fig. 7—Detail of Standard Tees and Crosses, Cincinnati H. P. F. S. See Table VI.

PIPE LAYING.

All materials needed in the construction are furnished by the city and stored in the city pipe yard. From there they are taken to the trench by the construction contractors. Material is delivered as much as two blocks in advance of where pipe is being laid. Suitable buffers or runners are used to protect the coating on pipe and specials during unloading. The location in which the trench is dug, the pipe laid and the appurtenances installed is anywhere within the street lines as directed by the city official in charge as the work proceeds. When the directing city official requires additional information relative to existing subsurface structures, over that on record, the contractor excavates test pits, for exploratory purposes, which are paid for according to the contract price for additional excavation. It is interesting to note that the specifications and contract do not classify materials encountered in excavating. The contractor bases his bidding prices on the character of formation he expects to encounter and his prices stand re-

TABLE VII.—DIMENSIONS OF HYDRANT TEE SHOWN IN FIG. 8.

Diam.		Dimensions in inches.					Weight
A.	B.	T_1.	T_2.	H.	I.	J.	of tee.
10	8	0.92	0.80	12	12	26	520
12	8	1.04	0.80	13	13	27	685
16	8	1.27	0.80	15	15	29	1,117
20	8	1.51	0.80	17	17	31	1,707

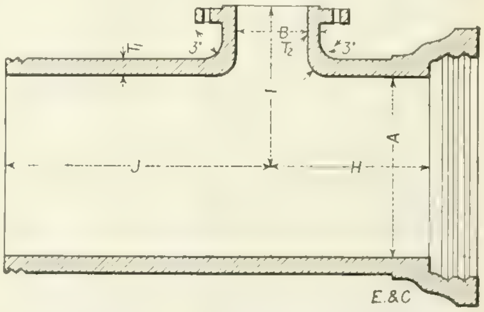


Fig. 8—Detail of Standard Hydrant Tees, Cincinnati H. P. F. S. See Table VII.

gardless of the relative amounts of hard and easy work eventually required.

At the elevation of the center line of the pipe the trench is at least 18 ins. wider than the nominal diameter of the pipe. Bell hole excavations are at least 1 ft. deeper than the bottom of bell on flange, at least 2 ft. wider than the diameter of the pipe and at least 3 ft. long. When the street pavement becomes undermined and unsupported, along the trench sides, it is broken down and removed. Trenches are bridged in front of existing fire hydrants and in front of driveways leading to private business properties.

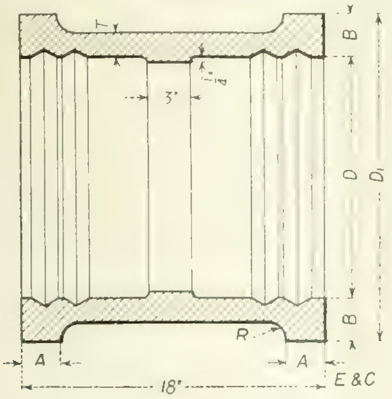


Fig. 9—Detail of Standard Sleeves, Cincinnati H. P. F. S. See Table VIII.

TABLE VIII.—DIMENSIONS OF SLEEVE SHOWN IN FIG. 9.

	Dimensions in inches.						Weight
Diam.	D.	D_1.	A.	B.	T.	R.	in lbs.
8	10.40	14.30	2	1.95	0.95	2	212
10	12.64	16.74	2	2.05	1.05	2	232
12	14.88	19.28	2⅛	2.20	1.20	2	366
16	19.34	24.44	2⅜	2.55	1.45	3	569
20	23.82	29.52	2½	2.85	1.75	3	808

Pavement is removed for a maximum distance of 100 ft. in advance of excavation and paving materials are laid to one side of the trench. All other matter is piled along the other side of and at least 2 ft. from the trench. The temporary repavement is kept within 100 ft. of the open trench. At least 100 ft. of open trench to grade is kept in advance of laid pipe. The total running length of trench open over which the permanent or temporary pavement is not in place does not exceed 1,000 ft.

TABLE IX.—DIMENSIONS OF FILLER PIECES SHOWN IN FIG. 10.

D.—Diameter.	H.—Flange diameter.	A.—Diameter of bolt circle.	Number of bolts.	Diameter of bolts.	B.	C.	E.	F.	Weight of double tongue piece.	Weight of double recess piece.
8	15.50	13.50	12	⅞	10.63	10.69	0.25	0.19	41.1	32.1
10	18.00	15.75	16	⅞	12.75	12.81	0.25	0.19	52.2	40.8
12	20.25	18.00	16	1	15.25	15.31	0.25	0.19	63.5	47.4
16	25.00	22.50	20	1	18.50	18.56	0.25	0.19	84.3	68.6
20	30.25	27.50	24	1¼	23.00	23.06	0.25	0.19	118.5	95.1
24	35.50	32.50	28	1⅜	27.80	27.86	0.25	0.19	160.1	124.4

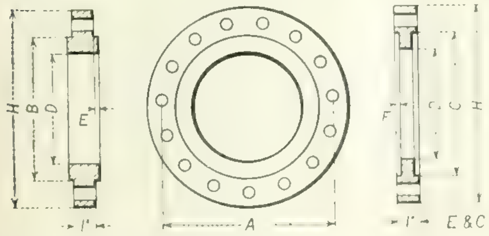


Fig. 10—Detail of Standard Filler Pieces for Use With Sleeves, Cincinnati H. P. F. S. See Table IX.

When necessary the pipe line is deflected downwards, or to either side, under or alongside such existing sub-surface structures as culverts, sewers, pipe or conduits. Extra excavation for this purpose is paid for at bid prices. Where it is necessary to move or reconstruct sub-surface structures the work is paid for at cost plus 15 per cent. The same provisions, in general, apply to service connections to private property.

Pipe is laid to line and grade. It is rolled to the trench and carefully lowered by a suitable derrick. Each 12 ft. length of pipe is laid on two blocks and four wedges of sound oak. The wedges rest on the blocks and the pipe on the wedges. The 24 and 20 in. pipes are laid on blocks 24 ins. by 8 ins. by 4 ins. thick; the 16 and 12 in. pipe is laid on blocks 18x6x4 ins. thick. All wedges are 6x4 ins. and taper from 3 ins. to ½ in. thick. Pipe interiors and joint surfaces are cleaned before laying and are so maintained.

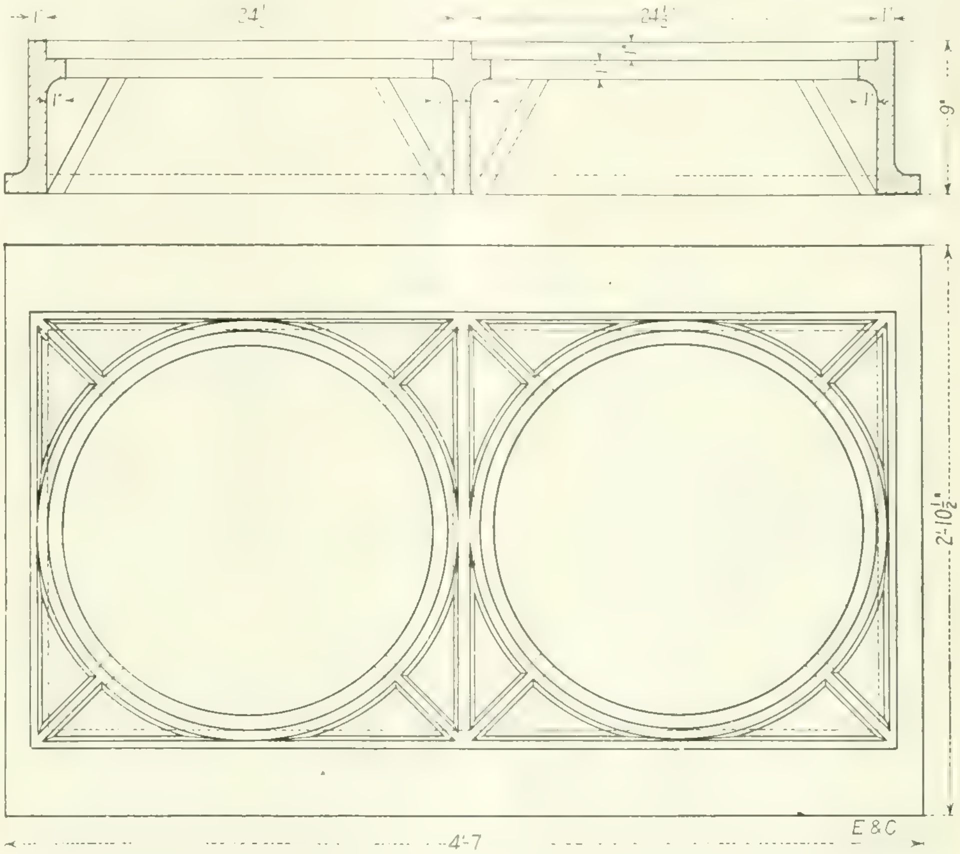


Fig. 12—Detail of Curb for Hydrant and Valve Chamber, Cincinnati H. P. F. S.

The joints are made with the best quality of hemped yarn or jute, closely twisted in one piece for each joint, well caulked into the socket. Cast lead joints are used. The joints are filled full with solid lead. Second pourings of melted lead and the calking in of cold lead are both prohibited. The joints for all pipes are at least 5/16 in. thick at all points and have a length after calking of at least 3½ ins.

Flanged joints are made with ten ounce canvas gaskets placed between two sheet lead gaskets, each 1/32 in. in thickness. The canvas is soaked in pure linseed oil and is given a coating on both sides with red lead paste ground in oil immediately before it is applied. The sides of these composite gaskets are coated with red lead paste before they are placed in the joints. Each joint bolt is dipped in asphalt paint before it is used. After joints are completed damaged spots in the coating are retouched with a heavy coat of asphalt paint.

All completed sections are given a test at 400 lbs. pressure. The tests are made between adjacent valves on the mains, and between valves and temporary caps or plugs, and include the hydrant branches either up to the 8 in. valve or to the independent valves of the hydrant as directed. When the main line test extends only to the 8 in. valve on a hydrant branch the portion of the 8 in. pipe between the valve and the hydrant is tested separately.

The leakage from the mains and hydrant connections for each section listed at a pressure of 400 lbs. must not exceed ½ gal. per lineal foot of pipe joint per 24 hours. The length of pipe joint is figured on the nominal interior diameter of the pipe. The test pressure is applied by means of a portable pressure pump

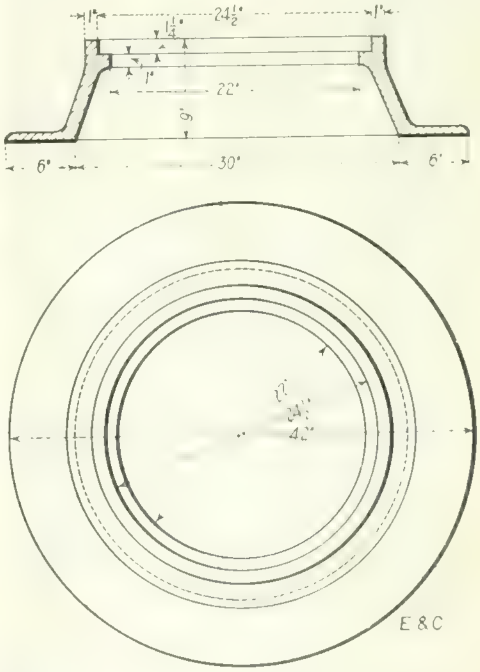


Fig. 11—Detail of Curb for 16 In. Valve Chamber, Cincinnati H. P. F. S.

equipped with a pressure gage. The water used in testing is metered by a meter whose accuracy is known by test. The test pressure is maintained for one hour. The amount of water forced into the main during the last 20 minutes of this hour is determined and taken as a basis for the computation of leakage per 24 hours.

The pump and testing apparatus are connected to the mains by attaching them either to a hydrant or to the air cocks which are placed at all high points along the main and one on each side of every valve in the main. The air cocks consist of 1½ in. brass gate valves connected to the main by a 1½ in. extra heavy brass nipple. These valves are water tight under a pressure of 700 lbs. per square inch. Water for testing purposes is taken from the existing hydrants. Generally mains are tested immediately after being laid and before the trench is backfilled.

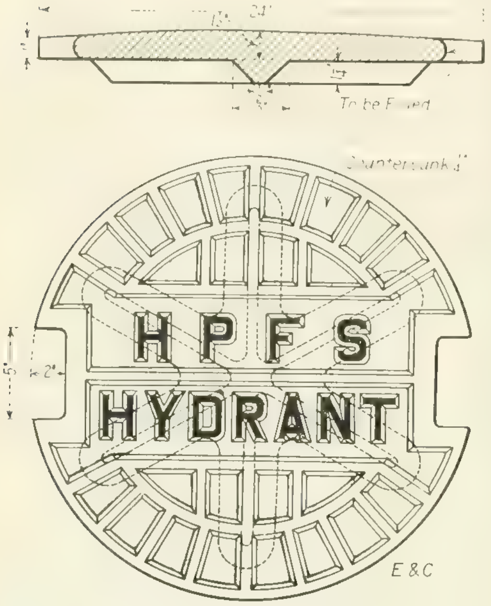


Fig. 13—Detail of Hydrant Chamber Cover, Cincinnati H. P. F. S.

Throughout the system all bends, reducers, blowoffs, caps and other parts likely to draw are firmly secured by steel clamps, bolts and rods. All valves are placed in brick chambers with cast iron curbs and covers.

In backfilling the bell-holes they are filled with selected material carefully rammed under the pipes. The backfilling at the bottom of trenches is of fine material and is tamped with special tools to insure the complete filling of the wedge-shaped space at the bottoms of the pipes and special castings. The material used for backfilling up to 6 ins. above the top of the pipes, and up to and around any suspended culverts, pipes, drains, or conduits is free from rock and is thoroughly tamped in 4 in. layers. The remainder of the backfilling is tamped in 6 in. layers to within 6 ins. of the street surface, and the trench is then thoroughly flushed with water and the filling is completed with dry material thoroughly rammed.

Mr. Philip Fosdick is Director of Public Service. Mr. J. A. Hiller is General Superintendent of Water Works. Mr. D. G. Hatmaker is in charge of the engineering and drafting department under Mr. Hiller. We are indebted to Mr. Hatmaker for the information here given.

It is stated that the municipal authorities of Guayaquil, Ecuador, have recently passed an ordinance requiring wire mesh or metal sheets to be used for building purposes in the city in place of split bamboo laths. This ordinance will doubtless create a demand for wire mesh, stamped metal sheets, etc., designed to take a coating of plaster or cement.

A Discussion of the Question of Allowance for Paving Over Mains in Valuation Work.

(Staff Abstract.)

With reference to paving over mains there seem to be vital economic and engineering considerations which the Court of Appeals of the state of New York overlooked in its decision in the case of New York Public Service Commission vs. Kings County Lighting Co., handed down on March 24, 1914.

In estimating the reproduction of a utility property the question has been often raised whether the cost of cutting through and replacing paving over mains should be included. It is not a new question and it is submitted, first of all, that it is not a legal question, but one involving engineering fact.

Is it physically possible to reduplicate a plant as of today, having a pipe distribution system in the streets in a modern city with pavements all as of today, without cutting through and replacing the paving? A straightforward, honest answer to this simple question will relieve us of much trouble and will clear up many difficulties. It is a question which not only the engineer but the courts can answer promptly and the answer must of necessity be that in all normal cases a humanly possible reduplication of a property cannot be accomplished without incurring those expenses.

Why, then, should this matter trouble valuers? The answer is, first, that nearly everyone unacquainted with the fundamental principles of valuation, but charged with its responsibility, is confronted with an uncontrollable desire to reason about value before all the evidence of fact is fully complete and before him; and, second, that there is always a tendency on the part of inexperienced valuators to mix up evidence on past or investment cost with evidence on reproduction or present-day cost before either are complete.

SOME FUNDAMENTAL PRINCIPLES.

Before proceeding to analyze the opinion of the court we may first of all define the following economic principles, which it is believed are fundamental, and should constantly be kept in mind.

Proposition 1. *"Property"* is seldom the same thing as *"investment."*

Proposition 2. *Cost* is seldom the same thing as *value.*

Proposition 3. *Past cost* or *investment* is seldom the same thing as *reproduction cost,* or cost new as of today, less depreciation.

In valuation work one should be careful not to use the words "Property" and "Investment" interchangeably. They may on rare occasions be identical, but usually they are applied to quite different things.

The past cost of a plant and the present reproduction cost, less depreciation, can only be identical: usually first, when property has been recently purchased under conditions of market stability and permanency; or, second, when the appreciations and depreciations of the past investment happen to chance to produce a sum which equals reproduction cost less depreciation.

WHAT IS IT THAT WE VALUE?

In valuation work it is important to know, first of all, what it is that we are to value. Are we to retrace the actual cash expenditure that has gone into a property, or are we to value the plant and business of the utility as a *property* and as of today? This is not an engineering question. It is the function of the law and the courts to guide us on this important point, and the courts would perform a notable service if they would construe the law on this point for us in a manner so clear and decisive that further discussion of it or dispute about it would be needless. As it is, about one-half the time of courts and commissions is now wasted in hearing opposing views on this particular question from parties who, for the sake of temporary advantage, desire the one or the other of these views to prevail in their particular case and for their particular side.

So far as engineers can gather the law from a review of court decisions and opinions, the courts are generally holding firmly to the view that it is the *value of the property* (not the past cost) and *as of today* (not as of yesterday or last year) that we are to find, but occasionally a court will wander back to the past investment theory, as the Appellate Court has in part done in this instance, and thus confuse appraisers, engineers and commissions engaged or about to engage in valuation work.

THE FUNCTION OF THE COURT IN REPRODUCTION EVIDENCE.

The court has two functions to perform in receiving and reviewing introduction evidence:

First, it should scrutinize the reproduction estimates in the light of reason and common sense aided by the engineering evidence to see that they are made on a basis that is humanly possible and practically feasible and workable; that nothing is left out of them that would ordinarily be encountered in real life and real work, and that nothing is included in them that is not necessary in fact or in good engineering practice; that they are neither padded out nor skimped; in a word, that *they are a fair and honest picture of what would really happen.*

This is the engineer's particular domain, and the views of the experienced and practical engineering expert should here receive weight, especially when he shows maturity, experience and fairness in his testimony. The engineer is in effect a court all by himself on this subject, but his decisions must have a reason back of them and must be subject to review.

Second: When reproduction, less depreciation, estimates have been fully completed, so that enough cost has been allowed to reproduce the entire property, including the reproduction of the business, then it is the function of the court, aided by the evidence, to reason out the question: *"Is reproduction less depreciation in this case a proper measure of value or a fair measure of value; and if not, why not, and to what extent not?"*

It is here that the Appellate Court has misconceived its problem. It has taken under consideration one of the items belonging strictly to the reproduction estimate and endeavored to reason out of existence an engineering fact that cannot honestly be eliminated, and then with this item alone in mind the court has endeavored to determine whether it is or is not *value* as applied to the property as a whole.

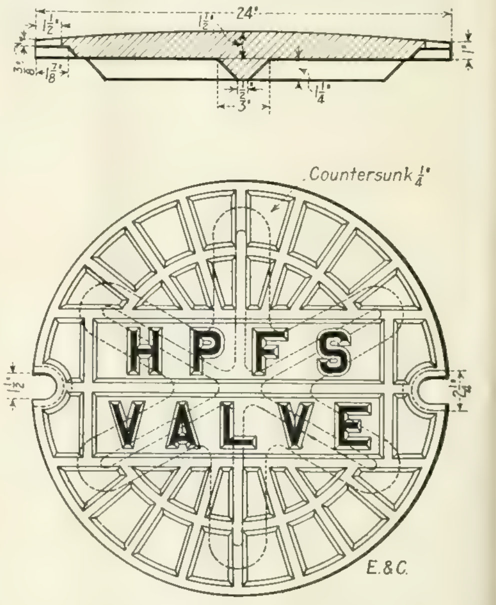


Fig 14—Detail of Valve Chamber Cover, Cincinnati H. P. F. S.

What the court should have done was first to reason out whether this item was properly a part of the reproduction estimate; and, secondly, has it fairly and properly estimated; and, thirdly, it should have asked itself: *"Is reproduction estimate itself as a whole a fair and proper measure of value in this particular case?"*

A method of approach such as is above described would have placed the court decision on firm and dignified ground and avoided an unfortunate attempt to controvert a fact in the evidence before it which is ordinarily undisputable.

THE OPINION.

To understand fully the application of these economic suggestions it will be desirable here to quote all of that portion of the opinion in the case referred to relating to the question of paving cost, bold faced type marking sentences that will be particularly discussed:

> In determining the cost of reproduction the commission allowed $12,717 as the cost of restoring the pavement as it existed when the mains and service pipes were laid in the streets. The relator claimed an allowance of at least $200,000 for the cost of restoring pavements subsequently laid on the theory that that cost would have to be incurred if the mains were to be laid today. **But the new pavements in fact added nothing to the property of the relator. Its mains were as serviceable and intrinsically as valuable before as after the new pavements were laid.** The controlling considerations under the preceding point also determine this. The rights of the public are not to be ignored. The question has a double aspect. **What will be fair to the public as well as to the relator?** (Smyth v. Ames, Supra.) Should the public pay more for gas simply because improved pavements have been laid at public expense? It is no answer to say that the new expensive pavements suggest improved conditions which, though adding to the value of the plant, will not, by reason of the greater consumption, add to the expense per thousand feet of the gas consumed. The public are entitled to the benefit of the improved conditions, if thereby the relator is enabled to supply gas at a less rate. **The relator is entitled to a fair return on its investment,** not on improvements made at public expense. It is said that the mains will have to be relaid. So will the new pavements, and much oftener. Both might possibly be relaid at the same time. The case is not at all parallel to the so-called unearned increment of land, that the company owns. **It does not own the pavements and the laying of them does not add to its investment or increase the cost to it of producing gas.** The cost of reproduction less accrued depreciation rule seems to be the one generally employed in rate cases. **But it is merely a rule of convenience, and must be applied with reason.** On the one hand it should not be so applied as to deprive the corporation of a fair return at all times **on the reasonable, proper, and necessary investment** made by it to serve the public, and on the other hand it should not be so applied as to give the corporation a return on improvements made at public expense **which in no way increase the cost to it of performing that service.**
>
> The Appellate Division felt bound by the decision of the United States Circuit Court in the Consolidated Gas case (157 Fed. Rep. 849), and it is true that such an allowance was made in that case. But the United States Supreme Court held in that case (212 U. S. 19) that the rate established was not confiscatory, and did not pass on the propriety of that allowance. What was said in the opinion on the subject of present value was merely a general statement having no necessary relation to the question now under consideration.

Reviewing the opinion as above quoted it must be apparent—

1st. The reasoning of the court does not seem to show a clear distinction between investment or actual past expenditure and the reproduction cost as of today, which latter it is in reality discussing.

2d. The court alters engineering facts to fit its reasoning, rather than attempts to fit its reasoning to the engineering facts.

3d. The court needlessly increases its dilemma by reasoning about the value of the property as a whole, with only one of the items of reproduction estimate in mind.

THE NATURE AND USE OF REPRODUCTION ESTIMATES.

A little thinking on the nature and purpose of *"reproduction cost less depreciation"* as a line of cost evidence, useful in arriving at the value of public utilities, will convince almost anyone not prejudiced in the matter that if this kind of cost evidence is worth anything at all as an aid to valuation it is because it produces something concrete and tangible; something which can be checked by experience and common sense; something which is so commonly done and so often repeated that engineers at least know fairly well what would happen under a given set of conditions.

A competent engineer with the proper experience can tell what it would cost today to reproduce a property because he is, and has been for many years, reproducing properties. It seems an entirely practicable proposition to him at least, if not to the layman or the court. Once the engineer is directed to estimate a reproduction he embarks upon a program to him not susceptible of violent expansion or curtailment; his reason and experience insist upon the inclusion of every item that must reasonably be encountered each step of the way.

When a court in its opinion deliberately advises the engineer, therefore, that reproduction is "merely a rule of convenience," apparently it says to him: "We, at least, are not bound down to reproduce this property in a way that is humanly possible if the final costs incurred do not seem to our lay minds reasonable." You must not, for instance, buy land that is now held at very much higher prices than formerly, nor must you compute the excessive cost of laying pipe in congested streets if once, long ago perhaps, you could have operated in grass-grown and deserted thoroughfares only just opened up from adjacent farm lands. Continuing this logic it says, in effect, you must seriously consider the laying down of pipe in paved streets without cutting through the pavements or replacing them, because it does not seem to us that the public should pay rates on this kind of expense.

Certainly engineers cannot acquiesce in any such loose ideas of "Reproduction" as an engineering estimating process.

WHAT IS REPRODUCTION?

To the engineer the reproduction of a property as of today can mean one thing, and one thing only, and that is the entire elimination of all methods which are not humanly possible.

To reproduce a property from an engineering point of view is to proceed in a manner which engineers commonly use to overcome the obvious obstacles that all new construction encounters. It must be done under conditions as they exist today, or will exist in the near future during a reasonably rapid period of construction. The life work of the engineer is to estimate in advance what the obstacles to such a process will be, and what it will cost to overcome them, and what will be humanly practicable to accomplish, and to advise the engineer that certain obstacles to a reproduction which he can clearly see must exist should not be estimated because the result will be too high or too low is as great a fallacy as to direct him in his estimate to use three as the product of two times two.

To compute the cost of only a part of a structure and call it "reproduction" is worse than a misnomer, for if the facts on which valuation reasoning are based are incorrect the valuation reasoning itself is vitiated.

Some courts and commissions confuse themselves at times by calling this item "the value of pavements over mains." This is not a correct designation. *The engineer in figuring the cost of reproducing a plant does not compute the value of pavements over mains at all. He computes the cost of the excavation work of cutting through pavements as an obstacle, laying his pipes thereunder, and the cost of the work of replacing the pavement in as good condition as it was before, and this is a very different thing from valuing a pavement, for it has no connection with the cost or "value of a pavement itself."*

HOW "REPRODUCTION" WORKS OUT.

Now it is quite idle to argue that a present day plant can be reproduced without ordinarily incurring such an item as we are here discussing. and the court fortunately has not attempted such an argument.

Where, then, arises its difficulty?

Obviously because it has lost sight of the true nature, limitations and use of that line of cost evidence known as "reproduction cost" *and is dwelling on past cost or investment, which is entirely a different thing.*

Let us inquire first how reproduction as of today should be worked as a practical matter.

Losses to the Utility. Gains to the Public.—Reproduction should present a faithful and practical picture of what the city or utility company would face if they had to build a new plant now, but like the existing plant in all respects. Reproduction less depreciation, therefore, shears away and casts aside from the original investment the following losses:

(1) Obsolete structures which, although they have served their day, are now useless.

(2) Expenditures and investments which perhaps seemed wise at the time they were made, but had since proved to be unwise.

(3) The higher prices for materials and machines which may have prevailed in the past.

(4) Investments made for population which may not have developed, or developed in other directions than was expected.

(5) Cost of appliances rendered valueless by reason of improvements in the arts.

(6) The wear and tear of the plant.

(7) Changes in public demand, producing obsolescence.

(8) Inadequacy of original plant due to rapidly increasing population.

(9) All other depreciations and losses from whatever cause they may have occurred.

Gains to the Utility. Losses to the Public.—Now it must be argued in all fairness and justice if we are thus to wipe out, by the reproduction of the plant as of today, all this kind of past investment which may have been made honestly and in good faith, every consideration of fairness and justice requires us to face the fact that utility properties when considered as being now recreated must take fully into account all the obstacles which they did not originally have to confront. Among these obstacles may be mentioned:

(1) Increased cost of land.

(2) Increased prices for labor and certain materials and often the high cost of living.

(3) Difficulties connected with installing a plant amid a more dense and exacting population.

(4) The necessity of conforming to police regulations and city ordinances made necessary by increased traffic and the public convenience.

(5) The necessity in underground distribution systems of meeting and avoiding an increased number of other utility conduits, such as sewers, gas or water, telephone or telegraph conduits, service pipes, heating mains and the numerous pipes which in a more developed city crowd the subsurface area.

(6) *The necessity of cutting through and replacing pavements.*

(7) The necessity of passing under steam railroad tracks, street car tracks, bridges, viaducts and other improvements not now possible to avoid, but perhaps non-existent at the time of original construction.

Clearly, if we must, by the force of correctly reasoned and carried out reproduction, eliminate all the obsolete expenditures, the mistakes of the past, the depreciation which property has suffered, we must as well find the cost of reproducing the property under the present conditions, with full allowance for such obstacles as the present conditions impose upon us. In reproduction we cannot be just and neglect, on the one hand, the things which favor the property, and on the other hand include those things which are unfavorble to the property. If we are going to dispense with the obstacles which a present day reproduction must meet by some process of "rubbing an Aladdin's lamp," then to be fair and just we must also include in our cost estimate the past obsolescence—that is, expenditures for structures which have disappeared, and immediately we do this *we are not reproducing the property at all, but are investigating its past history from the investment point of view.*

REPRODUCTION IS A SEPARATION FROM THE PAST.

The reproduction method has nothing whatever to do with the past.

It is true that recent past experience is our guide in deciding what proper costs are to be used in a reproduction, but such recent past costs are considered only as they aid the judgment in arriving at what the present and near future cost conditions will be. Reproduction, if it means anything at all, means that the engineer is to estimate the cost of a theoretical new work just as he estimates the cost of any actual new work he may be charged with. To mix actual past costs into reproduction costs, without a review as to whether they are similar to present costs, is a fatal state of mind and opens the door, especially with laymen, to all kinds of confusion and unreason. Past cost data are only data, and as data they are only of value as they help us to determine what the present or near future cost would be if the property had to be built new beginning today. The nearer to the present, therefore, that we have data on past cost, the more useful such data usually are in helping us to formulate the future cost of reproduction estimating.

REPRODUCTION A COMPLETE ENTITY.

Reproduction when complete is an entity, a complete whole. Unless it is complete it is dangerously deceptive as a line of evidence. To estimate what it would cost in part to rebuild a property, and then stop and try to reason from that incomplete reproduction the full value of such a property, is to produce something more dangerous than useful. Such partial estimates are especially dangerous when the court or the appraiser does not observe that they are not complete. If one estimates the cost to rebuild a house up to the top of the first story, how will that very much help him to find the value of the two-story house he is reproducing and wishes to value? He must reproduce the cost to complete the whole house, and then reason whether the house is worth that much or not.

The besetting sin of valuators new to the art is to estimate reproduction part way through, and then stop and try to reason about the value of the whole property. They do this often because they think of reproduction as a final summing and they get afraid they will be led to some conclusion by the reproduction formula to which they do not want to come, so they stop in the middle of things and wrestle with value of the property as a whole when they have no business to be thinking of anything but the reasonableness of the reproduction items.

There can be no formula for reasoning out value.

Some of the mental difficulties which the court encountered in trying to reason value of the property as a whole from partial reproduction items can be well observed in the following quotation:

> But the new pavements, in fact, added nothing to the property of the relator.

Is this or is this not true? Some simple questions can be asked which will apparently throw light on the question:

If a city desired to build its own municipal gas plant in this instance, would the fact that the utility company's pipes were already under the pavements give them any special value in its eyes?

Would a utility distribution system be likely to have as much value for sale or as a basis for an issue of bonds in an unpaved city as a paved city?

Do pavements over mains facilitate the installation of competitive conditions, or do they deter them?

If a city which never had a gas or water plant, but which was well paved, should decide to install one, would it cost more or would it cost less because the streets were paved?

If a city had a new gas or water plant installed and great expense was incurred in cutting through and replacing pavements, should the public properly pay rates on this expense or should they escape making a fair return on this portion of the cost thereafter?

An honest answer to these questions would appear to destroy the conclusion of the court on this question.

FAIRNESS TO THE PUBLIC.

The writer has been asked several times on the witness stand by commissions or counsel:

> Do you think it is right that the public should pay return on the value of paving over mains?

And he is accustomed to reply:

> Yes, if reproduction is found to be a proper measure of the present value of the property, and no, if reproduction is not such a measure.

This kind of an answer is necessary because the question presupposes that reproduction less depreciation is a final formula for the value of the property as a whole. It is in reality only one of the facts helpful to a determination of such value.

Continuing our analysis, we find the court further says:

> The rights of the public are not to be ignored. The question has a double aspect. What will be fair to the public as well as to the relator?

Setting aside an objection to this sentence that there is no time in valuation matters when one should forget the double aspect of the question and what will be fair to the public as well as to the utility, let us inquire how the allowance for paving, so-called, is unfair to the public. It is granted in reproduction estimate that the public ordinarily paid for the paving and it is conceded that the company ordinarily does not own it.

The key to this doubt about fairness lies entirely in the misconception of what the item is estimated for, and how it is to be used, as has been shown. It is not for the "value of the pavements" at all, but it is part of the natural cost of reduplicating the property under present conditions, and it has been shown that in a logical reproduction as of today this increased difficulty of pipe laying cannot be avoided.

If, then, there is any unfairness about this item at all to anybody it is because the entire reproduction less depreciation method of fixing value is unfair, and not because any one necessary item of it is unfair.

Now the question as to whether the entire reproduction method is a fair or unfair method to apply in any given case is an entirely proper one to raise; in fact, no valuation is properly made and completed unless this question of the fairness of the whole reproduction method to any particular case is thoroughly investigated.

WHEN REPRODUCTION IS UNFAIR TO USE.

It very frequently happens that reproduction less depreciation is entirely unfair to one side or the other. It is at times unfair to the public in the following instances:

1. When a utility company has installed in construction far greater, more costly or more numerous structures than it needed reasonably to have installed.
2. When the population and demand have diminished in the course of years so that there is no longer any need for so large a works.
3. When the existing works do not adequately meet the changed conditions of the public need, but still are efficient for the purpose for which they were originally designed.
4. When the builders were guilty of extravagance, wastefulness or misjudgment, dishonesty or graft resulting in too unreasonably expensive structures or machines.
5. When the prices for labor and material at the time the reproduction estimate is being made are all abnormally high, due to boom periods or acute market scarcity of materials.

Other situations in which reproduction less depreciation are unfair to the public might be added to this list.

Again, it is unfair to the utility company—

1. Where it owns and controls valuable processes not generally available, or, say, the sole source of supply, as, for instance, in water supplies from a limited number of desirable springs, or a peculiarly favorable geological or physical opportunity not readily duplicated.
2. Where skillful designers and experienced builders have accurately forecasted the changing needs of the public or of the future and economically provided properly for them with wisdom, skill and good judgment.
3. Where conditions of great hazard and risk have arisen and have been successfully overcome by ingenious and skillful engineering design costing but little to introduce.
4. Where careful study and prudent ininvestigation have produced an engineering work that results in special savings in operation not ordinarily available.
5. Where the prices for labor and material at the time the reproduction estimate is being made are largely depressed, due to panics or periods of temporary depression.

WHEN IS REPRODUCTION A FAIR MEASURE OF VALUE?

In valuation work it may be said to be a fundamental principle that the cost of reproduction as of today, in a manner that is humanly possible and practicable to the engineer, less the depreciation of the property, *must be the least value which can be put upon the property when the following conditions obtain*:

1. That the utility's product is needed by the public.
2. That the service is satisfactory.
3. That the city is prosperous and growing.
4. That no serious mistakes of engineering or finance have developed in the past history of the plant.
5. That the cost of the service to the consumer is less than any substitute service.

Under the above conditions it is obvious that if the public utility property, whether owned by the city or the company, were suddenly wiped out of existence its value to the community would be the cost of restoring it under existing conditions—i. e., in the near future—including the losses in revenue sustained while so doing, and, of course, all in a manner humanly possible as an engineering problem. When so estimated and restored its cost would be the least possible value that could be put upon the property. The greatest value which the property could then have would be the cost to the consumers of installing a supply in the next most available way—in other words, the worth of the service to the consumer demonstrated.

SHALL WE RETRACE AN INVESTMENT OR VALUE A PROPERTY?

It is to be regretted that the Appellate Court, after making so clear an argument for the inclusion of going value, and after showing in that argument that it considers that reproduction was the upbuilding of a new similar property as of today, should so reverse its reasoning when taking up the matter of pavement costs, for in the latter argument its mind was clearly on the past cost and history of the property rather than on the reproduction which it is discussing.

Three times in the opinion quoted it uses the term "investment," while only once near the beginning does it use the word "property." "The relator is entitled to a fair return on the investment."

And again: "It does not own the pavements, and the laying of them does not add to its *investment* or increase the cost to it of producing gas."

"It (reproduction) should not be so applied as to deprive the corporation of a fair return at all times on the reasonable, proper and necessary *investment* made on it to serve the public." Now the term "investment," as has been shown, is used to describe the cash which is usually put into an undertaking or has been put into such an undertaking in the past.

It is obvious that the term investment is not synonymous with value. An investment in a property may produce a value as time goes by much greater than the actual money expended, or it may become a total loss. The term "investment," therefore, as applied to a utility being valued, must necessarily relate to the money actually expended in the past to build up the property.

Now it is quite evident not only from the use of the term "investment" but by the entire method of expression and argument, that the court in writing its opinion was thinking of the actual money that had been expended in the past. But the subject under discussion is reproduction in the present—an entirely different thing.

If the court had decided, on reviewing this case, that investment or actual past cost was the best way to measure value of the property as a whole in this particular instance, then it is under no necessity to discuss reproduction at all, because reproduction has no bearing at all on past cost or investment, and if the court wished to use the basis of its past investment as a measure with which to value the property, then it can properly reject the item of paving if it were presented to it, because the cost of cutting through and replacing paving does not enter into past or investment cost unless the pavement actually existed at the time the pipes were originall laid.

But the court in this case is actually reviewing evidence presented to the commission to show reproduction estimates as of today, and in reviewing this evidence comes upon the stubborn fact that a reproduction as of today must include overcoming certain obstructions which did not originally exist, and it proceeds to utilize arguments against these obstructions proper enough in discussing past cost, but entirely improper in discussing present reproduction cost.

This is creating an entirely useless and needless dilemma, because of the lack of clear distinction between past or investment cost and reproduction cost.

DO PAVEMENTS INCREASE THE COST OF GAS?

Incidentally it may well be pointed out that the pavements over mains, as an engineering fact, do increase the cost of delivering gas, if not producing it. In the city of Chicago, for example, maintenance and operating repair work is seriously increased because the equivalent of from six to eight miles of full-width pavement are necessarily torn up and replaced every year in the ordinary course of repair and maintenance work to the gas pipe system, and it is indeed hard to see how this necessary expenditure does not increase the cost at least of delivering gas.

Much more might be said here upon the legal status of past cost and reproduction cost as two distinct lines of inquiry from which to reason value, but such line of thought is not entirely proper in this review, which seeks to confine the question to its economic and engineering aspects.

ACKNOWLEDGMENT.

The foregoing discussion is practically the full paper entitled: The Appellate Court of the State of New York and the Question of Allowances for Paving Over Mains in Valuation Work, read by John W. Alvord, Consulting Engineer, Chicago, before the latest annual meeting of the American Water Works Association.

GENERAL

The New Austin Dam and Power Plant.

Contributed by Frank S. Taylor, Resident and Directing Engineer, Austin, Texas.

III.

POWER HOUSE.

The power house is built of yellow, pressed brick and measures 118 ft. long by 50 ft. wide, inside measurement. The sides of the building are guarded by an elaborate railing of nickel-plated iron pipe.

The equipment comprises three vertical, or "umbrella type" generators, each of 1,800 KW. capacity, built by the Crocker-Wheeler Co. They are three-phase, star wound, revolving-field machines and generate current at 6,600 volts, which is the voltage of transmission, no step-up transformers being used. Each of these generators is driven by a pair of 36-in. turbines, built by the Platt Iron Works Co. Each pair of wheels is mounted on the same vertical shaft, with the generator rotor, and is set in a cylindrical chamber of reinforced concrete.

The generator rotor, the shaft and the water wheels attached thereto, are all suspended from a thrust bearing placed on top of generator frame. This bearing, together with the heavy box girders underneath that support it and form part of the upper cover of the generators, is clearly visible in the picture, Fig. 1, showing the interior of the power station. The turbine and generators run at a speed of 300 revolutions per minute. The weight of the rotating parts, supported by the top thrust bearing, is 44,000 lbs. The water wheels are, however, designed to produce an upward thrust, when in operation, using the pressure of the water in the turbine cases to produce this upward pressure, which amounts to about 24,000 lbs., leaving only 20,000 lbs. as the net weight to be carried by the thrust bearings. The bearings are, however, designed to carry 44,000 lbs. at 300 revolutions per minute. Each of these thrust bearings comprises 34 2-in. hardened steel balls, running in tool steel grooves, there being two tracks concentric with each other, one carrying 15, the other 19 balls. They were made in Sweden by the S. K. F. Co., and were mounted in place by the builders of the generators.

The reinforced concrete casings for the turbines, their dimensions, form and method of reinforcement are all shown in Fig. 2. It is believed that this is the first time that turbines of comparatively small size, and adapted for setting in cylindrical steel casing, have been placed in a cylindrical casing of reinforced concrete. The question of a cylindrical chamber as compared with the usual spiral form, resolved itself in favor of the cylindrical casing, because it was believed that if the latter were made of sufficiently great diameter, the efficiency obtained would be nearly equal to that which could be obtained from the spiral form of casing, and, owing to the labor conditions on form work, it cost considerably less to make a large cylindrical casing than a smaller spiral shaped one. The tests of the completed plant have amply demonstrated that this view was correct, an efficiency of 87 per cent for the turbines having been reached under actual operating conditions.

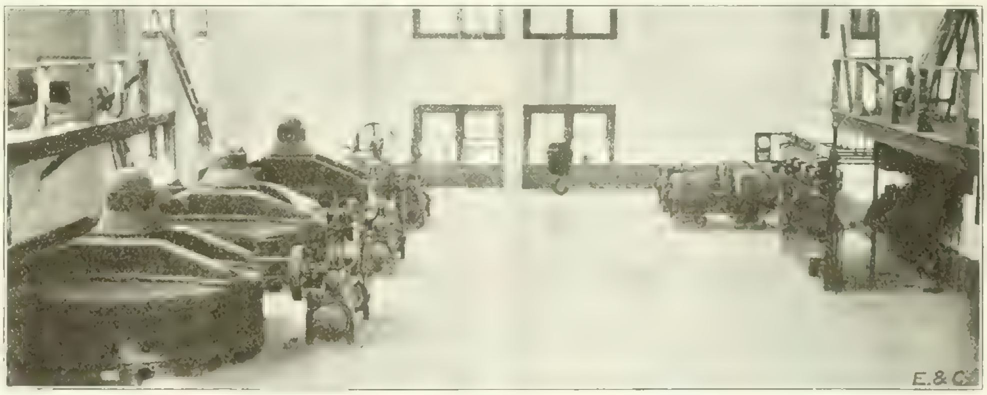


Fig. 1—Interior of Power House, New Austin, Tex., Power Plant.

It will be observed that the reinforcement of the casings comprise both cantilever and hoop tension reinforcement. Also, in view of the possibility of cracking of the concrete, the amount of steel used was considerably greater than that customarily employed for ordinary, reinforced concrete work, the stresses being limited to 10,000 lbs. per square inch, in the steel. Where the penstocks enter the turbine cases, and where the draft tubes pass through them, angles are riveted around the outer surface of the pipes so that ample contact with the surrounding concrete is provided. These cases have now been in service nearly four months, and have not shown any cracks or defects.

The cases were made of concrete instead of steel, principally because of the height of the vertical turbines and the possibility of vibration unless heavy masses surrounding them were provided of sufficient inertia to prevent any vibration. The top of each turbine chamber is closed in by a heavy, cast-iron cover, which is ribbed to give a sufficient strength to resist the upward thrust of the water and which is split to facilitate erection and dismantling. A cast-iron ring of approximately Z-section, and carrying a number of ribs from one flange to the web of the Z, is sunk into the concrete to the upper end of the casing, and anchored into the concrete by means of 32 1½-in. bolts. One flange of this ring projects slightly above the upper surface of the concrete and to it is bolted the cast-iron cover.

The draft tubes leave the turbine casings at an elevation half way between the top and bottom of the case, the elevation of the center of the draft-tube opening being 119.38 ft. The opening in the draft chest is 7 ft. in diameter and to this opening, is attached a short length of straight pipe 7 ft. in diameter, which passes out through the turbine case. Just outside the turbine case is attached a short piece of pipe, which is in the form of a truncated cone, being 7 ft. in diameter in one end and flared to 7 ft. 6 ins. at the other end. Attached to this piece of pipe is an elbow making a downward bend of 65°. This elbow increases in diameter continuously from the 7 ft. 6 ins. end to the lower end, which is 9 ft. in diameter, so that there is a gradual increase in the diameter of the draft tube from 7 to 9 ft. To the lower end of this elbow is attached a straight piece of plate pipe 9 ft. in diameter and this makes an angle with the vertical of 25°. The lower end of this last tangent section is at an elevation of 98.5, and, therefore, is submerged 18 ins. below minimum low water. The lower ends of these draft tubes are supported by concrete saddles, which are carried down to rock foundation and nearly surround the bottom of the penstock.

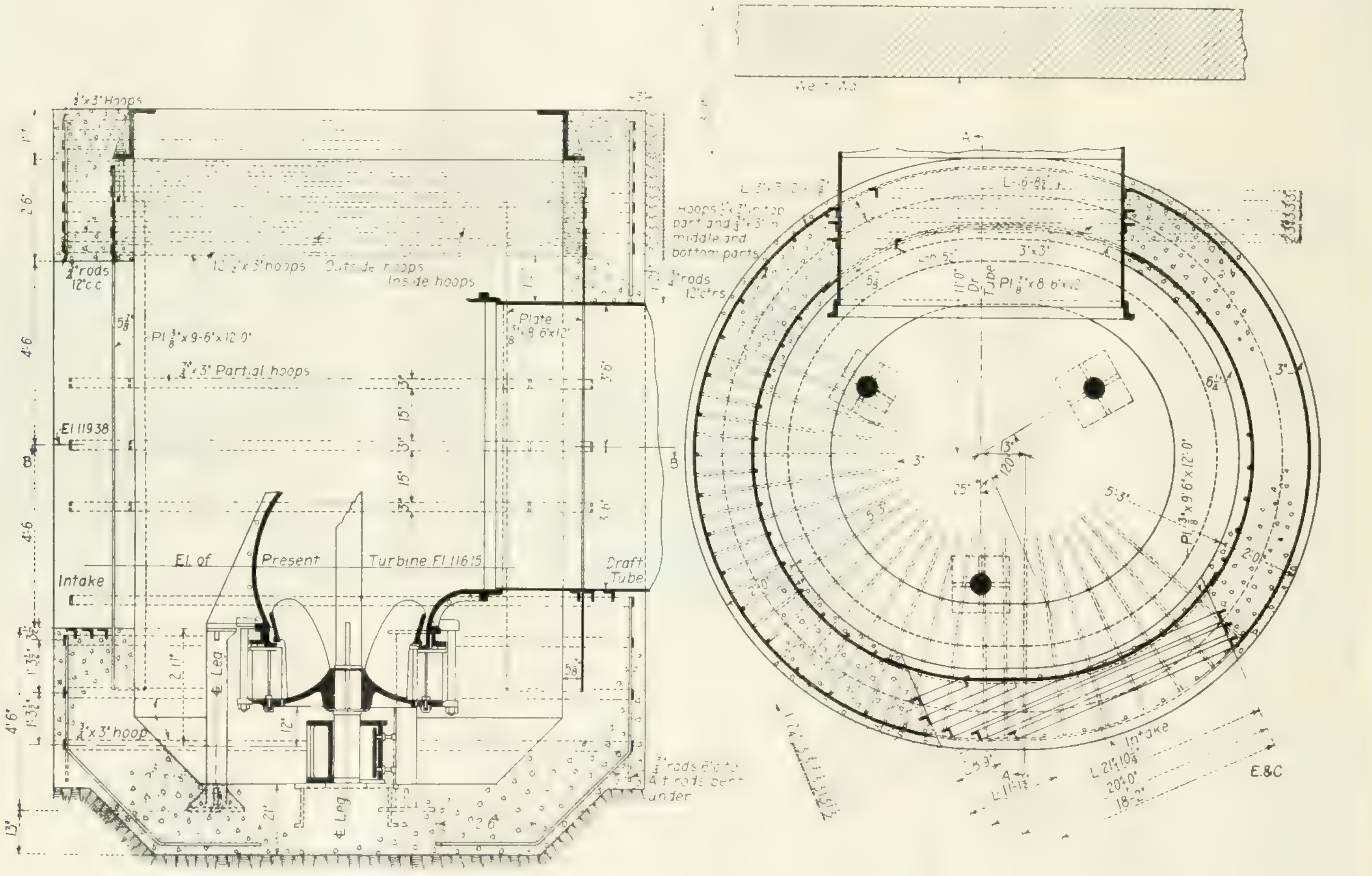
These saddles are so formed as to give a gradual change in the direction of the water as it passes the end of the draft tubes so that it emerges in a practically horizontal direction. A draft tube pit for the lower ends of these draft tubes to dip into is excavated in the rock, and of such dimensions that there is ample area for discharge of maximum amount of water that will ever be required through any of the draft tubes, or all of them simultaneously, and so that in no part of the pit will the velocity of the water exceed 3 ft. per second. The draft tubes, vent pipes and all steel plate work were made by the Payne & Joubert Company of New Orleans.

In order to make an efficiency test of the complete equipment, a weir was built in the tail race, which was provided with a notch 3 ft. in dept and 29 ft. in length, so that with the full load of 1,800 KW. on one machine and full head of 65 ft., the quantity of water required, gave a height of about 33 ins. over the crest of the weir. A six-hour test was conducted on each of the units. Calibrated instruments from the Electrical Testing Laboratories of New York were used.

The total efficiencies, from the gross energy in the water to the electrical enegy delivered at the switchboard varied but little, among the three units, the maximum difference being not over 1¼ per cent. The average, over-all efficiency at full load was 83½ per cent, which showed the average efficiency of the water wheels to be 87 per cent.

PERSONNEL.

The contractor for the complete development was the Wm. P. Carmichael Co. of St. Louis. Mr. Lamar Lyndon of New York was consulting engineer, and Mr. Frank S. Taylor of Austin, Texas, was resident engineer.



Section A-A

Hor Section B B

Fig. 2—Details of Reinforced Concrete Turbine Casing, Austin, Tex., Power Plant.

The Rove Tunnel on the Canal from Marseilles to the Rhone.

(Staff Abstract.)

A rock tunnel 72 ft. wide is being driven through the headland which separates the bay and city of Marseilles from the little inland sea known as L'etang de Berre. This tunnel is the predominant engineering feature of the new French canal to connect the great Mediterranean port with the River Rhone at Arles. The information at hand does not give the tunnel length exactly but it scales about six kilometers. A sectional profile showing all dimensions is given in Fig. 1. Other French tunnel sections are shown in Fig. 2 superimposed on the section of Fig. 1. This comparative arrangement of sections indicates clearly the great size of the new French canal tunnel.

The Rove Tunnel is wide enough to pass two canal barges such as ply the River Rhone and also to provide for a side path 2 m. (6.56 ft.) wide on each side. It penetrates rock and construction on the bore proper was begun in 1910. The construction procedure is indicated by Fig. 3. An annular excavation conforming to the roof curve is completed and in it the roof arch is built. Next the core is excavated and the invert is completed. The processes in detail are as follows:

Excavation of drift No. 1 precedes and is kept in advance of all other drifts. This primary drift is kept to line and grade and to it all other drifts are referenced. Drift No. 2 is next driven and at intervals of 100 m. (328 ft.) is connected by cross galleries with drift No. 1. These cross galleries serve for communication and storage, aid in ventilation and are essential in keeping drift No. 2 in line and grade with drift No. 1. Both side drifts are timbered and carry spoil tracks on which run 3 cu. m. cars hauled by compressed air locomotives. At intervals of 18 m. (59 ft.) from each side drift inclined drifts as indicated by dotted lines in Fig. 3 are driven upward to the crown of the section. Drift No. 3 is then excavated, the spoil being chuted down the inclined drifts into cars operating on the tracks in the two side drifts. The crown drift is then enlarged by side cuts Nos. 4 and 4 and by the bottom cut, No. 5, all spoil being disposed of down the inclined drifts.

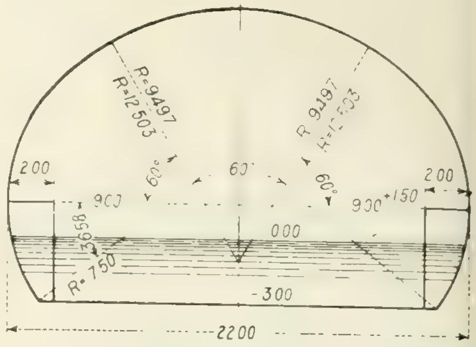


Fig. 1. Dimensional Sectional Profile of Rove Tunnel, Marseilles-Rhone Canal.

The next process is the excavation of the large haunch cuts, Nos. 6 and 6. These are excavated in sections 6 m. (19.68 ft.) long along tunnel and only one section of any three contiguous sections is opened at a time. Thus the 6 m. section embracing the top of an inclined drift is first excavated and completely lined, then the second adjacent section is opened and lined and finally the third section. Open joints are left in the lining between sections so that each is separate and independent. All spoil from the haunch cuts is chuted down the inclined drifts to the cars in the side drifts.

The lining is stone masonry in hydraulic lime mortar. It is built on centers made of steel ribs spaced 1.5 m. (4.9 ft.) apart and supported on radial posts resting on the rock core. Material for lining work is brought in on the track in drift No. 2 and by switch tracks on inclines is taken to the top level of the rock core. The inclines are located about every 300 m. (984 ft.) along tunnel. By this arrangement the placing of all lining except at the crown is downward.

The rock core, No. 7 in Fig. 3, is next excavated by ordinary open cut procedures in blasting and the spoil is handled by the cars in the side drifts. The disposition of the bulk of the rock core spoil is, as the diagram Fig. 3 indicates, downward.

The problems of ventilation and drainage have been simple and call for no particular mention. The drilling is done with compressed air hand drills and practically all mucking is by hand. Haulage is by compressed air locomotives. The power plant and buildings for various purposes are located at the south end of the tunnel. All plant is operated by electric power furnished by the Electric Co. of Marseilles.

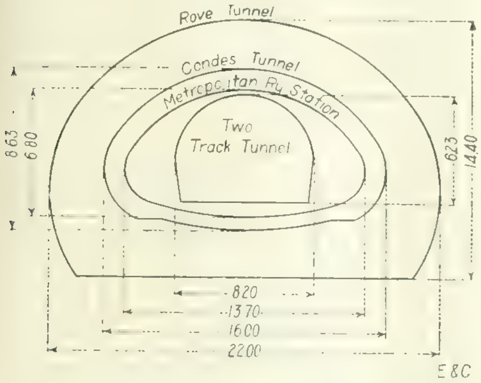


Fig. 2. Large Tunnel Sections Compared With Rove Tunnel Section.

This account is taken from an article on the Marseilles-Rhone Canal by Mr. Bourgougnon, the engineer, in "Annales des Ponts et Chaussees" for Nov.-Dec., 1914.

The Relation of Research to Progress.

We humans can never quite appreciate the incredible applicability and utility of new facts of nature. We are repeatedly shown by our experience, but each new example only augments our stock of wonderment or bewilderment. A very few months ago a certain well-known scientific investigator (Lord Rayleigh) found a slight difference in the density of nitrogen taken from air and nitrogen derived from other sources. He felt obliged to know about this little difference. In co-operation with Sir William Ramsay, he discovered argon. This was present in the atmospheric nitrogen and had always escaped detection. It formed less than one per cent of the air. It was discovered to be entirely inert and chemically inactive. This was an apparent promise of great chemical uselessness. At that time it was also exceedingly difficult to separate it from the air, and except for its scientific interest, it seemed destined to be left inactive. Newly discovered methods of liquefying air and of combining nitrogen for fertilizer, as in the cyanamid process, have just made the argon available commercially. Other pure scientific research had shown the value of such a gas in incandescent lamps, and it is just at this time being used to produce the most efficient incandescent lamps of our knowledge. It was the recently discovered differences between this gas and other gases which made this lamp possible. When its existence and properties were known, its application was relatively simple and easy.

Our American people are quick to see the value of new things where value exists. They are given, in this era, to actively utilizing every scheme which means better health, greater safety, greater pleasures, greater profits, and greater economies. We can hardly conceive of a people devoting their lives to inactivity and idleness. To better living conditions, to improve and extend manufacturing industries, and to conserve resources is quite generally the life aim of our ablest men.

A nation or a race does not stand still. It either advances or falls behind its neighbors. Knowing more has been the means of every nation's advance.

Research is a convenient word which covers the pioneer work upon which advances are founded. It is significant that as life becomes more and more complex, it is ever less possible for advances to be made by accident or by the designs of an individual working for short periods on different subjects. The day of that inventor is past who discovers an animal carrying a new hide, who modifies the shoe machinery or devises a new button or buttonhole. Each of these and a thousand other such details are now the fertile fields in which groups of trained experts are at work. We want shoes badly and there are many of us. We want them to wear well, even to the enamel on the brass eyelets. The fact that we are collectively willing to pay hundreds of thousands, or even millions of dollars for some slight improvement in a shoe or additional economy in the manufacture, indicates not only that we are many, but that we want actively every possible improvement and economy.

A Benvenuto Cellini lived and left the impression that he did all the work of an army of artists, inventors, soldiers, politicians, murderers, and—I may as well add—biographers. Besides his autobiography, he wrote books on the goldsmith art, sculpture and bronze, foundry practice, architecture, and poetry. There are none extant like him.

A Franklin wrote equally advanced discourses on electricity, on coal stoves, on the recently united states of America which he represented, on economy, on philosophy, and many other subjects. We have few Franklins and Cellinis today.

Today the research chemist, with his analytical methods, the metallographist, with his microscope, the physicist with his pyrometer, the mechanical engineer with his tensile strength apparatus, and the coke, gas, oil and electric furnace experts are each separately working on the still wonderfully complex cast iron of which a stove is made. Certainly they will not be satisfied, nor will we, the people, be satisfied, with any final state, so long as we can conceive of a better one. Iron must cast better, must rust less, be stronger, be permanent in the grate bar, be cheaper, keep an unaltered color, and so on.

The entire work involved in developing such new devices and processes may be called research, but there is a part of it which deserves more careful attention than the rest. This part is sometimes called pure research. Most people mean by this term the search after new knowledge, without reference to its utility. Others mean the search for new and useless knowledge. There certainly are searchers after new truth who do not wish to see the usefulness of their disclosures. But facts of nature or true principles of science live forever and are sure to be useful. The attempt at worship of pure research for its own sake, as is often done, is merely the tipping backward of those who wish to stand erect, unbent by sordid aims in their search after truth.

Bergson points out that the essential object of science is to enlarge our influence over things. He says:

> Science may be speculative in its form, disinterested in its immediate ends; in other words, we may give it as long credit as it wants. But however long the day of reckoning may be put off, some time or other payment must be made. It is always then, in short, practical utility that science has in view.

A fair example of scientific research lies in the history of our talking at a distance. First, we called out as loudly as we could and the strongest voice was the best telephone. The use of some new knowledge which was not immediately or obviously connected with the voice was later put to use, and a tin or iron pipe was used for short distances as a speaking tube. After this idea was disclosed, plumbers, tinsmiths, or pipe fitters could do the rest. Then, later, the possible application of formerly entirely undreamt of principles to the increase of the speaking distance was tried. Those to which I refer were the electromagnetic principles which, in short, produced the telephone transmitter and receiver. These changed the short, thick pipe into a long, thin wire. I regret that I cannot go into detail to point out the extended researches which, without the slightest premonition of telephony, had to be made before the knowledge was at hand to enable Bell to contribute his part. Joseph Henry, for example, studying in the basement of an Albany school, had to wind wires with insulation and study the properties of the magnet, and this had to be followed by the studies of many others for half a century. To the early art, in the pipe stage, the telephone wire may have looked merely like a more refined pipe of the same material, but it was not. There were entirely new, and what I may call remote, principles, brought into play and added to the metal of the pipe. These were discovered by patient scientific research of the highest order. The outcome could not have been foreseen from any knowledge of pipes or piping. In a practical treatment of the subject of Research and the Industries, this point must be made clear. The final gathering of the fruits of the labor of research often seems as little anticipated by the real planting done by search for new knowledge, as the picking of the fruit of a tree seems anticipated by burying a seed in the ground. Nevertheless, the developments are the same in the two cases. It may be for this reason that the President of the Carnegie Institution, in his 1914 report, referred to the work of the Institution in the words:

> The general reader must take it for granted (provisionally, at least) that these investigations are in the main worth undertaking . for in proportion as such investigations are fundamental, and hence worth carrying on, they will be difficult of exposition and more difficult of comprehension.

Of the lines of activity of that institution, the farmer sees value in the studies in heredity in cattle, but wonders why anyone should want to synthesize rocks; the glass maker who sees value in the geophysics work, wonders why the sun spot work is of use, while the naturalist* says: "The sublime ideas of infinity of space and time, and the beauty of the simple laws of planetary motion, have had a value to mankind far transcending that of any so-called practical application of stellar science." Thus, those who have had the broadest comprehension have generally most highly valued pure research.

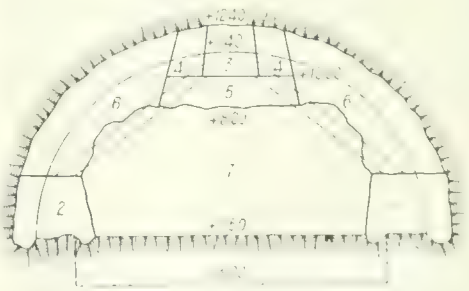


Fig. 3. Diagram Showing Sequence of Excavation of Rove Tunnel.

So we are now in our day apparently seeing our telephone wire grow finer and longer. Talking from New York to San Francisco is a thing of every day commercial experience. This, in turn, was due not alone to the use of longer wire or lower resistance or more delicate instruments (what Bacon calls an increase in the efficient), but involved new, remote ideas, the result of research. Such is the Pupin loading coil, for example, which has made long distance telephony possible. We are also aware that to all appearances the telephone wire is now being drawn so fine that it is altogether disappearing, and wireless telephony is an accomplished fact. This becomes possible not through finer wire drawing, but by the application of newly discovered laws or principles of nature. It was not even done by those who were most industrious in construction of telephones, any more than the tin speaking tube was really displaced by the tinsmith. The work was done by those already trained scientific investigators, who were learning new facts of physics or electricity which, at some stage of their work seemed applicable to telephonic use. This new work, this pioneer obtaining of facts which never revert to the undiscovered state, constitutes research.

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*R. G. Harrison, President of the American Society of Naturalists, Philadelphia, 1913.

Our government, among others, has schemes for the promotion of research. One of them is the patent law. If a discoverer will disclose his discovery to the public, he may exercise a monopoly of it for seventeen years. In some cases this is very encouraging, but it seems to have at least one serious defect. The discovery, besides being new, must be, at the same time, useful. With many great discoveries this is not the case. It may seem ridiculous to favor useless discoveries, but it is quite the reverse. The thing to encourage is the search and finding of new facts, principles, laws, and habits of nature; i. e., additions to our knowledge without reference to immediate value. These are the surest guarantees of ultimate utility. The process of making knowledge useful is not half so difficult nor so rare as is the production of the knowledge itself. But the rewards usually go to the man who shows us the utility. For this reason we must plan better ways of encouraging scientific research. To emphasize this is the only object of this paper. It is being done to some extent. Many of those, living and succeeding under our system of advance, have realized the way the seeds have first to be sown. They have usually selected some special field where the utility to be expected from newly disclosed facts would be of greatest public good. In this spirit have been established many of those research institutions which are devoted to the health of the people, the cure of disease, etc. These are starts in the right direction and are naturally made where the need is most painful.

Of a little more remote benefit is such research work as is being carried out by the Research Corporation, from whose minutes the following abstract was made:

> This far-sighted and patriotic conception found its realization through the Research Corporation which for administrative reasons was substituted for the Smithsonian Institution as the custodian of Dr. Cottrell's endowment. The objects of the Research Corporation as stated in its charter are:
>
> "To provide means for the advancement and extension of technical and scientific investigation, research and experimentation by contributing the net earnings of the corporation, over and above such sum or sums as may be reserved or retained and held as an endowment fund or working capital, to the Smithsonian Institution, and such other scientific and educational institutions and societies as the board of directors may from time to time select in order to enable such institutions and societies to conduct such investigations, research and experimentation."
>
> Organized in 1912 as a stock corporation, but precluded by its charter from paying dividends, and capitalized by a group of gentlemen desirous of furthering Dr. Cottrell's objects, without personal profit, the Research Corporation undertook and successfully accomplished the installation of the Cottrell processes in various industries throughout the country, with the result that in two years' operation its surplus has provided the capital of twenty thousand dollars required by its charter, and a fund of over one hundred thousand dollars for scientific research.

A few such steps as this one would soon build up a fund of new knowledge. I think it is safe to say that most of our new knowledge of physical, chemical, and electrical phenomena has come to us through the publications of various scientific societies. The work was largely done as a by-product of poorly paid services in colleges and universities of the world. Let me illustrate this point. The general field of colloid chemistry is open for investigation. There is surely no more fertile field. It touches all the reactions of living organisms and most of those of organic and inorganic chemistry, from the growth of cells through immunity to disease in animals, to the decay of metals, from the coloring of glass and dyeing of fabrics, to the production of a river delta or the manufacture of an automobile tire. It is being largely done as the by-product or hobby of a few teachers in their spare time. As the principles governing this part of chemistry are made known, the applications in useful processes will be rapid, but there are many men ready to perform the latter operation compared to the few who are making known the laws involved. For every investigator who might point out from his experiments the possibility that the antitoxic action of immunized blood serum might lie in the magnitude of the electric charges on the colloids concerned in the reactions, there are hundreds of others who will ably test the hypothesis when it is advanced. For every chemist whose experiments go to clarify the laws of tensile strength and the wear and friction of colloidal materials, for example, there are hundreds who will test his conclusions in new aerometals and automobile tires. We in this country are particularly active in putting the "useful" into the invention, but we are less active in the study for the "new." For this reason it is necessary to encourage research of the advanced type. Anyone who has followed the subject knows that during the past ten or more years, the amount of research work in connection with the industries has greatly increased. Large manufacturing companies in many lines have groups of men who devote all their time to advancing the methods of manufacture by more or less pure research. They are never expected to become part of the production department, but are always kept on the exploring line in laboratories. There are now research laboratories connected with almost every art and profession. The American canners and the American dentists have them, as well as the companies making powder and shot, and those making armor plates. There are laboratories devoted to research on paper and others on paint, some working on cements and others on soils, some on gas lights and others on electric lights, some on fertilizers, others on sterilizers, and some on almost everything. They could all use more knowledge to advantage if they could get it. If there were no way to increase the rate of our acquisition of knowledge, then this argument would be useless, but we have had a lesson from Germany during the past forty years which shows one way of increasing the world's stock of knowledge. It is by encouraged or endowed research. Germany did it through her universities. Every year there were turned out one or two thousand men with the degree of doctor of philosophy. This meant that each one had done a couple of years research work and, in most cases, freely published it. The stock of investigators in the country was rapidly increased. The industries and the arts felt the effects. In 1912 there were 1,703 of these doctorates conferred there, 705 were on science and 355 in chemistry. How could such a country stand still in industry? Last March, Lord Haldane, addressing a teachers' meeting in London, said:

> We are behind the level which has been reached by several of our competitors, a level which will put us in peril. We cannot dissociate national progress from the basis of knowledge, even when it comes to the question of making money.

This conclusion is only a year old, but it is being proved.

In addition to the very helpful and important university methods of Germany, there should continue in America, beyond what is done by government laboratories and bureaus, the natural extension of the ideas exemplified by the cancer research laboratories and hospitals, the Rockefeller Institute for Medical Research, the Carnegie Institution, the Smithsonian undertakings and others.

Here also a start has been made in such work as Dr. Duncan inaugurated in the Mellon Research Laboratory at Pittsburgh and at the University of Kansas, in the very recent Brush endowed fellowships at the Nela Park laboratories, and in the Mayo brothers endowment at the University of Minnesota.

Dr. Woodward, President of the Carnegie Institution, has recently said, "Successful research requires neither any peculiar conformity nor any peculiar deformity of mind. It requires rather peculiar normality and unusual patience and industry." This certainly applies as well to the researches of an Edison, devoting his life to the immediate utilities, as to the abstract researches of the mathematician. It is for this reason that research ought to and does succeed in its applications in the case of many industries. In the industrial research laboratories, normality, patience and industry are apt to be encouraged. Interruptions are there at a minimum. Equipment, power, facilities and the rest are made a matter of some one's business. On the other hand the universities and colleges, which are forced to combine with short hours and short years the teaching of science and the methods and habits of research, are still our foremost organized research institutions. It seems possible that manufacturing companies may offer in the future nearly as great assistance to the increase of useful knowledge. Co-operation between laboratories of research in universities and industries has already been the subject of considerable study. There is a committee of one hundred of the American Association for the Advancement of Science which was appointed to encourage it. Naturally, with so great an undertaking, the progress may be slow. It is certainly possible for industrial research laboratories to economically add to scientific knowledge and to grow in the process. This fact is being recognized.

It is unfortunately true that most of what we may call the new knowledge in physical science of the past decade has had to cross the Atlantic for us. No one knows this better than those Americans who make the most use of it. The fundamental knowledge behind almost every utility which Yankee ingenuity has assisted, grew on older soil than ours. The list is almost discouraging to an American. The encouraging view to take is that we have it within our power to force the future to write different history. It is unfortunately quite safe to predict, for example, that just as most of our technical advances of the past can be traced to early fundamental discoveries in academic fields in Europe, so also we will have to see here future applications of still more modern European scientific thought. A wonderful list of useful results, processes, products, conveniences, cures and economies are sure to be produced by applications of the new knowledge of such things as radium, X-Rays, wireless waves, electrons, crystal structure, atomic numbers, canal rays, none of which were "made in U. S. A."

In physical science there is but little chance that our country will do its full share for years to come. If the wisdom of attempting it, rather than confining attention to short-sighted application of research to pressing commercial problems can be gradually recognized, the future is assured. It is surely the duty of our American research laboratories to contribute effectively in the advance of knowledge, and particularly is this true of those richly endowed with men, new materials and appliances.

And so I return to the cardinal point in any suitable consideration of research in its relation to our industries. Search for new knowledge is the insurance for the future of the industries. Many of them will later be manufacturing things not even conceivable today. The past has proved it. Most of the present products will, like the ox-yoke and flail of our grandfathers, be replaced in our factories by utilities more fitting to our new needs and less exhaustive of our energies and assets. This change is practically continuous. Technical complacency is like the mercuric chloride tablet taken internally—it means a lingering suicide. The incandescent lamp business will serve me for illustration, because I am more familiar with it than with others. I have seen whole factories entirely overhauled a number of times in the past few years, in order to make the newest lamps. Not only have entire floors of complicated and expensive machines for making carbon lamps been thrown out and new machinery for making metal filament lamps installed, but before packing cases containing new machines could be opened and unpacked in the factory they have been thrown out as useless, as the advance from squirted metal filaments to drawn wire filaments proved the better way. Before the limit of factory efficiency on vacuum lamps could be reached, the introduction of nitrogen into the lamps brought the factories an entirely new factor, and now, before the consumers have more than commenced to feel the effects of the nitrogen-tungsten lamps, the manufacture of argon and its introduction into the incandescent lamp becomes a reality. If the research laboratories which discovered the means for bringing about these changes, with their corresponding economies, could tax the consuming public a cent for every dollar thus saved to the public, the laboratories would receive over a million dollars a year to spend for further research. This is not written in a spirit of dissatisfaction at all, but rather to point out what is probably true in many fields. The people are the ones most interested in research, though they may not know it. It is easier seen in therapeutic and curative research, but even there the more ignorant fail to realize the great lasting value of such work.

Bacon wrote:

> For man, being the minister and interpreter of nature, acts and understands so far as he has observed of the order, the works and mind of nature, and can proceed no further; for no power is able to loose or break the chain of causes, nor is nature to be conquered by submission; whence those twin intentions, human knowledge and human power, are really coincident; and the greatest hindrance to workers is the ignorance of causes.

ACKNOWLEDGMENT.

Reprinted from a paper by W. R. Whitney in Annals of the American Academy of Political and Social Service, May, 1915.

BRIDGES

Methods and Equipment Used in Erecting Girder Spans of Pennsylvania Ave. Viaduct, Kansas City, Mo.

Contributed by Wm. F. Wynne, Kansas City, Missouri.

The construction of the Pennsylvania Ave. Viaduct, which spans the tracks of the Kansas City Terminal Railway Co., Kansas City, Mo., involved difficulties which were overcome by the contractors in a novel manner. The track layout would not permit of any considerable changing, and there were buildings facing on Pennsylvania Ave. in such positions as to interfere seriously with the handling of the long-span girders required. The operations of a constant stream of work trains and switch engines, together with a number of regular freight and passenger trains, also complicated construction work. In addition there was other construction work along the right-of-way which could not be obstructed. Figure 1 is a sketch plan showing the locations of the various girder spans of this viaduct.

ERECTION OF SPAN NO. 9.

The first difficulty arose during the erection of the end span, No. 9, the conditions existing at its site being shown in Fig. 1. The distance between the two three-story buildings on opposite sides of the street is 80 ft., while the width of the viaduct is 79 ft., leaving only 6 ins. clearance at each side. As the girders in this span have a length of 87 ft. it was impossible to turn them in the space existing between the buildings. The erection was accomplished, in the case of the three west girders, by laying temporary tracks (see Fig. 1), and mounting one end of a girder on an ordinary car truck. A cable was made fast to this truck and passed through a block fastened to the pier at "A" (see Fig. 1). It was then carried back through another block fastened to the permanent track at "B" and hitched to a switch engine. Then with the derrick-car supporting the rear end of the girder and following it and the switch engine (which was backing away), the girder was drawn up into the space between the buildings. A gin-pole was then set up at "A," with which that end of the girder was raised, using the switch engine for power, while the derrick-car raised the other end. As the columns of bent 9 were set, each girder was raised with the south end about midway between the column on which that girder was to set and the column to the east. The derrick-car was then pulled forward to the position required, this movement pushing the north end into place.

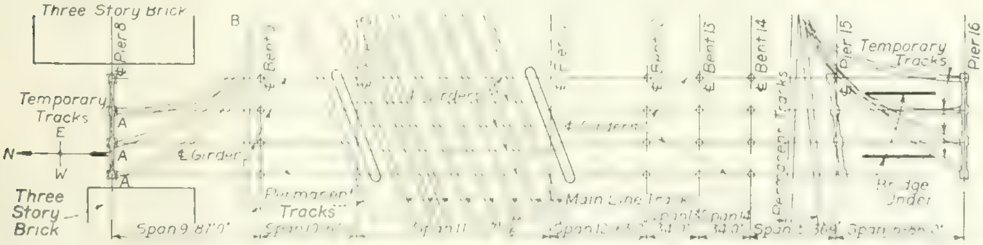


Fig. 1. Sketch Plan of Pennsylvania Ave. Viaduct, Kansas City, Mo., Showing Positions of Girders in Viaduct and Tracks Beneath.

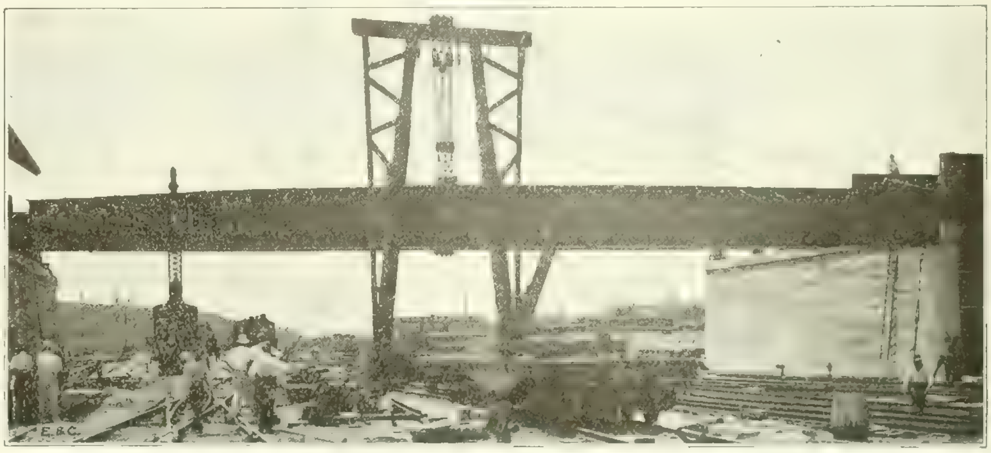


Fig. 2. View Showing Manner of Erecting 127-Ft. Girders in Span 11 of Pennsylvania Ave. Viaduct, Kansas City, Mo.

The fourth, or last, girder in this span had to be handled in an entirely different manner, due both to its nearness to the building on the east side of the street and to the fact that operations could be carried on in only one direction (to the east) on the permanent track. This girder was "walked around," rear end swung forward. The girder was that is, first it was carried a distance of about 10 ft. on the truck, as with the other girders; then the truck was blocked and the next blocked up in the center and the front end swung in toward the building as far as possible; the track with the truck was then swung in to this new position, and the operations repeated. In this manner the girder was finally worked up to its position and hoisted into place in the same manner as the other girders in this span. These girders were comparatively light, weighing about 20 tons each.

ERECTION OF SPAN NO. 16.

Similar difficulties were encountered in erecting span 16, the main point of difference being that the track, instead of being in the span in which the girders were erected, was in the next span to the north (see Fig. 1). Moreover, the ground to the south of pier 15 is about 3 ft. higher than the track, and there is an ascending grade of about 3½ per cent; while at span 9 the ground is even with the track, and the street is practically level. There are no buildings near span 16, but the obstruction here consists of a small bridge. This bridge is 40 ft. wide between the concrete hand-rails, the latter being 4 ft. high. These conditions made it necessary to raise the front end of the girder in order to place the truck beneath it, the entire operation of moving the girders into place being carried out on an upgrade. Due to the position of the obstructing bridge, each girder in this span had to be "walked around" to some extent. As in span 9, a considerable part of the work of pulling the girders into place and of raising the south end was done by a switch engine, the north end being raised by a traveler "on top." These girders are 86 ft. long and weigh about 20 tons each.

ERECTION OF SPAN NO. 11.

Great as were these difficulties, they appeared insignificant in comparison with those encountered in erecting span 11. The girders in this span have a length of slightly over 127 ft., and they are above the eight main line tracks shown in Fig. 1. The five girders in this span each weigh about 70 tons, and they had to be erected in such a manner, and at such a time, as to interfere as little as possible with the operation of trains—in fact it was specified that there should be no interference with passenger trains. The north two tracks could not be blocked with a derrick as these were used both for passenger and for regular freight traffic. This problem was solved by the contractor for the erection, in the novel manner illustrated in Fig. 2.

The gallows bent used for this erection was designed by the contractor and was checked by the Bridge Department of the Kansas City Terminal Ry. Co. It was constructed of 8x16-in. yellow pine timbers, with two 24-in. 80-lb. I-beams at the top. Three 4-sheave blocks were used at the top and three at the bottom, making twelve complete turns of the ⅞-in. cable. The power required was supplied by a switch engine. Both ends of the cable were brought down and passed through blocks at the foot of the gallows bent and then hitched to the switch engine. The gallows bent was set up over a track, which happened to be at about the center of the span, at an angle of 45° with the center line of the track. This left the track clear for use, and placed the bent in such a position that the girder could be swung into the required position. The girder was run in, on flat cars (see Fig. 2), under the bent in a position approximately at right angles to its final position.

The first girder set, the one shown in Fig. 2, required about two hours, owing to the uncertainty of everybody concerned as to what would happen and to the desire of the superintendent to make a good showing before the crowd of critical engineers present. However, every thing worked as planned, and a record of twelve minutes, from the time the girder was picked up to the time it was set in place, was made on two of the other girders in this span.

The moving of the gallows bent was nearly as interesting as the raising of the girders. A chain was hitched to the slings (shown just above the girder in Fig. 2), and the bent was raised by means of the derrick shown on the adjacent track. These slings were so placed that when the bent was turned at right angles to the girder, and was freed, it would swing into a horizontal position, in which position it could be pulled back and set up for the next girder.

The five girders in span 11 were set in three days. Despite the difficulties encountered the job was finished without injury to anyone.

PERSONNEL.

The viaduct was designed by the Engineering Department of the Kansas City Terminal Railway Co. The contractor for the erection was the Kansas City Bridge Co., J. B. Neely, chief engineer.

The Pacific Highway Interstate Bridge Over the Columbia River and Its Approaches Between Vancouver, Wash., and Portland, Ore.

(Staff Article.)

The Interstate Bridge over the Columbia River and its approaches will extend across the Columbia River Valley from the city limits of Vancouver, Wash., to the city limits of Portland, Ore., a distance of about 3¼ miles. The structure will include about 5,000 ft. of steel bridge and 12,000 ft. of embankment, with a secondary approach on the Oregon side, for which, at the present time, an embankment about 6,000 ft. long will be built. The bridge and its approaches will provide a roadway for street traffic and for street cars, together with a sidewalk over the steel structures. This improvement forms one of the most important and most expensive sections of the series of highways included under the "Pacific Highway," which shortly will extend from Vancouver, B. C., to San Diego, Cal. The Interstate Bridge over the Columbia River is the first bridge built exclusively for highway and street car traffic over the lower portions of any of the four great Western rivers, viz., the Yukon, Fraser, Columbia and Colorado, although the Fraser River is crossed by a bridge carrying highway traffic only, at New Westminster, B. C.

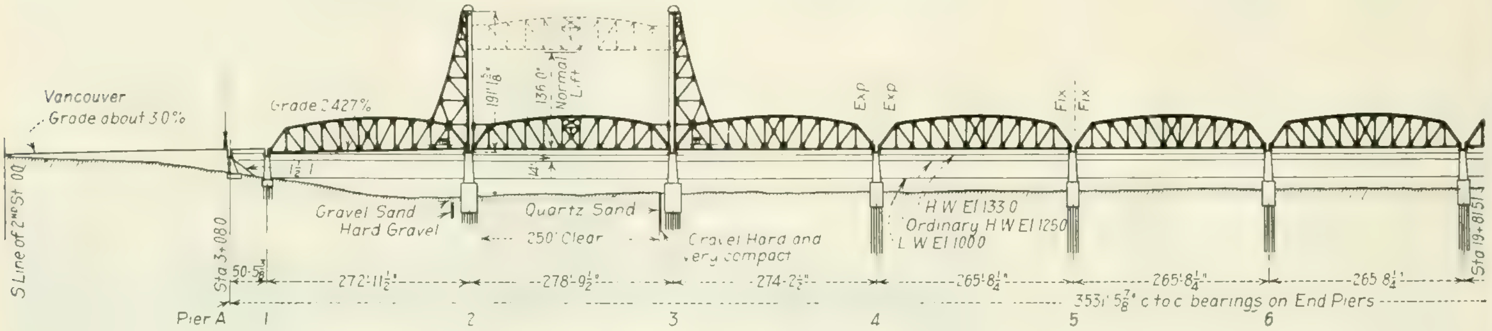


Fig. 1—General Elevation of Interstate Bridge Over Columbia River,

The bridge is being constructed under the direction of the Columbia River Interstate Bridge Commission, comprising the commissioners of Clarke County, Wash., and those of Multnomah County, Ore., with the Governor of Oregon acting as a commissioner of Multnomah County, for certain purposes. The construction of the bridge is the result of a popular movement originated by the commercial clubs of Vancouver and Portland, and supported by the people of Washington and Oregon. An attempt was made to have the structure built by the two states, but when this was not successful the two counties, including the above two communities, provided funds by issuing general county bonds, Multnomah County issuing $1,250,000 of bonds and Clarke County $500,000.

TOPOGRAPHICAL FEATURES AT BRIDGE SITE.

The main channel of the Columbia River, at the bridge site, is 3,500 ft. wide, with a maximum depth of 30 ft. at extreme low water and with variations from extreme low to extreme high water of 33 ft. The water rises each spring to about 20 ft. and about once in four years to about 25 ft. It has reached a stage of 33 ft. only once in known history. At times of extra high water the Columbia River covers the entire three-mile width of the valley. The bed of the river consists of sand with small quantities of gravel, extending to great depths. At the north shore very compact cemented gravel is found a few feet below the surface, dropping to a depth of 100 ft. at a distance of about 700 ft. from this shore. Only sand with some gravel was found over the remainder of the river bed, up to depths of over 100 ft.

The Oregon Slough forms an important secondary channel, particularly for flood conditions. It is about 1,000 ft. wide and 25 ft. deep, and is separated from the main river by an island about 1,500 ft. wide. The Government has built a dike some distance above the bridge site and island to divert practically all of the low water flow down the main channel, the top of this dike being about 6 ft. above low water. The bed of this slough is principally sand.

The Columbia Slough, which provides some drainage near the Oregon side of the valley, is about 600 ft. wide and 20 ft. deep at low water. The bottom of this slough consists of clay and sand, while hard and compact gravel is found about 80 ft. below the low water stage.

The average elevation of the ground across the river valley is from 12 to 15 ft. above low water, and much of this ground is inundated at very high water stages.

SUPERSTRUCTURE.

The bridge consists of a series of through riveted truss spans with curved top chords, including three 275-ft. spans, ten 265-ft. spans, and one small deck girder span at the Vancouver end, making a total length of 3,531 ft. 5⅞ ins. between end shoes (see Fig. 1). Provision for navigation on the river is made by a vertical lift span. The central span of the three 275-ft. spans is arranged to lift between towers supported by the other two spans, giving a channel 250 ft. wide at right angles to the current of the river, with a clearance of 150 ft. above ordinary high water. For entrance features there are placed at each end of the bridge heavy concrete railings terminating in ornamental concrete columns about 22 ft. high, supporting lamps and forming the beginning of the steel hand rails.

Live Loads and Specifications.—The following live loads were used in designing the floor system of this bridge:

On street car tracks: 50 ton cars on both tracks.
On roadways: 12-ton motor truck, Class A uniform load, with special provisions for 24-ton machinery trucks.
On sidewalk: 120 lbs. per square foot.
For impact allowance 50 per cent is added to all except sidewalk loads.

The live loads used for trusses and girders were:

On street car tracks. 40-ton cars on both tracks.
On roadways: Class B uniform load.
For impact allowance the percentages given by the following formulas are to be added:

For street car loading, $I = \frac{230}{N L + 300}$, but not greater than 50 per cent.

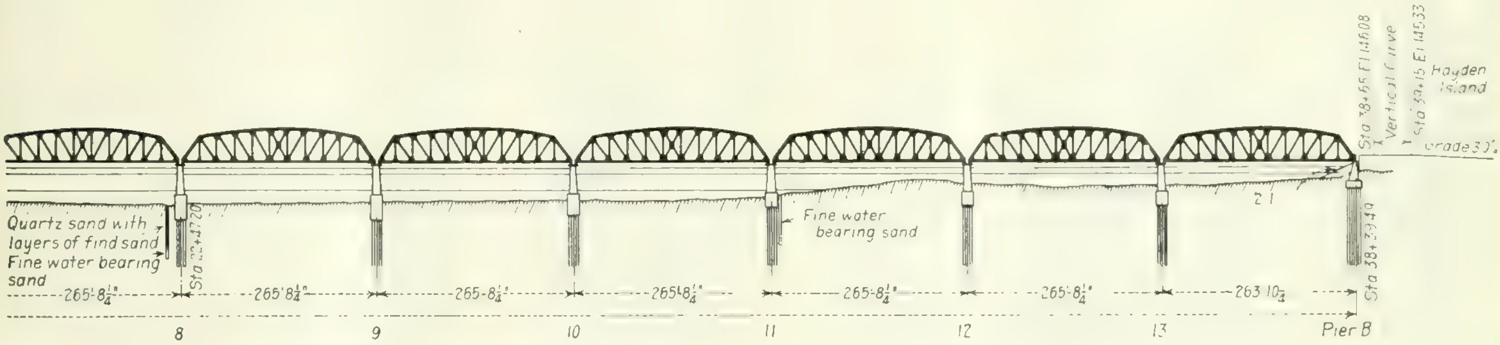
For roadway loading, $I = \frac{180}{N L + 300}$, but not greater than 50 per cent.

Where I = impact percentage; L = loaded length of bridge producing maximum stresses, and N = number of loaded tracks for street car loading, or number of lines of traffic for highway loading.

The working stresses used in the design are those allowed by the Harrington, Howard and Ash specifications.

Fixed Spans.—The riveted truss spans have a vertical clearance of 21 ft. 6 ins., and are spaced 41 ft. on centers, with the roadway between them and the sidewalk cantilever beyond one of the trusses. The roadway has a width between curbs of 38 ft., with steel hand rails where required. The sidewalk has a clear width of 4 ft. 6 ins. The floor consists of a reinforced concrete slab having a thickness of 5¼ ins.; the sidewalk is also of reinforced concrete, 4 ins. thick. The arrangement of the beams and of the concrete slab for the floor is original with the designers. As will be noted by referring to Fig. 2, there are longitudinal stringers between the usual floorbeams, the stringers being spaced about 9 ft. on centers. On top of the stringers, extending entirely across the roadway, there are 8-in. I-beams spaced about 33 ins. apart. These roadway cross beams are bent to conform to the crown of the roadway, and the concrete slab rests directly on top of them. The six rails required for the two-gage, double-track street car tracks (which are spaced 10 ft. 8½ ins. on centers) rest directly on the roadway crossfloorbeams, and are fastened to them with standard Carnegie steel tie clips. As the rails are 7 ins. high, there remains a space of 2 ins. from the top of the rails to the top of the concrete slabs for the 2-in. special bituminous concrete surfacing which forms the pavement. To form a rail heading which can be moved, if necessary, without damage to the roadway slab, the space for a width of about 5 ins. on each side of the rails is filled with concrete to the top of the rails, and a flangeway is provided as shown in Fig. 2.

The type of floor used has the advantage of providing a concrete slab whose greatest dimension is in the direction of travel. It also provides comparatively short spans and insures simple shop work on the supporting steel beams. It is expected that the cross floorbeams will be formed to their curve by shimming up the hot beds to the proper curve in order that the beams may form while cooling. Due to the lateral stiffness of the floor, as constructed, the lower laterals of the spans are somewhat lighter than would be required for an open deck bridge. To reduce the number of expansion joints to a minimum two fixed ends and two expansion ends of the spans are placed adjacent. The expansion joints are made with checkered plates, supported by and sliding on metal supports. The corresponding expansion joints for the rails at the ends of the spans consist of manganese steel castings placed beside the webs of the rails, for which one side of the rail heads is planed off.



Showing Types of Structure and Topographical Conditions.

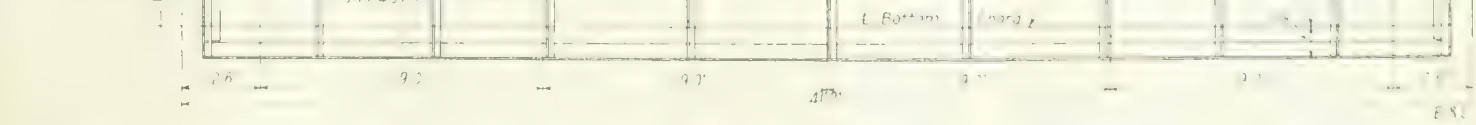


Fig. 2—Cross Section of Floor System of Interstate Bridge Over Columbia River—Note Unusual Type of Construction.

A drainage intake, with a down-spout, is placed at intervals of 50 ft. along each curb.

Towers, Lift Span and Operating Mechanism.—The towers for the lift span are of riveted construction throughout, and are so arranged that the front columns of the towers support all the load of the lift span and its counterweights, the rear columns being merely bracing members.

The lift span is suspended from each of its four corners by 16 plow-steel wire ropes, each 2 ins. in diameter, which pass up and over cast-steel sheaves, 12 ft. in diameter, and are attached by a group of equalizing levers to concrete counterweights built around a steel frame. These counterweights are of the same weight as the span, so that the work to be done in operation consists of overcoming the friction and inertia, and of lifting the unbalanced portion of the ropes. The span is guided in its ascent and descent by cast-steel jaws which engage upon tracks on the towers. At one end of the lift span these jaws guide both laterally and longitudinally, but at the other end the span is guided only laterally, thus allowing for the expansion and contraction of the span and for slight variations in the positions of the towers. The span is operated by means of cables, of which there are two pairs at each corner. The operating machinery, which is placed on the span at its center, just above the roadway clearance line, consists of four spirally grooved drums connected by a train of gears to an electric motor. Each of these drums controls the operating ropes for one corner of the span; one pair of operating ropes, leading from the top of the drums, passes over a deflecting sheave at the corner of the span, thence downward, and is connected near the bottom of the tower; while the corresponding pair, which leads from the bottom of the drum, passes under a deflecting sheave at the corner of the span, thence upward, and is connected near the top of the tower. All of the drums are similarly connected, so that when they are operated in one direction the ropes leading to the tops of the towers are wound onto drums and those leading to the bottom of the towers are paid off, thus lifting the span by the force exerted upon the corner sheaves.

The machinery for operating the lift span is exceedingly simple, consisting of one transverse shaft extending across the span, one pair of reduction gears in a frame inside of the house, and the back gears on the motor. An indicator and limit switch are provided by which the current is automatically cut off and the solenoid brakes applied to the motors at points near the upper and lower limits of the run of the span. For ordinary operation there is a hand band brake which is equipped with a push-button switch so that when the span is under control the operator can hold off the emergency brake and bring the span to rest under the control of the hand brake.

To provide for emergency operation (instead of the usual hand operating capstan), the span is equipped with a small gasoline engine connected through a speed reducer to the machinery, so that in case of failure of electric current the operator will be able to move the span at slow speed without having to seek outside assistance. There is a manually operated lock at each end of the span in connection with a centering device by which the span may be locked down. The solenoid brakes, together with the down-haul ropes, also serve as a lock. Buss-bar trolleys are attached to the tower, and a sliding contact shoe is placed on the lift span to supply current to the motors during operation. The operating cables are attached at the tops of the towers to small drums with worm-gear connections in order that adjustment for the stretch of the operating cables may readily be made. When the span is at its upper limit the counterweights are 2 ft. above the floor level, and a special arrangement of the trolley wires under the counterweight is made. This consists of a swinging frame upon which the trolley wires are fastened, this frame being pushed down by the counterweights and returned to position by means of a small counterbalance.

The rail connections at the ends of the movable span are scarf-jointed so that the span lifts away from the fixed rails and returns to them without any movable devices.

The machinery is designed with great care and nicety. Gears and pinions which operate together are set in cast steel frames in order that they may be adjusted and built complete in the shops, the adjustment of parts of the machinery in the field being thus reduced to a minimum. All of the gears are cast steel with cut teeth. A duplicate motor equipment with either motor of sufficient size to operate the bridge is provided.

At the ends of the fixed span adjacent to the movable span there are provided roadway gates which form an effective barrier across the roadway. These gates are connected to derailing switches in the street car tracks so that the derail is thrown when the gate is closed across the roadway. The gates will be manually operated, and a small steel and concrete cabin is provided at each for the gatetenders.

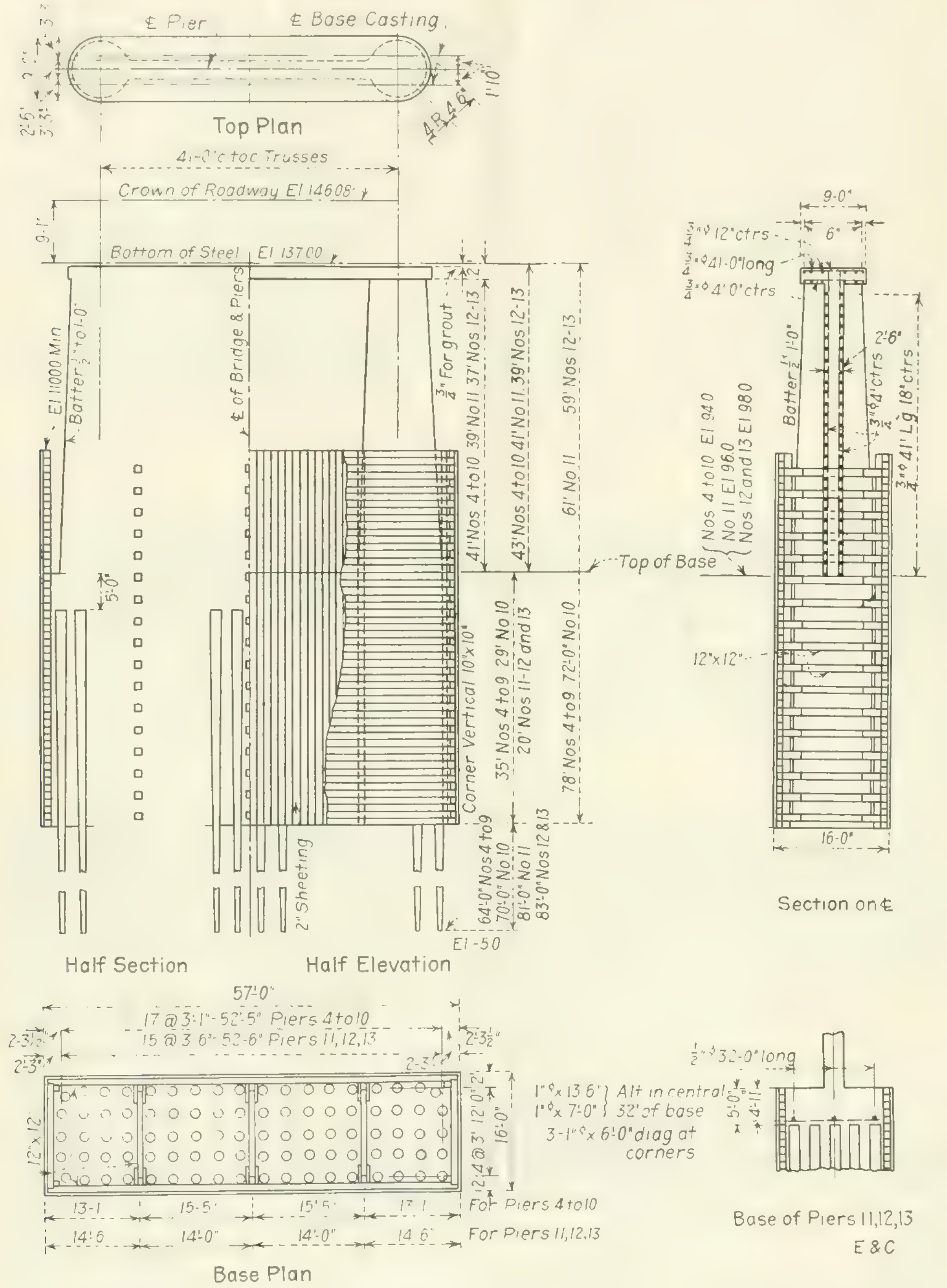


Fig. 3—Details of Piers and Timber Cribs Nos. 4 to 13 of Interstate Bridge Over Columbia River—Note That Piles Are Embedded in Concrete in Cribs from 20 to 25 Ft.

SUBSTRUCTURE.

At the bridge site the river is subject to some scour, but an inspection of the soundings taken for many years failed to show any indication of scour to extreme or unusual depths, even though the river is shallower at the bridge site than it is for a considerable distance both upstream and downstream. The exceptional facility for securing piles of great length at a very reasonable cost was an important factor in determining the type of pier to be used.

The piers are to be constructed of concrete, containing and resting on piles sunk by means of water jets to a depth of about 105 ft. below low water. Open cribs of timber braced by transverse trusses and forming permanent parts of the pier bases will be sunk to a depth of about 20 to 25 ft. below the river bed, and the piles will be jetted inside of the cribs. An average of one pile for each 10 sq. ft. of crib area will be driven. Concrete will then be deposited through the water in sufficient quantities to seal the bottom of the crib, and after this concrete has hardened the crib will be pumped out, the piles will be cut off a short distance below low water, and the remainder of the concrete for the pier placed in the open. A certain amount of heavy stone riprapping will be placed about the piers, which will be replenished, if necessary, during the first two years after the completion of the structure. The piles will thus be about 120 ft. long, with a diameter at the top of 10 or 12 ins. and a diameter at the butt of 22 ins. No followers will be used in driving the piles, but the necessary cut-offs will be wasted. (Piles of this length can be purchased at the bridge site for about 12 cts. per linear foot.)

Figure 3 shows details of the timber crib and pile foundations for the piers which support the 265-ft. spans. It will be noted, by referring to Fig. 3, that the upper ends of the piles are embedded in the concrete of the pier bases from 15 to 20 ft., thus forming an integral part of the pier. It is evident that the pier would be stable, even though there should be scour below the base of the crib, due to the great depth of penetration of the piles and to the rigidity of the upper support.

The occurrence of ice in the Columbia River in floes of large size is very rare, and it was therefore unnecessary to provide steel or stone facings for the concrete piers.

As shown in Fig. 3, the concrete pier shafts consist of two cylindrical battered columns, one under each pair of shoes, joined together by a vertical diaphragm and by a horizontal coping at the top. The diaphragm has a thickness of 2 ft. 6 ins. and the coping a thickness of 2 ft.; both are reinforced with steel, as shown in Fig. 3. The use of this type of pier shaft effects a considerable saving in weight and eliminates a large amount of concrete which otherwise would have been required, but which does not serve any structural purpose.

PRELIMINARY DESIGNS.

Several types of movable span, designed to provide the channel openings required for navigation, were originally considered, but the selection finally lay between a swing span and a vertical lift span. As the commission desired to receive bids on both types of movable span, plans were prepared for bridges containing both types. These designs were made under the same specifications and were as nearly duplicates as was possible.

Application was made to the War Department and tentative approval was received for either type of movable span, provided the swing span should have two 200-ft. channels and the lift span should provide a 250-ft. channel with a vertical clearance above normal high water of 150 ft. Bids were received on both types of bridge, with the result that the lowest bid for the structure which included a vertical lift span was $70,000 less than that received on the structure which included a swing span. The lift span type was adopted after a consideration of width of channel, first cost, and cost of operation and maintenance.

APPROACHES.

The approaches to the Interstate Bridge include bridges over the Columbia and Oregon sloughs, and embankments. The bridges over the sloughs consist of deck plate girder spans, which provide a roadway and floor of the same general type as that used in the main structure. In these spans, however, a portion of the roadway and the sidewalk is carried on cantilever beams; there are also other minor differences in details. These spans rest on concrete piers supported by piles arranged in similar manner to those used in the main bridge. The piles will be sunk to about the same depths, but the bases will not be carried so far below the river bed, as the probability of scour is much less in the sloughs.

Oregon Slough Bridge.—The bridge over Oregon Slough is on a 3 per cent grade and consists of ten 100-ft. deck plate girder spans and one 115-ft. deck plate girder span, giving a total length between end bearings of 1,137 ft. 6 ins. At the present time there is no navigation in this slough above the bridge site, but, as there is possibility of navigation being developed above the site, it was necessary to make provision for some type of movable span. Permission was secured from the engineers of the War Department to build the structure with all fixed spans at the present time, with the provision that one span be so arranged that at any time in the future it can be converted into a movable span by providing towers at each end and by equipping the span with machinery, counterweights, etc., for operation as a vertical lift span. The 115-ft. span, which is centrally located, is arranged for possible use as a movable span, and it will provide a 100-ft. channel. This arrangement resulted in a saving of about $30,000, and it will permit a change to a movable span without interrupting traffic.

Columbia Slough Bridge.—The bridge over Columbia Slough consists of four 75-ft. deck plate girder spans of the same type as those adopted for the bridge over Oregon Slough. After the first tentative approval of the plan for this bridge was given by the engineers of the War Department the status of this slough was so changed that there is a remote possibility that it may at some future time be made navigable. It has therefore been agreed that, should such development occur, one of the 75-ft. spans will be made a vertical lift span to provide a 60-ft. channel.

Embankments.—The main approach on the Oregon side will contain about 931,000 cu. yds. of embankment, while the secondary approach will contain about 500,000 cu. yds. The embankment will be constructed of sand, which probably will be dredged with suction dredges from Oregon Slough. For the main fill there is being installed a 24-in. suction dredge equipped with electrically operated pumps, which will deliver the sand a distance of about 5,000 ft. At this point a booster pump will be installed, also electrically operated, so that for the extreme end of the approach the material will will be carried through about 10,000 ft. of pipe.

The embankments are to be 22 ft. wide on top, with side slopes of 2 to 1, and with an average height of between 20 and 25 ft. The upstream side of the embankment will be protected to an elevation of about 20 ft. above low water by concrete slabs laid on the slope of the finished embankment. These slabs are to be 4 ins. thick, in strips about 8 ft. wide, extending continuously up and down the slope, and reinforced with wire mesh. The overflow, which at times inundates most of the river valley, is largely back water with little current, except at the time when the water is just rising above the surface of the ground and at the time when it is falling to its lowest point. The concrete protection extending part way up the slope will therefore guard against erosion during these periods. It is planned to sow the remainder of the slopes with grass seed in an attempt to develop a compact sod. At the foot of the slopes there probably will be planted a row of evergreen blackberries, a hardy indigenous shrub, which will be of considerable value in preventing erosition. Around the ends of the embankments at the buried piers the concrete slope protection extends entirely over the slope of the embankment to its upper edge. The embankment across Hayden Island is more exposed than the other embankments, and the engineers of the War Department required that some form of revetment extend over both sides up to 5 ft. above normal high water.

The embankments are to be provided with wooden railings, and they will be paved with some form of hard-surface paving. As the embankments will consist principally of sand pumped into position, it is expected that there will be practically no settlement, which will permit the pavements to be constructed in time for the completion of the remainder of the structure.

DIVISION OF CONTRACT AND BIDS.

The consulting engineers prepared complete detailed plans and specifications covering every feature of the structure. Bids were called for on the unit basis, based on the approximate quantities of materials given in the specifications. To insure competition the total contract was divided into twelve units —into what seemed to be natural divisions. Of these twelve divisions eight of them refer to the types of construction actually used; the others refer to alternate designs calling for a swing span. The contracts for the lighting system and for the pavement on the embankments have not yet been let. Bids were received Feb. 23, 1915, and contracts were let soon afterwards to six bidders. The large number of duplicate spans and the careful manner in which the spans were detailed, warranted exceedingly low bids on the steelwork and on its erection.

The erectors are planning to erect, rivet and paint the spans on a dock at the shore, to transfer them to barges, and to float them to position on the piers without the use of falsework. As the total contract price of the structure is about $230,000 less than the appropriation made for it the commission was able immediately to arrange for the construction of a secondary approach previously mentioned, which will accommodate a portion of the city not directly adjacent to the main approach.

The work of the various contractors has been arranged in order of time to permit cooperation, in order that the various operations may proceed consecutively and without interruption. It is expected that the bridge, which is fireproof in every particular, will be in service late in the fall of 1916.

CONTRACTS, QUANTITIES OF MATERIALS AND SUCCESSFUL BIDDING PRICES.

The following data give the division of contracts awarded, the names of the successful contractors, the quantities of materials, the unit bidding prices, and the total bid for each item of each contract:

Contract No. 1.—This contract, which includes the manufacture and delivery of the superstructure steelwork of the main bridge over the Columbia River, was let to the U. S. Steel Products Co. The following data apply to it:

Item.	Weight, lbs.	Unit price, cts. per lb.	Total, each item.
Truss spans, etc.	12,921,000	[illegible]	[illegible]
Towers	822,000	3.43	28,194.60
Railings, etc.	620,000	2.755	17,081.00
Sheaves, etc.	318,000	10.00	31,800.00
Motors (two)	....	....	1,325.00
Switchboards	....	....	156.00
Gasoline engine	....	....	728.00
Total bid	....	.....	$417,316.20

Contract No. 2.—This contract, which includes the erection of the superstructure steelwork for the main bridge over the Columbia River, was let to Porter Brothers of Portland, Ore. The following data apply to it:

Item.	Weight, lbs.	Unit price, cts per lb	Total, each item
Truss spans, etc.	12,924,000	0.55	$71,082.00
Towers	822,000	0.90	7,398.00
Railings, etc.	620,000	0.40	2,480.00
Sheaves, etc.	318,000	1.25	3,975.00
Motors (two)	....	....	200.00
Gasoline engine	....	....	200.00
Electric wiring	....	....	3,100.00
Operator's house	....	....	2,100.00
Gate tender's house	....	....	700.00
	Cu. yds.	Per cu. yd.	
Counterweights	621	$14.00	8,694.00
Total bid	....	....	$99,829.00

Contract No. 5.—Contract No. 5 is for the manufacture and delivery of the superstructure steelwork of the bridges over Oregon and Columbia sloughs. It was let to the Northwest Steel Co. of Portland, Ore., and includes the following items:

Item	Weight, lbs	Unit price, cts per lb	Total, each item
Metal	3,191,000	2.55	$81,370.50
Rails	259,000	3.00	7,770.00
Total	....	.	$89,140.00

Contract No. 6.—Contract No. 6 is for the erection of the superstructure steelwork of the bridges over Oregon and Columbia sloughs. It was let to Porter Brothers and includes the following items:

Item.	Weight, lbs.	Unit price, cts. per lb.	Total, each item.
Metal	3,191,000	0.55	$17,550.50
Rails	259,000	0.40	1,036.00
Total	..	.	$18,586.00

Contract No. 7.—In contract No. 7 there is included all work in connection with the substructure of the main bridge over the Columbia River. This contract was let to the Pacific Bridge Co. of Portland, Ore., and the following data apply to it:

Item and quantity.	Unit price	Total, each item
Pier shafts, 5,350 cu. yds.	$ 9.00	$ 48,150.00
Reinforcing steel, 109,000 lbs.	0.03	3,270.00
Bases, 15,810 cu. yds.	12.00	189,720.00
Bases, buried piers, 418 cu. yds.	12.00	5,016.00
Piles, 77,900 lin. ft.	0.46	35,834.00
Dolphins, 5,900 lin. ft.	0.25	1,475.00
Timber ferry, 105 M ft. B. M.	30.00	3,150.00
Rip-rap, 16,000 cu. yds.	2.05	32,800.00
Mattress, 34,600 sq. yds.	0.70	24,220.00
Total		$319,415.00* 310,835.00†

*Rip-rap. †Mattress.

Contract No. 9.—Contract No. 9 includes all substructure work in connection with the bridge over Oregon and Columbia sloughs. This contract was let to the Pacific Bridge Co., and it includes the following items:

Item and quantity.	Unit price.	Total, each item.
Pier shafts, 2,480 cu. yds.	$10.00	$ 24,800.00
Reinforcing steel, 34,000 lbs.	0.04	1,360.00
[illegible]	16.00	[illegible]
Bases, buried piers, 894 cu. yds.	16.00	14,304.00
Piles, 58,100 lin. ft.	0.35	20,335.00
Rip-rap, 11,000 cu. yds.	2.00	22,000.00
Mattress, 21,000 sq. yds.	0.50	10,500.00
Total		$119,759.00* [illegible]†

*Rip-rap. †Mattress.

Contract No. 10.—In contract No. 10 there is included the main embankment of the approaches. This contract was let to the Tacoma Dredging Co. of Tacoma, Wash., and it includes the following items:

Item and quantity.	Unit price.	Total, each item.
Embankment in place, 931,000 cu. yds.	$0.1324	$123,264.40
Ditches, 3,000 cu. yds.	0.25	750.00
Slabs, 38,000 sq. yds.	0.80	30,400.00
Rock fill, 1,900 cu. yds.	2.00	3,800.00
Total		$158,214.40

Contract No. 11.—Contract No. 11 is for the reinforced concrete floor and pavement on the bridge over the Columbia River and on those over the Oregon and Columbia sloughs. This contract was let to the Warren Construction Co. of Portland, Ore., and it includes the following items:

Item and quantity.	Unit price.	Total, each item.
Bitulithic, 21,624 sq. yds.	$ 3.48	$75,251.52
Sidewalk slabs, 3,254 sq. yds.	2.10	6,833.40
Hand rails, 21 cu. yds.	30.00	630.00
Bronze lamp standards, 2	44.00	88.00
Total		$82,802.92

The contract for the secondary embankment, which was not included in the original project, was let to the Standard American Dredging Co. of Oakland, Cal.

PERSONNEL.

The plans and specifications for the Interstate Bridge and its approaches were prepared by Harrington, Howard & Ash, consulting engineers, of Kansas City, Mo. We are indebted to E. E. Howard of that firm for the data upon which this article is based.

Some Data on Oxy-Acetylene Welding and Cutting Equipment.

(Staff Abstract.)

The ordinary method of welding, and the one that has been in common use for many years, is that known as the compression process. By this method the pieces to be welded are heated in a forge to a temperature slightly above the proper degree for welding. The two ends, after being treated with a suitable flux to decrease scale and shut out air, are placed together and a compressive force, usually created by hammering, is depnded on to form a junction. The smith must be able to judge the proper temperature for welding, make sure that the flux is properly applied, and then hammer the adjoining ends so that slag, scale and air are forced out. It is evident then that the efficiency of the weld is very much dependent on the skill of the operator and the thoroughness with which he performs his work. This process, when properly carried out, is satisfactory for small operations, such as the ordinary work in a blacksmith's shop, but it is entirely unsuited for the demands of modern, up-to-date repair shops, where large sections of boilers, engines, and other heavy parts of metal are to be joined, because of the uncertainty of the weld and the time and labor involved.

From time to time attempts have been made to weld metals by using oxygen in combination with a combustible gas. Hydrogen, "Pintsch," and "Blau" gas have been tried, but were not found satisfactory because of temperature limitations. If sufficiently confined, the flame from any one of these would be hot enough to melt most of the common metals; but experience shows that these gases cannot be well enough regulated or localized, in commercial work, to give wholly satisfactory results.

The introduction of the electric furnace has made possible the production of calcium carbide in large quantities, and from this acetylene gas is made. The combination of oxygen and acetylene, when ignited, produces the oxy-acetylene flame, which is hotter than the oxy-hydrogen flame by over 2,000° F. The extra heat generated by the oxy-acetylene flame not only melts the metals to be joined, but also fuses them so completely that they automatically run together, thus forming a weld. In addition to the 50 per cent increase in intensity of heat in the oxy-acetylene flame over other oxygen flames, there is about 500 per cent increase in the amount of heat. Another valuable feature of the oxy-acetylene flame is its concentration into a small volume at the working point, as compared with other flames,—a condition especially suited for rapid and thorough welding and cutting.

METHODS OF GENERATING ACETYLENE.

There are two methods for generating the supply of acetylene for welding and cutting operations, one generally called the carbide-to-water plan, and the other the water-to-carbide plan. The first makes use of a cylinder partly filled with water into which calcium carbide is dropped by a mechanism controlled by the pressure of the gas in the cylinder. This has the double advantage of producing the largest volume of gas per unit of carbide, while the gas is also separated from certain of its impurities by bubbling up through the lime water.

On the other hand, the water-to-carbide method is very apt to reduce the calorific value and the amount of acetylene produced per unit of calcium carbide, and at the same time form a tar product which will clog up the pipes, valves, and torches. For these reasons, among others, the superiority of generators of the carbide-to-water type is generally acknowledged.

STORING ACETYLENE.

It is not safe to store gaseous acetylene in tanks under a pressure approaching two atmospheres; and to overcome this difficulty storage tanks are provided, containing a porous substance such as brick or asbestos, and filled with acetone. Acetylene gas is then pumped into the tanks and this combines with the acetone, which has the property of absorbing approximately twenty-five times its volume of acetylene for each atmosphere of pressure, at 60° F. By this process acetylene may be safely stored under a pressure of 150 lbs. per square inch.

ACETYLENE TORCHES.

A great deal of the success of oxy-acetylene welding depends on the torch. The low-pressure, or injector-action torch, is used in connection with acetylene under a pressure of a few ounces. A chamber in the torch permits the accumulation of a small quantity of acetylene, and the oxygen passing through this chamber, under pressure, carries along a certain amount of acetylene, usually in quantities of 1 part of acetylene to 1.6 to 1.8 parts of oxygen. This excess of oxygen, besides being wasteful of the oxygen itself and increasing the length of time required for making the weld, tends to oxidize the metal, thus forming a brittle, unsatisfactory joint.

To overcome this defect the high-pressure or positive-mixture torch was designed. In this torch both the acetylene and the oxygen are admitted under pressure, the ratio being 1 part of acetylene to 1.13 to 1.15 of oxygen. Since both the acetylene and oxygen are under a pressure of several atmospheres, reducing valves and pressure gages are employed to regulate the flow of the gases in the correct proportion to produce rapid and satisfactory welding and cutting.

GENERATING OXYGEN.

The quality of the oxygen has an important bearing on the efficiency of the welds, and for this reason it is essential to see that the impurities, incident to the generation of oxygen, are eliminated. This is practically impossible in a portable pressure-generator, since some of the deleterious impurities, such as chlorine, must pass through nearly 100 ft. of washing fluid before they are removed. In a stationary oxygen-generating outfit, however, it is quite easy to provide the necessary amount of washing fluid, and to store the oxygen in tanks. This increases the cost of the oxygen, but, since better results are obtained, the ultimate cost of the weld is no doubt less than with a portable generator.

If portability is essential, it is recommended that both the oxygen and acetylene be obtained from storage cylinders. A portable acetylene generator has the disadvantage of requiring the removal either of the water or the calcium carbide before the generator can be taken safely from one place to another. If neither the water nor the calcium carbide is removed, and the generator tips over, the mixture of all the water and carbide will generate large quantities of gas, causing an explosion; or in case of a small leak the escaping gas may become ignited, thus causing severe burns.

PRECAUTIONS TO AVOID ACCIDENTS.

A number of accidents have occurred due to the practice of using an open-flame light when cleaning out an acetylene generator. It is customary to wait until the pressure gage indicates no gas in the generator before cleaning operations are started. Sometimes a small pocket of the gas remains, however, and burns the workman when ignition takes place from the open flame. Calcium carbide will occasionally cake on the sides of the generator tank, and unless the water is removed at once the caked carbide will generate gas as it is knocked from the tank, and will ignite and burn the workman. A portable incandescent electric lamp should be used instead of an open light, and the lamp bulb should be protected against breakage by a fiber or wire guard.

The tubes or hose connecting the torch with the acetylene and oxygen supply are constantly subjected to twists, turns, and abrasive action, and are apt to be so weakened that minor leaks occur, or the fastenings may become loosened and permit gas to escape. The torch itself provides a flame that will ignite the escaping gas, or the sparks from the welding or cutting operation may also light it. Occasionally gas escapes from loosened fastenings and gathers about the clothing of the man wielding the torch. Sparks from the burning metal then cause the gas to ignite, severely burning the workman. This indicates that the hose fastenings and the hose itself should be frequently inspected to see that no leaks exist or are likely to occur during an operation.

It is essential that colored glasses be worn by every one connected with oxy-acetylene welding or cutting work. Not only should the eyes be protected from the intense light of the oxy-acetylene flame, but also from the very fine, slag-like substance that occurs during the welding operations, and that is decidedly harmful to such sensitive organs as the eyes.

Very little, if any, attention has been given to the subject of the effect of oxy-acetylene welding upon the health of the workers. The amount and intensity of the heat from the flame is sufficient to cause vaporization of the metals, and since the workman's head must be within a foot or two of the flame, he cannot avoid breathing the products of combustion unless some protection is provided. It would seem that a helmet, with a colored-glass front, would afford the necessary protection in this way, as well as protect the eyes from the intense light.

The economy and efficiency of this method of making welds and cutting metals has led to its adoption in many of our manufacturing plants, and this in turn has created an oxygen-generating industry. The cost of transportation is such, however, that the oxygen is usually sold in cylinders in which it is stored under pressures up to 1,800 lbs. per square inch. Should one of the cylinders be defective a destructive explosion is apt to result. To guard against accidents to the workmen from this cause, the cylinders should never be stored in the working room, but should be kept in a special storage room having substantial walls. Care should also be taken to avoid leaving full tanks in places where the direct rays of the sun may strike them, or in close proximity to heating apparatus or any other sources of heat.

ACKNOWLEDGMENT.

The foregoing data were compiled by the engineering and inspection division of The Travelers' Insurance Co., of Hartford, Conn.

ROADS AND STREETS

Cost of Macadam Object Lesson Roads in North Carolina.

(Staff Abstract.)

Methods and cost of constructing three short sections of macadam road in 1912 in North Carolina are given as follows:

Jerusalem, N. C.—Surfacing was started on a road leading from Jerusalem southeast toward South Yadkin River on Oct. 15, 1912, and completed on Dec. 2, 1912. No data concerning the cost of grading could be obtained. The land adjacent to the road is rolling, and the soil is sandy loam from station 0.00 to station 13.00 and red clay from station 13.00 to station 20.00. The macadam surface is 2,210 ft. long and 12 ft. wide, making a total area of 2,950 sq. yds. The stone consisted of coarse-grained light granite for the foundation course and trap or field stone for the wearing surface. The compacted depth of the foundation course was 3¾ ins., and of the top course, including the screenings, 2¼ ins. Surfacing material to the amount of 655 cu. yds. was used, and of this 364 cu. yds. were purchased.

Concrete gutters 1 ft. wide, 3 ins. thick, and dished from 1 in. to 2 ins., were constructed on each side of the road throughout its length. Cross drains 14 ft. long, of bell-joint pipe, were constructed at stations 3.00, 5.50, 10.75, 13.00 and 18.50. The diameter of the first four drains was 4 ins. and of the last 6 ins. The ditches for the cross drains in each case were filled with broken stone. Underdrains of 6-in. bell-joint pipe 12 ft., 33 ft., 40 ft., and 16 ft. long were constructed at stations 3.00, 5.50, 10.75 and 13.00, respectively. Concrete drop inlets 10 ins. square and 2 ft. deep, having 3-in. walls, were provided for these drains. Three hundred and seventy-four sacks of cement were used in constructing the gutters and drop inlets.

The equipment consisted of a crusher having an average capacity of 50 cu. yds. per 10-hour day, a 10-ton roller, a sprinkling cart, and slat-bottom road wagons. The crusher and roller were both borrowed, and the only cost in connection with their use was the operating and maintenance expense. The average haul from quarry to crusher was one-half mile and from crusher to road 500 ft. The water for the crusher, roller, and sprinkler was pumped. Prices were: labor, $1.40 per day; teams, $3 per day, and fuel, $6 per ton. The cost items were:

Item.	Per sq. yd.
Materials for gutters and inlets	$0.065
Labor for gutters and inlets	0.041
Drain pipe	0.006
Labor for drain pipe	0.002
Surfacing material	0.092

Quarrying	0.083
Hauling to crusher	0.085
Crushing	0.046
Hauling crusher to road	0.052
Spreading	0.047
Sprinkling	0.005
Rolling	0.004
Hire of sprinkler	0.008
Explosives	0.034
Crusher repairs	0.008
Drill steel	0.009
Sharpening drills	0.006
Fuel	0.022
Lubricating oil	0.004
Loosening old macadam	0.005
Screening	0.001
Clearing	0.008
General expenses	0.067
Total	$0.700

Monroe, N. C.—A macadam road leading southeast from Monroe toward Wingate, known as the Lee Mill road, was started on Oct. 12, 1912, and completed on Nov. 22, 1912, and during this time 3⅓ days were lost on account of unfavorable weather. This road had been graded before the arrival of the office representative, and no data relative to the cost of grading were available. The grade varies from a maximum of 3 per cent to level. The adjacent land varies from rolling to hilly, and the soil is red clay and clay shale. Local sandstone was used for surfacing. This stone possesses good wearing qualities, but poor binding qualities, making it a good material for the foundation course, but not well suited for the top course.

The total length surfaced was 2,510 ft. and the width 10 ft., giving a surfaced area of 2,789 sq. yds. The stone was laid in three courses—the bottom course consisting of stone varying in size from 1¾ ins. to 4 ins., the second course from 1 in. to 1¾ ins., and the top course from dust to 1 in. The total compacted depth of the surface was from 7½ ins. to 9 ins. The crown of the finished roadway was ¾ in. to 1 ft. Stone to the amount of 1,133 cu. yds. was crushed, but only 997 cu. yds. was used. The stone was hauled from the quarry to the crusher for an average distance of 175 ft. in wheelbarrows, and from the crusher to the road for an average distance of 2,000 ft. in slat-bottom wagons, with a capacity of approximately 1 cu. yd. The stone was loaded directly from the bins into the wagons. Water for the crusher engine was carried 200 ft. by hand, and hauled 300 ft. for the roller. Four tons of fuel were used at the crusher and 5½ tons by the roller.

The equipment consisted of a stone crusher having 73 cu. yds. capacity per 9-hour day, an engine, a 10-ton roller, slat-bottom wagons, and hand tools. Convict labor and teams owned by the county were used. The cost to the county per day per convict and per mule was $0.45. The total cost of the road was $647.15, making a rate of $0.232 per square yard. The principal items of cost were:

Item.	Per sq. yd.
Preparing subgrade	$0.008
Quarrying	0.043
Hauling to crusher	0.024
Crushing	0.018
Hauling crusher to road	0.042
Spreading stone	0.008
Sprinkling	0.003
Rolling	0.026
Stacking and loading screenings	0.012
Shaping shoulders	0.004
Loss of time due to bad weather	0.021
Incidental expenses	0.023
Total	$0.232

North Wilkesboro, N. C.—Work was begun on a macadam road leading from North Wilkesboro toward Wilkesboro on Oct. 2, 1912, and was discontinued on Dec. 21, 1912. Thirteen and one-half days were lost on account of bad weather. A section of road 800 ft. in length was entirely completed and an additional length of 494 ft. was partially completed. The section completed follows the Yadkin River, and the entire road is subject to overflow at flood seasons. To remedy this condition the grade of the road was raised and the macadam was laid on a Telford base.

The natural soil is clay and silt and the adjacent land is level. There was no cut, and the maximum fill was 3.9 ft. and the average fill 2.1 ft. The maximum grade of 5.85 per cent was reduced to 2.5 per cent.

A total length of 1,294 ft. was graded 30 ft. wide. All the material for the embankment was taken from pits located at an average distance of three-eighths mile from the road and in no case more than one-half mile. It was loosened with a plow, loaded with shovels on slat-bottom wagons, and spread by hand.

A subgrade 16 ft. wide was prepared for a distance of 1,294 ft. and a Telford base 12 ins. thick was laid upon it for the same distance. A macadam surface was laid upon this base to the same width for a distance of 800 ft. The surface was laid in two courses, each 3 ins. thick compacted, and each course was bonded with screenings. The stone used on the bottom course consisted of pieces from 1½ to 3 ins. in size, and the stone used in the second course ranged from ½ in. to 1½ ins. The screenings consisted of material ranging from dust to particles ½ in. in size.

The Telford base and the macadam surface were both made from mica gneiss obtained from the same quarry. This material possesses excellent binding and wearing qualities. It was quarried at an average distance of 1½ miles from the road, crushed at the quarry, loaded into dump wagons by means of a chute from the bins, and hauled to the road, where it was spread with forks.

The following drainage structures were constructed: One reinforced concrete culvert 2x4 ft. by 29 ft. long; one reinforced concrete culvert 2x6 ft. by 30 ft. long; one reinforced concrete culvert 2x6 ft. x 28.5 ft. long; and one wooden-box culvert 2x3 ft. at an intersection road.

The equipment consisted of one stone crusher with a capacity of 25 cu. yds. per day, elevator, bins, one 10-ton roller, six 1½ cu. yd. dump wagons, slat-bottom wagons, one turn plow, and hand tools.

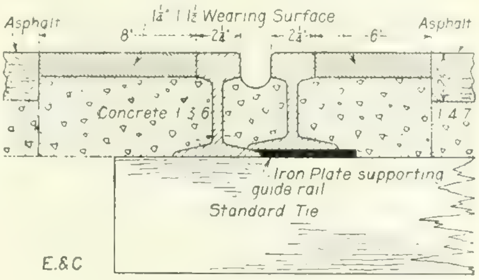


Fig. 1—Cross-Section of Concrete Header Along Car Tracks.

The labor cost for men was $0.12½, $0.13½, and $0.15 per hour, and double teams cost $0.30 per hour. The working day was 10 hours long. The principal items of cost were:

Item.	Unit.
979 cu. yds. excavation and embankment	$0.400
2,300.4 sq. yds. clearing and grading	0.0017
2,300.4 sq. yds. shaping subgrade	0.066
2,300.4 sq. yds. Telford foundation	0.489
380 cu. yds. quarrying and crushing	1.525
380 cu. yds. hauling	0.645
380 cu. yds. spreading	0.108
1,422.2 sq. yds. rolling	0.150
Reinforced concrete drainage structures	$473.00
General expenses	40.63

The above costs do not include any charge for the use of the stone crusher, elevator and bins.

The preceding information has been partly quoted and partly rewritten from the Report of the North Carolina Geological Survey.

Cost of Concrete Header Along Rails.

Contributed by H. R. Ferris, Victoria, B. C.

The sketch shows concrete header laid along the rails of a car line in asphalt pavement in a fairly light traffic residential street. The track is all on curve as it follows the inside of a circular "place" where four streets come together. The headers have been down nearly two years and are still in good condition, although several lateral cracks have occurred between expansion joints. This is possibly due to the jarring of cars passing around the Circle, as, where similar headers have been laid on straight tracks, no difficulty has arisen. It has been suggested by the engineers of the street car company that this defect could be avoided by the use of reinforcement laid longitudinally with the rails. The concrete was machine mixed; it would probably have been cheaper to lay by hand.

The costs of constructing 2,200 lin. ft. of header were as follows:

	Cost per 100 lin. ft.
Labor:	
Foreman, 33 hrs. at 55 cts	$0.825
Mixer eng., 9 hrs. at 45 cts	0.184
Mixer helper, 14 hrs. at 35 cts	0.222
Cement man, 4 hrs. at 30 cts	0.055
Common labor, 170 hrs. at 30 cts	2.318
Form setter, 11 hrs. at 50 cts	0.250
Form setter and helper, 30 hrs. at 40 cts.	0.545
Form setter and helper, 10 hrs. at 35 cts.	0.159
Finisher, 40 hrs. at 60 cts	1.091
Finisher helper, 30 hrs. at 40 cts	0.545
Finisher helper, 2 hrs. at 30 cts	0.027
Labor mixing surface, 40 hrs. at 30 cts.	0.545
Total labor	$3.766
Cartage on tools, etc. ($2)	0.091
Materials delivered:	
Cement, 51.25 bbls. at $2.60	$6.057
Sand, 13.6 cu. yds. at $1.70	1.050
Gravel, 28 cu. yds. at $1.60	2.036
Lumber for forms	0.273
Total materials	$9.416
Grand total	$13.273

Comparative Cost of Asphalt and Brick Pavement.

To THE EDITORS:—In your issue of June 2, Page 504 appears a "challenge" of a statement made by me in an article on the "Design of Pavements" of which you made an extract in the issue of May 12, page 433.

The statement, "There are three pavements: brick, asphalt and asphaltic concrete that cost about the same," relates to a rational interpretation of Table I accompanying said article. Mr. Draney is correct in that the prices bid on *first cost* of these pavements range from 30 to 60 cents higher for brick than for asphalt or asphaltic concrete. This is correctly shown on Table I in column 4. Apparently the complete analysis of the table is not understood.

Unfortunately, promoters and others not fully conversant with the factors entering into an economic comparison of pavements consider *first cost* the sole value by which a pavement should be judged. Municipalities are generally beginning to realize that first cost is really a minor matter. Economic cost based on such factors, as first cost, repairs, life under various traffic requirements, ease of repairs, cleaning, etc., while giving a rational comparison, is often over shadowed by other factors such as noiselessness, sanitation, good foothold, acceptability and local conditions. As may be seen by referring to column 9 of Table I the *total annual cost* or comparative value of the three types mentioned, brick, asphalt and asphaltic concrete is 19, 18 and 17 cents, respectively. Therefore it seems permissible to make the statement that these three types "cost about the same." Of course, this table represents only average conditions in but one locality and the relative costs are based on prices which even my critic will agree are right and on other factors which experience and observation in other cities all appear to confirm. It should be fully understood that *first cost* is a poor criterion by which to judge any product, and people everywhere are becoming gradually convinced that *value* (or true cost) means more than this.

Very truly yours,
H. J. FIXMER,
Engineer, Board of Local Improvements,
Chicago, Ill.

Chicago, Ill., June 3, 1915.

P. S.—On p. 433 (May 12 issue) in first column of Table I on line five appears, "Asphalt, concrete or Type 8 asphalt." It should read, "Asphaltic-concrete or Type B asphalt." Type "B" asphalt as used in Chicago differs from the standard sheet asphalt in that the concrete base may be 5 ins. or 6 ins. thick and the two top courses are binder 1 in. and top 1½ ins., whereas in the standard sheet asphalt the binder is 1½ ins. and top 2 ins. thick.

H. J. F.

Brick Pavement on Old Gravel Road Foundation for Portion of the Lincoln Highway.

Contributed by F. A. Churchill, Dunn Wire Cut Lug Brick Co., Conneaut, O.

That portion of the Goshen-Fort Wayne section of the main line of the Lincoln Highway which is in Elkhart county, Indiana, is being paved with wire-cut lug-brick at the request of the County Commissioners and with the approval of the local branch of the Lincoln Highway Association. The section is five miles long.

The highway is to be 66 ft. wide, with an 8-ft. dirt road running along either side of a 16-ft. brick roadway. A somewhat unusual type of construction has been adopted. The brick surface is to be laid upon a sand bed superimposed upon an old gravel roadway, and without a concrete foundation. The road to be improved is an old gravel road which is to be carefully dressed down to the desired grade and cross section *by hand*, so as not to disturb the solidity and foundation function of the old compressed gravel and subsoil. On this is spread the sand cushion, thoroughly compacted, and then the brick, with a first-class 1 to 1 grout filler, are to be laid.

The extremely low price at which this method of construction is had is a revelation in brick highway construction. The contract price of $63,465 is more than $9,000 below the engineer's estimate, and it brings the cost to $800 per foot mile; that is to say, the 16-ft. roadway will cost $12,700 per mile. The contract price includes 46,933.34 sq. yds. of brick pavement, grout filled; 46,933.34 sq. yds. of sand bed 1½ ins. deep; 52,836 lin. ft. of 6x12-in. concrete curb (1-2-4 mix); 3,380 cu. yds. of embankment; 10,930 cu. yds. of excavation; two complete culverts, and the grading of the dirt roadway. Neese & Seaman, of Frankfort, Ind., are the contractors, and wire-cut-lug brick will be furnished by the Terre Haute Vitrified Brick Co. of Terre Haute, Ind., and the Veedersburg Paver Co. of Veedersburg, Ind.

The method of construction, on an old gravel roadbed, is something new in northern latitudes, but County Engineer A. A. Rieth of Elkhart County is confident that results will justify the experiment, both in durability of pavement and economy of construction. Resurfacing scarified macadam with brick has been done in many places, and, in instances in which the macadam was not worn through in spots, the results have been satisfactory so far; but this is believed to be the first instance of using an old gravel roadway for a foundation for a brick pavement. The theory of Mr. Rieth, and of the County Commissioners and of the Elkhart County branch of the Lincoln Highway Association, is that with a smooth monolithic surface such as grouted wire-cut lug-brick gives, the compacted gravel will furnish a sufficiently solid foundation to assure a durable roadway that will give satisfactory service for many years. Theoretically, at least, the only element of uncertainty in that method of construction is the possible action of frost upon the gravel foundation. It is believed, however, that this element of possible danger is minimized by the solidity of the foundation and subsoil resulting from years of compacting by traffic.

The three features of this road which challenge attention are: First, the approval of brick by the local branch of the Lincoln Highway Association; second, the use of an old gravel roadbed for a foundation; third, the extremely low cost of construction.

If this method of construction proves as satisfactory in northern latitudes as grouted brick pavements laid on natural soil are proving to be in the South, the cost of brick highways will be materially reduced. If brick highways can be constructed at an approximate cost of $800 per foot mile, this type of improved road will come into favor generally in communities in which the expense of improving highways is a matter of serious concern, and in which the expense of standard type of brick pavement is not justified by traffic requirements or by the financial resources of the district.

The laying of brick on a natural gravel foundation has been practiced here and there for some years, and where the construction has been good the results have been satisfactory. Main St., Conneaut, O., from Buffalo St. to Liberty St., a distance of several blocks, was paved with brick laid on a natural gravel foundation 15 years ago, at a cost of $1.11 per square yard, and it still is in good condition generally—some of it not showing a flaw. Several other brick pavements in the same city were laid on gravel foundation more than a dozen years ago, and in every instance in which care was taken in construction, the pavements show comparatively few defects. Some of the pavements of this type are in better condition than some of the pavements laid upon a concrete foundation, and some of the former are showing up poorly. In each case, however, the defects obviously arise from the use of poor grouting material or from negligence in construction. Malvern, O., is about to pave several streets with grouted brick on natural gravel soil, about 30,000 yards in all.

Of course, the success of this type of construction depends upon good drainage, a well-compacted foundation brought to a true cross-section, and the best grout filler properly applied. Naturally, one of the most essential things is a surface firmly bonded. Wire-cut-lug brick has proven to have greater bonding strength than any other type of brick, and it is now being used on highways constructed on natural soil foundations wherever its superiority is known.

Split Float for Finishing Joints in Concrete Road Work.

(Staff Article.)

A split float used in finishing the joints on some 60,000 sq. yds. of concrete pavement in Jefferson, O., is illustrated in the accompanying sketch. The joints were unarmored but had a filler of ¼ in. thick asphaltic felt. This felt was sufficiently wide to extend not only through the entire thickness of concrete but well above the finished surface. By the use of split floats the finishers were able to bring the concrete to the same elevation on each side of the joint. After the concrete had hardened the protruding portion of the filler was cut off by a sharp shovel or adz to a height of about ½ in. above the concrete, the remainder being ironed down by traffic. In this manner crushing and spalling of the concrete at the edges of joints, which is often experienced when the filler does not come to the top of the concrete, is eliminated. This method of constructing unarmored joints is included in the new specifications of the American Concrete Institute. The contractors for the pavement were Appenzeller, Dilhoff & Karsch, Greenville, O., and the engineer in charge was R. N. Case, county engineer, Ashtabula county, O. We are indebted to the Universal Portland Cement Co., Chicago, for information.

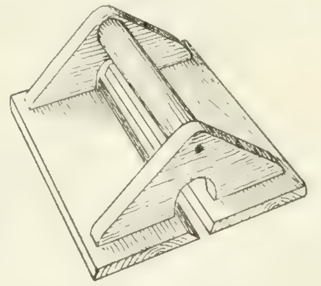


Fig. 1—Split Float for Finishing Joints in Concrete Roads.

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Paving Brick Manufacturers' Convention.—The board of directors of the National Paving Brick Manufacturers' Association at their quarterly meeting held in Cleveland May 27 affirmed arrangements tentatively made for holding its annual meeting October 11-12 at Dayton, Ohio. During this week, namely October 12, 13, 14, will be held the annual meeting of the American Society of Municipal Improvements. This arrangement will not only enable the members of the National Paving Brick Manufacturers' Association to attend the meeting of the American Society, but it will also give the engineers of Ohio, Indiana and Kentucky, and other states who have not heretofore been members of the American Society of Municipal Improvements an opportunity to attend that meeting and become enlisted in its roll of membership.

Things a Lump of Coal Can Do.—The exhibit of the Barrett Manufacturing Co. in the Mines and Metallurgy Building at the San Francisco Exposition, illustrates the variety of uses which science has found for soft coal. An enormous block of coal is shown surrounded by its products. The first "generation" consists of ammonia, illuminating gas, crude benzol, coal tar, and coke. The derivatives of each of these substances are in turn grouped around it. Coal tar, for instance, is the parent of Tarvia and other bituminous road binders, numerous ready-roofings, creosote oil, etc. The exhibit is a graphic illustration of the possibilities of coal products.

CURRENT NEWS

The Doings of the Week.

Business continued to show improvement during the past week. The publication of President Wilson's note relieved the anxiety regarding the international situation and there now is a general belief that a peaceful solution of the difficulties with Germany will result. There was some disturbance in the stock market immediately following the resignation of Mr. Bryan, but this was followed by a vigorous forward movement that took in nearly the entire list of stocks. Bank clearings for the week ending June 10 were nearly $100,000,000 over those of the previous week and $130,000,000 more than those for the corresponding week of last year. There is no question but that business circles are more cheerful than they have been for some time, and this cheerfulness is based on facts not hopes. Even up in New England the cotton business is now 90 per cent normal. The government crop reports made public last week indicated a possibility of a wheat crop exceeding even that of last year and a record oat crop. Many large war orders were placed last week. The lumber and copper industries continued to show gains. In the construction field a fair amount of new work made its appearance. Some good-sized jobs were placed under contract, while others reached the call for bids stage. Municipal work, especially water and sewerage undertakings in the eastern states, are now offering many construction opportunities. State highway construction, as regards new work coming up for bids, showed a falling off during the past week. No particularly large jobs in this field were advertised. County road work, however, makes a good showing, and in the municipal street paving field many jobs are being advertised. In the iron and steel trade increased activity was a feature of the week. Mills in the Pittsburgh district are now operating at better than 80 per cent capacity. Pig iron production by the blast furnaces of steel companies was 110,000 tons greater in May than in the previous month. A 1.25 ct. price on bars is now being confidently predicted by the mills. The *Iron Age* prices for finished iron and steel and for sheets, nail and wire for the week ending June 9 were as follows:

Finished Iron and Steel. Per lb. to large buyers:	June 9. Cts.	June 2. Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia........	1.17½	1.17½
Iron bars, Pittsburgh..........	1.25	1.25
Iron bars, Chicago.............	1.20	1.20
Steel bars, Pittsburgh.........	1.20	1.20
Steel bars, New York...........	1.369	1.369
Tank plates, Pittsburgh.......	1.15	1.15
Tank plates, New York.........	1.319	1.319
Beams, etc., Pittsburgh.......	1.20	1.20
Beams, etc., New York.........	1.369	1.369
Skelp, grooved steel, P'gh....	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh.......	1.30	1.25
Sheets, Nails and Wire. Per lb. to large buyers.		
Sheets, black, No. 28, P'gh....	1.75	1.75
Galv. sheets, No. 28, P'gh....	4.50	4.25
Wire nails, Pittsburgh.........	1.55	1.55
Cut nailss, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh........	1.35	1.35
Barb wire, galv., P'gh.........	2.40	2.20

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—No developments of importance in the railway construction field have taken place during the past week. Some of the larger contractors believe that work of considerable magnitude will come up for letting early this summer, but this inference seems to be based more on hopes than on definite facts. One feature of interest is the incorporation of new companies. In the last two or three weeks many new projects have reached the corporate stage. Engineering work on several of these prospects is now under way.

Roads and Streets.—Most of the work in these fields that came up for advertising during the past week is for street paving. New York, California, Illinois, Massachusetts, Maine and other states have a large amount of state highway construction yet to be placed under contract this season, and bids on part of this will be asked in a few days. Philadelphia, Pa., is asking bids on street improvements to cost about $175,000; New Boston, O., is calling for proposals for 60,000 sq. yds. brick pavement; Malvern, O., opens bids June 29 on 30,000 sq. yds brick pavement; Scarsdale, N. Y., is asking proposals on 24,000 sq. yds. bituminous macadam; Fort Dodge, Ia., opens bids June 18 on 17,400 sq. yds. asphaltic concrete; Fairmont, Minn., is advertising a letting covering 12 blocks of streets; Pipestone, Minn., asks proposals on 40,000 sq. yds. concrete or asphaltic concrete. County road jobs include 10 miles of concrete for Lake County, O., and a good-sized job for a Minnesota county. Watonwan County, Minnesota, awarded contracts for grading 22½ miles of road; Spokane County, Washington, let a $165,500 road job, the work involving 130,000 cu. yds. excavation and 108,000 sq. yds. Warrenite; Wilmington, Del., awarded contracts for 100,000 sq. yds. street paving and will call for bids shortly on 110,000 sq. yds. additional.

Bridges.—Bids have been taken on several large bridge jobs, and other work of considerable magnitude came up for advertising. The Pennsylvania R. R. opens bids June 23 on a 1,600 ft. reinforced concrete and steel bridge over Schuylkill River to cost $300,000. The city of Buffalo, N. Y., will readvertise the work of reconstructing the Chicago St. viaduct, a $185,000 job; A. J. Yawger Co., Indianapolis, Ind., at $89,200, was low bidder on county concrete bridge at Wood St., Hamilton, O.; bridge contracts amounting to $210,000 were awarded by Floyd County, Georgia; grade crossing elimination work at Buffalo, N. Y., totaling $155,000, was let; contract for $79,800 bridge over Millica Creek was let by the freeholders of Atlantic County, New Jersey. The new work advertised includes two bridges for the city of Seattle, Wash., to cost about $910,000, and a $150,000 bridge for the city of Indianapolis, Ind.

Drainage and Irrigation.—No particularly large jobs in either the drainage or irrigation fields appear to have reached the call for bids stage during the past week. Several small drainage undertakings in Minnesota are being advertised, and in North Carolina the drainage commissioners at Salisbury are asking bids on a 331,000 cu. yd. project. The Trustees of the Sanitary District of Chicago are asking proposals on two contracts, one calling for 175,000 cu. yds. of excavation on the main channel, the other for improvements in the shore channel.

Waterworks.—Covington, Ky., is calling for bids on furnishing 3,600 tons cast iron pipe; Gloucester City, N. J., is asking bids on waterworks equipment; Le Roy, N. Y., opens proposals June 25 on waterworks improvements to include earth dam, fiytration plant and 25,000 ft. of mains; Oakfield, N. Y., is asking bids for waterworks to include 4 miles of mains; Rittman, O., opens proposals June 29 for waterworks; Moorhead, Minn., is advertising for 300,000 gal. elevated tank, pumps and water mains.

Sewerage.—Sewerage undertakings reaching the call for bids stage this week are fewer than usual. Scarsdale, N. Y., is asking bids on sewerage extension totaling 22,900 ft.; Cleburne, Tex., awarded a $144,000 contract for sewer construction; San Francisco, Cal., let a $65,000 job

Rivers and Harbors.—The commissioners of the Port of New Orleans are asking bids on 2-story wharf-house, 120 ft. by 2,000 ft., and Warehouse D, 150 ft. by 580 ft., both reinforced concrete construction, for the cotton warehouse and terminals. Walter H. Denison, Memphis, Tenn., was awarded contract at $94,842 for 660,000 cu. yds. of levee work in Third District.

Some Union Requirements.

Building contracting is becoming more complicated every day. At a recent letting for a schoolhouse in an eastern city, after the bids had been opened and canvassed, labor leaders announced that their unions would insist that certain materials to be used in the construction must come from union shops. Unless this was done the workmen would refuse to handle the material. No notice of this requirement was made by the unions prior to the opening of the bids. As a consequence the contractors had neglected to provide for the increased cost in their estimates. In this particular instance the successful bidder, in order to avoid labor troubles, will have to pay $4,000 more for his materials than he had figured on paying. Had the contractor been notified in advance he could have allowed for this contingency in his bid. As it is, his profits will be reduced by the difference in the cost of the materials he had intended using, and the ones he will have to use.

Two Prosperity Promoters.

The Pennsylvania R. R. and the city of Philadelphia are doing their share towards bringing about a return of prosperity. The railway company last week placed orders for 155,500 tons of rails; a few weeks ago it gave out contracts for cars and other equipment calling for an expenditure of perhaps $20,000,000. In addition it is going ahead with the building of its great terminal in Chicago, and it also has many other construction projects under way or planned for the immediate future. Philadelphia probably is undertaking more construction work this season than any other American city. It already has let numerous large contracts and has many more in contemplation. If more railroads would do as the Pennsylvania is doing and more cities would imitate Philadelphia, there would be better times for everybody.

Flood Prevention Work.

Flood prevention work in Ohio will furnish some big construction jobs—some time. And this sometime is not so far distant either. Already formal action has been taken by two districts, and on June 4 the Ohio Supreme Court handed down a decision removing thhe principal legal objections to beginning the work. The court held that the Conservancy Law, under which the improvements will be carried out, was constitutional. This settles the great fundamental questions involved in the law itself. The organization of the Conservancy Districts can no wgo ahead. In the Miami Valley District the engineering is now several months in advance of legal developments, so unless something unforeseen develops it is likely that some of the largest earth-moving operations ever undertaken in this country soon will be ready for contractors.

9-ct. Levee Work.

Unusual disturbances were noticed on May 26 in the cemeteries along the Mississippi River. The old-time contractors were turning over in their graves as a result of the prices obtained at the levee letting at Memphis. Exceptionally low bids were secured on the 3,866,000 cu. yds. of earth work offered at this letting. On certain sections prices as low as 9 cts. and 10 cts. per cubic yard were submitted. On other sections bids of 11 cts. and 12 cts. were received. The low figures were based on the use of machines for constructing the levee, but even on the team and scraper work the prices were unusually low.

The Lighter Side of Engineering and Contracting

DURING the construction of the new Rock Island line in Arkansas numerous rattlesnakes were encountered. One of the gangs on the work was composed of Italians from the north and they had never seen a rattler. They naturally were quite alarmed at the possibilities of being bitten. Their foreman reassured them by telling them that a rattlesnake never struck without first giving warning, by sounding his rattle. One day one of the Italians seated himself on a log. A big rattlesnake without wasting time for any preliminaries promptly struck at him. The man glanced down and by a quick jump saved himself from being hit. When he had put about a 100 yards between himself and the reptile the Italian paused and shouted indignantly: "Hey you, why you no ringa da gong?"

* * *

MIKE CARROLL, the grading contractor, was showing a friend over his camp, when the cook sounded the call for dinner. Immediately there was a grand rush for the tent. One of the skinners who was well in front stubbed his toe on a root and fell flat on his face. He made no attempt to get up and Mike's friend thinking that the man was seriously injured ran over to assist him. "Are you hurt?" he inquired anxiously. The man rolled over on his back. "No, I ain't hurt." "Why don't you get up then and get something to eat?" The skinner sat up and pulled out his pipe. "What's the use" he replied, "they've eat it all up by this time."

* * *

IRA CROSBY, one of the biggest of them in his day, made his stake and retired from the contracting game some years ago. He now spends most of his time on his stock farm back in New England. He has several horses that show well in the races, but his especial favorite is a driving mare. To hear him tell it you would think this animal was the original breaker of all records. As an illustration of the prowess of his favorite he recounts this "true" happening: "Last summer I was out driving in a light buggy. My dog trotted along behind. I saw a thunder storm coming down the valley so I turned the mare and headed for home. Just as I reached the edge of the dry bridge, 6 miles from the farm, the storm broke and it began to rain. I gave the mare a free rein and we raced down the road ahead of the storm, and do you know we went so blamed fast that not a drop of rain fell in the wagon, but the dog keeping along 3 ft. in the rear, why he swum all the way."

* * *

Here Is a Game We'd Like to See.

WINNING the world's baseball championship has rejuvenated the venerable national pastime down Boston way. An evidence of this comes in the announcement of a baseball game between teams representing the New England Water Works Association and the Boston Society of Civil Engineers. The game will be played June 16, the occasion being the joint annual field day and excursion of these societies.

It is reported that the Boston society has a very strong nine and expects to win. On the other hand, the New England Association has among its members men who have played ball since Sebastian Cabot was cruising around in the offing. The water works men threaten to ring in Bill James and Hank Gowdy to do the battery work. The further threat is made that if these worthies do not show up there will be an equally capable substitute battery present.

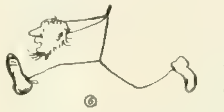
We dare anyone who sees the game to write it up for publication in this department.

* * *

MURPHY had begun with a pick and Mrs. Murphy had "rassled" the pots for Tim and "the boys" who boarded with the "ould man." But Tim was of the old Fenian stock. In a few years he was a boss and then in a few more years a contractor and a power in the ward. As Murphy gained in prosperity and position Mrs Murphy also came up in the world, and set about resolutely not only to forget the old days herself, but to discourage their recollection by others. Being a lady with a resourceful vocabulary and a sharp tongue there were few who had the temerity to refer to the time when she knew more about Irish stews than she did about English stewards. In his prime Murphy passed away and his many friends sincerely mourned and bore flowers to his bier. There were the "gates ajar" and the cross, and the wreath, and pillows and, above all, the glorious anchor of hope. And when all was ready the widow came to give her word whether all was as she would have it. "Ochone! Ochone! It is a bad day for me, Tim, me man, the day that you are gone; But it is a proud day it would be to you could you see the remembrances of your friends. The "gates ajar" ready to your feet, the wreath of eternity, the cross of salvation, the pillow of eternal rest, and here, above all—who the divil sent that pick"?

* * *

IN the good old days of the nine-million dollar improvement of the Erie Canal "Pliny" McNaughton of lively fame had many contracts between Buffalo and Lockport. This work called for cofferdamming several lock sites. Elimination of water was one of the tasks at which "Pliny" always worked earnestly and with prevailing success, but these cofferdams developed a much becursed ability to develop leaks and the genial "Pliny" devoted many night hours to watchful waiting for the next break in his sheeting. When, therefore, the rare occasion happened that the good fellow could sleep on a sheet and not on a sheet pile, he felt small patience at interruptions. One night "Pliny," who had gone home for a night's sleep, showed up three hours later at the "Iroquois" and demanded a room *without* a bath. The boys in the lobby were curious. "Thought you went home to sleep," ventured one of them. "Couldn't sleep," said "Pliny," wife's got lumbago or something and has to keep on cloths soaked in water. Every time she got up to change the cloth and let the water run I thought I heard another cofferdam leak and woke up with a scream. I'm going to get a room here and get some sleep. Say, clerk, if this room's got a bath or any water in it outside a pitcher, I'll put you out of business. Good night!"



* * *

THE late William H. Brown, for many years chief engineer of the Pennsylvania railroad, took especial pride in the many notable bridges that had been constructed under his direction. One time Mr. Brown was introduced to a clergyman as the greatest bridge builder in the world. The minister, thinking to show the futility of human effort, said: "Mr. Brown, could you construct a bridge from here to heaven?" Without a moment's hesitation the engineer replied: "Yes, if you will furnish the abutments."

* * *

Skinner Mulvey says: "I'm goin' up to Chicago to see them invisible skirts they say women folks be wearin' this year. Mike Conway says 13's an unlucky number. He bid 13 cts. on a job and it cost him 27."

DEVELOPMENT OF PORT OF BOSTON.

Plan for Future Improvement of Harbor Facilities.

Pier Construction—Warehouses—Industrial Facilities—Railway Connections.

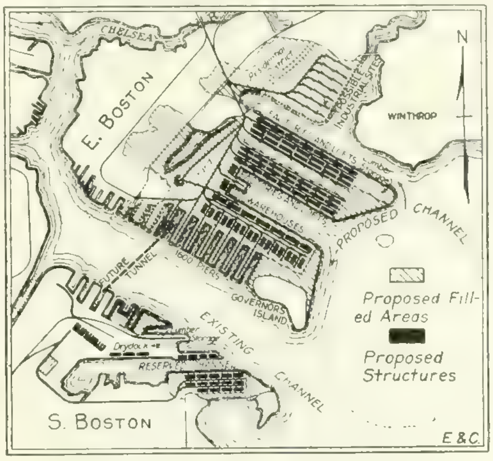
A comprehensive plan for the future development of the harbor facilities of Boston, Mass., has been submitted to the General Court by the directors of the Port of Boston. The plan requires modifications of the United States pier and bulkhead lines and a corresponding revision of the existing harbor lines of Massachusetts. This latter feature has been provided for by an enabling act passed by the state legislature. The proposed changes also have been submitted for approval to the Secretary of War and a hearing in the matter was held by the U. S. Engineer on May 25. The suggested development is shown in the accompanying map. It is expected that the plan outlined will proceed upon a unit basis, by the construction of piers at such times as they may be leased or otherwise disposed of for a return that will cover an amortizing interest on the cost.

The main features of the plan provide for developments at South Boston and East Boston. At the first mentioned locality the filling of the Commonwealth flats has been in progress since 1874 and the state now owns an area of 163 acres at this point. The suggested development here provides for a wholesale provision market to be located north of Summer St., an industrial development south of Summer St., distributing warehouses along the Reserved Channel, and a dry dock at the easterly end of the Commonwealth flats. The dry dock contemplated is 1,200 ft. in length. In addition it is proposed to fill 80 acres of flats south of the Reserved Channel and use this area for industrial purposes.

The South Boston development also proposes the filling in of another area south of the Reserved Channel and its use as an extension of the park system now extending along the southerly side of South Boston around Pleasure Bay to Dorchester. Railway connections would be supplied by the electrification of the Union Freight R. R. and the extension of its tracks from Atlantic Ave. across Northern Ave. bridge to a connection with the yards of the N. Y., N. H. & H. R. R. and the yards of the Commonwealth at South Boston. In addition the plan contemplates an extension of tracks from the Boston & Albany line at Cottage Farm to connect with the New Haven line at the South Bay. This extension would be partly on filled land and partly by subway. A railway tunnel connecting the yards at South Boston with the railway system in East Boston also is shown on the map. The tunnel connection, however, would be very expensive to build and it probably will be many years before its construction is started.

The proposed development for East Boston includes steamship piers, warehouses for steamships, a central power plant and other improvements. Between Jeffries Point and Governor's Island there is a frontage of nearly a mile available for the construction of modern steamship terminals along similar lines as established by the state in its development of its flats at South Boston. The pier head lines at South and West Boston would be over 3,200 ft. apart. This frontage is adjacent to the main ship channel dredged and maintained by the United States government. The piers would be 1,600 ft. in length, with dockage space of 350 ft. To the north of the proposed piers an area of 1,500 ft. in width would furnish locations for the necessary warehouses, grain elevators and other structures. To the north of the warehouses there would be a dock 1,500 ft. in width. This would serve as an inner anchorage basin. At the head of this basin a site has been reserved for a central power plant. A car storage and switching yards of sufficient size to accommodate all cars designed for East Boston would be located to the west of the power plant.

Under the proposed plan a filled area east of Wood Island Park would be devoted to factory sites. This would give about 500 acres for the location of plants. Wood Island Park would be extended southerly from its present location and a large swimming and boating basin added. An anchorage basin dredged to a depth of 30 ft., now exists between the main ship channel and the proposed location for the piers in East Boston. This basin would serve as the approach to the pier. The Grand Junction branch of the Boston & Albany R. R. would be extended along the East Boston water front, turning northerly along the proposed railroad yard and running to the west at the northerly side of Wood Island Park, making a connection with the present line of the Boston & Maine R. R. near Chelsea River. Provision also has been made for the extension of the metropolitan park system by a boulevard from Beachmont across Breeds Island to Wood Island Park.



Development of Port of Boston.

In submitting its plan to the General Court the Port Directors state that they do not contemplate or expect at this time, or even in the immediate future, that appropriations sufficient to carry out the entire plan will be made.

A $25,000 Dam Job Near Akron, O.

An excavation and concrete job of interest to smaller contractors is being advertised by the State Superintendent of Public Works at Columbus, O. The work calls for the construction of a dam, waste weir and flood regulation gates at East Reservoir, Portage Lakes, near Akron, O. The legislature appropriated $25,000 for this improvement. There will be an earthfill dam 550 ft. in length with a maximum height of 22 ft., a 30 ft. top width and a 112 ft. base. The dam will have a reinforced concrete cutoff wall resting on interlocking steel piling. The waste weir will be constructed of reinforced concrete and will be crescent shaped. At the foot of the apron, which extends nearly 100 ft. downstream, there will be steps to serve as a public landing for the users of water crafts. There will be two regulating gates, circular in shape and 30 in. in size. The dam will carry a 23 ft. roadway. The crossing at the apron will be made by a 28 ft. reinforced concrete arch.

Bids for the work will be received until 2 p. m., July 1, by John I. Miller, Superintendent Public Works, Columbus, O.

The headquarters of the American Electric Railway Association are now located at 8 West 40th street, New York City, instead of 29 West 39th street, as formerly.

ST. MAURICE RIVER STORAGE PROJECT, QUEBEC.

Bids Taken on Reservoir to Have Capacity of 160 Billion Gallons.

Concrete Dam 1,720 Ft. Long and 80 Ft. Maximum Height.

The Quebec Streams Commission is about to start construction on a storage reservoir having a capacity of 160,000,000,000 cu. ft. of water. This project, one of the first to be taken up by the Commission, has for its object the regulation of the flow of the St. Maurice by means of a storage dam to be erected above La Loutre rapids.

The minimum flow of the river, according to records of daily observations at Shawmigan from 1900 to 1912, is 6,000 cu. ft. per second. This is the figure for the average lowest day for the period. The average lowest week was 6,907 cu. ft. per second, and for the average lowest three months the flow was 8,477 cu. ft. per second. It is estimated that the minimum flow available after the storage reservoir at La Loutre is built will be as follows:

Days.	Cu. ft. per second.
For 150	12,345
For 200	9,317
For 250	7,417
For 300	6,172

The carrying out of this development involves a number of interesting and somewhat unusual features. The work is located in the wilderness, 40 miles from the nearest railroad. The temperature at the site of the dam varies from 80° F. in summer to 60° below zero in winter. Ice begins to form in the fall and reaches a thickness of 26 ft. in midwinter.

The dam will be located 2½ miles above La Loutre rapids, or 4 miles above the mouth of the Wabano River and will be about 50 miles from Weymontachingue, Que., and about 40 miles from Parent, Que., the latter being a divisional point on the Transcontinental Ry. The main features of the work will include the following: A storage dam about 1,720 ft. in length, the plan of which is a broken line, formed of four straight lines intersecting under an obtuse angle; a measuring weir of reinforced concrete, 375 ft. in length and its abutments and wing walls; a power house, two gate houses and gauge house, a sluice for logs and rubbish; ten gates 7½ ft. by 10 ft., capable of discharging 18,000 cu. ft. of water per second; generators driven by two turbines, and a heating system for the gates.

The storage dam will be of the gravity type and will have a maximum height of 80 ft. above the foundation. It will have a width of 20 ft. at the crest. The spillway portion of the dam will have a total length of 865 ft. and its top will be 10 ft. below the crest of the remaining part of the dam. The bulkhead portion of the dam will be about 435 ft. in length, and the section containing sluice gates and power plant will be about 365 ft. in length. The bulkhead section will have a base width of about 60 ft.; the base width of the spillway will be about 48¾ ft. The dam will be constructed of cyclopean masonry laid on concrete of a 1:2½:5 mix.

Investigations at the dam site indicated that on the east side and on the island bed rock was covered with a layer of earth and moss from 1 ft. to 3 ft. deep. On the west bank 15 ft. test pits were dug to an average depth of 14 ft. before reaching rock. A bed of sand from 6 ft. to 8 ft. deep was found, and this can be used in making the concrete. The dam will be founded on Laurentian gneiss, rough with erosion, but free from seams and fissures.

One of the principal difficulties for the contractors will be the transportation of material and supplies. Various routes have been investigated. One of these begins at Weymontachingue, and runs along the east bank to the head of the Chaudiere falls. There it crosses the St. Maurice by means of a bridge and runs along the western bank to the dam.

estimated distance by this route is 45 miles. It would involve the building of a bridge at a point where the river is about 70 ft. wide with rock banks. Investigation also has been made for a route from Parent to the dam site, and for a line suitable for laying out a wagon road or railway from Weymontachingue to La Loutre rapids. This latter route would be about 40 miles in length. In some of the engineering work a canoe route by way of the St. Maurice was employed. The total distance by this for canoes was 52 miles, of which 2¼ miles were for 7 portages. It took two good men three days to transport 1,200 lbs. of provisions by this route. The return trip was made in a day and a half.

The bids for the construction of the La Loutre storage dam were opened on June 15, at the office of the Quebec Streams Commission, Parliament Bldg., Quebec, Que. O. Lefebvre is chief engineer of the Commission.

NINE CENT LEVEE WORK.

Low Prices Obtained at May 26 Letting.

Bids Received at Memphis, Tenn., on 3,866,000 Cu. Yds. Earth Work.

Nine cent levee work was a feature of the letting at Memphis, Tenn., on May 26. Bids were opened on this date by Maj. E. M. Markham, U. S. Engineer, on 3,866,300 cu. yds. of earthwork in the Upper St. Francis, Lower St. Francis and White River Levee Districts. In all 31 different contractors submitted bids, and some exceptionally low prices were obtained. The letting attracted much attention and earth moving contractors from many sections of the country were in attendance.

The levee will be put up to grade with 8 ft. crown and 3 to 1 slopes. One foot topping will be added on the 8 ft. crown. The banquet will have 40 ft. crown, 20 to 1 crown slopes and 4 to 1 back slopes.

The work in the Upper St. Francis Levee District, amounting to about 1,920,000 cu. yds. was divided into 14 sections. On all of these sections Roach, Stansell & Lowrence Bros., Memphis, bid 13.9 cts. This bid was based on securing all of the work in the district. Yale & Regan, Chicago, submitted a bid of 13¼ cts. on several of the sections, and Rodgers Bros. put in bids of 12.8 cts. It is understood that the low bid of Yale & Regan was based on the use of a tower cableway excavator. The Oglesby Construction Co., Memphis, Tenn., bid 10 cts. a cu. yd. on two sections and 9 cts. a cu. yd. on seven sections. The bids of this company for all of the work in the Upper St. Francis District was recommended for acceptance. The Oglesby Co. has been working on a 240,000 cu. yd. levee enlargement job near Waverly, Ark. On this work it has been using the tower dragline excavator described in our issue of May 12, 1915. The bids on the work in the Upper St. Francis District presumably are based on the use of this machine.

The yardages, average height and high and low bids on each section of the work in the Upper St. Francis District were as follows:

Section.	Cu. yds., thousands.	Av'ge height, ft.	No. bids.	High bid, cts.	Low bids, cts.
1	170	18	16	35	13.9[1]
2	115	17.5	16	30	13.9[2]
3	140	15.9	16	26.5	13.9[3]
4	100	15.9	17	26.5	12.8[4]
5	102	14.6	17	26.5	12.0*
6	102	14.5	17	26.5	11.0*
7	100	14	17	26.5	10.0*
8	100	14	17	26.5	10.0*
9	158	17	15	26.5	15.75[5]
10	120	17	16	26.5	9.0*
11	110	14.8	16	26.5	9.0*
12	100	14.8	16	26.5	9.0*
13	112	14.7	16	26.5	9.0*
14	112	14.5	16	26.5	9.0*
15	142	17	16	30	9.0*
16	141	17	16	26.5	9.0*

*Recommended for acceptance.
[1] Bid recommended for acceptance was 20 cts.
[2] Bid recommended for acceptance was 18 cts.
[3] Bid recommended for acceptance was 16 cts.
[4] Bid recommended for acceptance was 13.6 cts.
[5] Bid recommended for acceptance was 16.56 cts.

The construction in this district is all new work and banquette. It comprises about 8 miles of new levee with a standard 40 ft. banquette, beginning at a point about 3 miles below Dorena Ferry Landing, opposite Hickman, Ky. All of the work is riverside brim.

The work in the Lower St. Francis District amounted to 1,333,000 cu. yds. and was divided into 9 sections. Sections 1 to 4 form a continuous stretch beginning 3 miles above Golden Lake, Ark. The first six sections call for enlargement and are riverside work. Sections 7 and 9 are landside work with banquette. A portion of Section 8 (sta. 145/11 to 146/15) is presumably steam shovel and car work. The high and low bids on the various sections in this district were as follows:

Section	Cu. yds., thousands	Av'ge height, ft	No bids.	High bid, cts.	Low bids, cts.
1	73	19.6	9	20	15.65
2	50	17.[illegible]	9	18.5	15.65
3	90.5	16.8	8	23.9	15.65
4	126.5	20.8	9	25	15.65
5	110.6	26.3	10	29	18.0[1]
6	100	27.1	9	29	18.8[1]
7	124	26.1	8	30	19.5*
8	140	29.8	5	36	21.8*
9	218.7	26.5	11	29	17.0[2]

*Recommended for acceptance.
[1] Bid recommended for acceptance 19.5 cts.
[2] Bid recommended for acceptance 17.5 cts.

There were not so many bidders on the work in the Lower St. Francis District, nor was there so great a range of prices, as in the upper district. M. C. Connors, Chicago, Ill., at 15.65 cts. respectively, was low bidder on Sections 1 to 4 inclusive. The other low bids on these sections were 16 cts. on sections 1, 2 and 3 and 15.75 cts. on section 4, and 17.4 cts. on the four sections. Roach, Stansell & Lowrence Bros. & Co. bid 18 cts., 19.5 cts. and 19.5 cts. on sections 5, 6 and 7, and these bids were recommended for acceptance. The bid of 21.8 cts. on Section 8, of Yale & Reagan, Chicago, Ill., was recommended for acceptance. M. C. Connors bid 21.9 cts. on this section. On section 9 Roach, Stansell & Lowrence Bros. & Co. bid 17.5 cts. and this was recommended for acceptance.

The work in the White River Levee District is divided into four sections, the total yardage being 623,000. It begins 2 miles below Fair Oak, and runs continuously for 4 miles to a point 1½ miles below Dawson's Landing, Ark. It is all enlargement work. The high bids, low bids, and number of bidders on each of these sections were as follows:

Section.	Cu. yds., thousands.	Av'ge height, ft.	No. bids.	High bid, cts.	Low bids, cts.
1	158	5	13	25	18.2*
2	146	5.1	13	24	18.2*
3	144	5.3	13	22.5	18.0[1]
4	175	5.7	13	28	18.2*

*Recommended for acceptance.
[1] Bid recommended for acceptance 18.2 cts.

The 18.2 ct. bid of Rodgers Bros., Memphis, Tenn., on all of the work in the White River District was recommended for acceptance. It was provided in this bid that if awarded all of the work in the district they would do it for 0.1 ct. less per cubic yard than the prices bid on the individual sections.

A $120,000 Bascule Bridge Contract.

The Board of Public Works of San Francisco, Cal., is calling for bids on a bridge undertaking that will cost in the neighborhood of $120,000. This work provides for the construction of a bascule bridge over the Channel St. Waterway at Fourth street. The bridge will be a double track, pony truss, highway Strauss trunnion bascule with a 40 ft. clear roadway and two 6-ft. sidewalks. The length of the moving leaf will be 94 ft., and it will be carried on trunnions resting on trunnion bearings supported on structural steel posts.

This leaf will be counterbalanced by a reinforced concrete counterweight, pin connected to the tail ends of the bascule trusses, and maintained in a vertical position during the operation of the bridge by means of structural steel links. The operating machinery will consist of two trains of gears operated by two motors. The equipment will include an operating pinion which engages cast steel racks bolted to the tail ends of the trusses. The motors will be of the series wound direct circuit, heavy duty, Crane type K, Westinghouse, or equal. The current will be furnished at 240 volts.

The improvement also requires the removal of all piles, fenders, foundations, masonry and steel superstructure of the present Fourth street draw bridge, and the construction of a new reinforced concrete substructure, supported on concrete cylinders. In addition there will be a section of sea wall supported on piles and a paved reinforced concrete dock approach supported on reinforced concrete piles. This will connect the foundations with the sea wall.

Bids for the construction of the bascule, the substructure and approaches will be received by the Board of Public Works, San Francisco, Cal., until 2 p. m., June 23. M. M. O'Shaughnessy is city engineer.

Los Angeles Can Sell $6,500,000 Power Bond Issue.

The last legal obstacle to the sale of the $6,500,000 power bonds authorized by the electors of the city of Los Angeles, Cal., on May 8, 1914, has been removed. The State Supreme Court has handed down a decision holding that the bond issue is valid. Bonds to the amount of $1,482,000 have been printed and when sold the proceeds will be used in completing the San Francisquito Canyon power plant and in providing for the transmission of the power to some central point in the city and its distribution. The remainder of the proceeds of the bond issue will be used in acquiring the property of the Edison Co. now in process of condemnation.

Water Works Improvements to Cost $1,600,000 for St. Paul, Minn.

Improvements to the waterworks of St. Paul, Minn., requiring an estimated expenditure of nearly $1,600,000, are recommended by Allen Hazen, Consulting Engineer, New York City, in a report submitted last month to the Water Board of the city. The improvements and their estimated costs are as follows:

Storage reservoir on Rice Creek	$489,000
New high service reservoir	260,000
Filtration plant	475,000
Pure water reservoir	30,000
Aerator, pump and connections	25,000
Low service reservoir	25,000
Pumping station equipment	70,000
Piping from low service pumps to low service reservoir	10,000
Engineering and contingencies	207,000

About 60 per cent of the city of St. Paul is supplied by the Water Department, the remaining 40 per cent obtaining its supply from wells. The artesian wells in the central part of the city have been worked nearly to their economical limit and deep well pumps are now being employed in many of the downtown wells to obtain a supply. The report states that the municipality cannot hope to get an additional supply by sinking wells in the city. As an emergency measure wells could be sunk outside the city and the water piped in, but in this event the city might be liable for damages by destroying the value of wells in the vicinity of its municipal wells.

The report asserts that the city can best increase its supply by adding to the capacity of its surface sources. By building a dam on Rice Creek and raising the level of the Rice Lake system and other lakes in that vicinity, it is believed the city would be assured of a daily supply of 30,000,000 gals., which is double the present supply. To improve the quality of the water the construction of a filtration plant at McCarron station is recommended. This would have a daily capacity of 35,000,000 gals. There also would be a covered pure water reservoir of 3,000,000 gals. capacity, costing $30,000. The other recommended improvements include a new high service reservoir with a capacity of 30,000,000 gals., as a part of a 60,000,000 reservoir; a covered low service reservoir; a 15,000,000 gal. high service pump and two 6,000,000 gal. low service pumps.

To temporarily improve the quality of the water, the installation of a testing laboratory on the lake system, the use of copper sulphate, an aerator at the high service reservoir and the use of screens are recommended. The plan provides that when the city outgrows the increased supply to be secured from the outlined improvements, it can obtain unlimited water from the Mississippi River. The waterworks of St. Paul are in charge of the Bureau of Water of the Department of Public Utilities. Garrett O. House is General Superintendent.

15 Bridges and Culverts for Bureau Township, Illinois.

A bridge and culvert letting in Bureau County, Illinois, of interest to contractors specializing in smaller undertakings of this kind, is now being advertised. The work on which bids are being taken calls for the construction in Bureau Township of four bridges and two culverts, all of reinforced concrete construction. In addition, however, Bureau Township has six smaller bridges and culverts in the vicinity of the advertised work which will be let by private contract, and may be advantageously taken by the contractor for the rest of the work. There are also three county aid bridges in this township, two 30-ft. spans and one a 16-ft. span, that will be let soon by the County Road and Bridge Committee.

The work on which bids will be received until 1 p. m., June 27, by the Town Clerk, at his office 1 mile west of Wyonet, is as follows:

Name.	Span, ft.	Height over all ft.	Reinf. concrete, cu. yds.	Reinf. steel, lbs.
Wallace	16	13	61.4	5,389
Young	14	13	52.3	4,160
Drayman No. 1	16	9.4	36.2	4,535
Drayman No. 2	16	9	34	4,393
Harrington	10	7½*	35.2	3,732
Crossing	10	6*	45.8	4,514

All above except last have 20-ft. roadways: Crossing culvert has 24-ft. roadway.

*Culvert; inside height.

The nearest railroad is the C. B. & Q., at Kasbeer and at Walnut. The distance from each structure to Kasbeer is about as follows: Drayman Nos. 1 and 2, 7 miles; Young, 7¾ miles; Wallace, 8¾ miles; Harrington, 10¾ miles; Crossing, 11 miles. From Walnut, Young, 5¾ miles; Drayman Nos. 1 and 2, 6; Wallace, 6¼; Harrington, 8¾; Crossing, 8½.

Quotations have been received offering screened and washed stone and sand delivered at Kasbeer for 90 cts. per ton; delivered at Walnut price might be 5 cts. higher freight. Local material is scarce and of poor quality, and its use will not be permitted unless it is brought up to specification requirements in every respect. The present wooden bridges are to be removed. Test borings indicate sound bottom of clay basis at a depth of 1 ft. to 3 ft. at all bridges except Drayman No. 1 and Drayman No. 2, where black soil extends at least 5 ft. but probably will give a foundation. Work is to be completed on or before Oct. 1, 1915. Plans and specifications were prepared by the County Superintendent of Highways, Princeton, Ill.

NEWS LETTERS

St. Louis Items.

Miss Elizabeth Smith, an attractive and pretty young lady of Danville, Va., became the bride of Mike Costello on June 1st. The wedding was solemnized at the residence of Rev. A. J. Halbleib in Danville, Va. After the ceremony Mr. and Mrs. Costello departed for an extended trip through the west and are going to take in both expositions on the coast before their return east. The bride and groom are expected to arrive here on their return about July 1st, and a noisy welcome is awaiting their arrival in St. Louis, where Mike was born and raised. We wish to extend our heartiest congratulations to the newlyweds.

Costello Bros. have finished their work on the Southern R. R. at Danville, Va.

Judge Sanborn of the Federal Court has issued an order authorizing the Frisco receivers to purchase 27,000 tons of 90-lb. steel rails for replacement on various portions of the Frisco main lines, equivalent to 150 miles. The amount involved is $800,000 and the contract will be awarded at once. This will place the main line system in fine physical condition for the heavy crop traffic movement in the fall.

H. W. Nelson Co. has moved its office from 14 S. Canal St. to 210 S. La Salle St., Chicago. At the present time the H. W. Nelson Co. has between 400,000 to 500,000 yds. of bridge filling on the Illinois Central R. R. and is working double shift to good advantage. It also has a job at Benton, Ill., on the Illinois Central R. R. of 15,000 yds. of shovel work and 30,000 yds. of team work. The team work was done by M. L. Windham and they expect to finish the shovel work there in a few days. They also have another job at Memphis of 150,000 yds. of levee work which they expect to finish by the first of the year.

Bids will be received by the city of St. Louis, Room 315, New City Hall, until 12 m., June 22, 1915, for furnishing and delivering at the City Pipe Yard 2,595 tons, more or less, of 3-in., 6-in., 8-in., 12-in., 20-in., 30-in. and 36-in. cast iron coated water pipe. Specifications, form of contract and other information can be had at the offices of the Board of Public Service and the Director of Public Utilities.

List & Gifford Construction Co. are increasing forces on their M. K. & T. R. R. contract in Oklahoma. Jack O'Callahan is head pusher on this job and Jack has a reputation of being some pusher on shovel work.

P. J. Hannon, Boatman Bank Bldg., St. Louis, Mo., would like to know the present whereabouts of John Lowrey, a colored camp cook who worked for him some years ago.

Geo. C. Smith & Sons are going to do the drag line work on Hickey Bros.' dam and reservoir job at Paris, Ill. They are going to send one machine over there and still have another one idle at Valmeyer, Ill., which they would like to place on any kind of a job suitable for drag line.

M. L. Windham has been in several times from Centralia, Ill., looking up work for his team outfit.

The McCarthy Construction Co. of St. Louis was awarded the contract for constructing two villas by the Board of Managers of the Missouri Sanitarium for the treatment of Incipient Tuberculosis at Mount Vernon, Mo. One building for adults will cost $24,245, and the other for children will cost $36,325. The money was appropriated at the last session of the Legislature.

The Fruin-Colnon Co. were awarded the contract by the St. Louis Basket & Box Co. to build a new two-story first-class warehouse at the foot of Arsenal St. here.

T. E. Brogan, the new sales agent of the Hercules Powder Co. here, has been busy since his arrival getting old matters and contracts fixed up. Says he has caught up with his work now and will be pleased to meet all of his friends when here in Room 1624 Pierce Bldg.

The Davis Commissary & Supply Co. secured the contract for boarding Owsley & Mann's men on their clearing job in the Little River Drainage District near Kennett, Mo.

A. B. Koenig.

PERSONALS

Mr. Joseph W. Hunter has been re-appointed as first deputy state highway commissioner of Pennsylvania.

Mr. Charles Saville has been appointed director of sanitation of the city of Dallas, Texas, under the recently organized Department of Health of that city.

Mr. Paul Lindholm, Engineer of Highways, Copenhagen, Denmark, has been awarded the Traveling Fellowship of the American Scandinavian Foundation for 1915-1916. He will devote the year to graduate work in highway engineering at Columbia University.

Mr. T. D. Kilkenny has been appointed city engineer of Vallejo, Cal., where a large amount of street paving is under way or proposed. Mr. Kilkenny graduated in civil engineering from the University of California in 1906, and for a year was employed as structural draftsman by the Southern Pacific. For two years he was assistant engineer for the Mt. Whitney Power Co., and then for a time was structural draftsman for the State Board of Harbor Commissioners. Since 1911 he has been assistant engineer with Haviland & Tibbetts, consulting engineers of San Francisco.

Mr. Claude L. James has been appointed superintendent of water works for the city of Mattoon, Ill. Mr. James has been city engineer of Mattoon for the past 14 years, and has also been retained as consulting engineer by a number of neighboring towns and villages. He was construction engineer on the Mattoon municipal water works, and will now be general manager of the plant. He also continues his consulting engineering practice.

Mr. Charles R. Pratt has opened an office at 55 Liberty street, New York City, as consulting engineer. Mr. Pratt will specialize in electrical operation of hydraulic and steam elevators. He has devised and perfected a system for applying electric drive to hydraulic or steam elevators and is prepared to undertake the design, construction and installation of all types of elevators, and to advise as to special requirements under varying conditions in plants.

Mr. J. W. Mavity of Lyndon, Kan., has been appointed city engineer of Wellington, Kan., and will have charge of a large amount of paving and sewer work which is to be done there this summer. Mr. Mavity has had twelve years of general engineering practice, including railroad, municipal, highway and irrigation work. For six years he was engaged in the design and supervision of construction of municipal work, including complete water purification plants and sewage disposal systems. For the past year he has been county highway engineer for Osage County, Kansas.

Mr. John A. Goetz has been appointed city engineer of Mattoon, Ill., succeeding Mr. C. L. James, who has been appointed superintendent of water works. Mr. Goetz has been in the engineering contracting business since 1908, and has been employed as construction engineer or superintendent on bridge work, pavements, etc. He was assistant superintendent of construction of the Grand avenue viaduct in Milwaukee, 1909-10. From 1910 to 1914 he was with the Goggin Construction Co. of Arcola, Ill., as construction engineer, and since that time has been in business in Mattoon as engineering contractor.

Professor Robert L. Sackett has resigned his position at Purdue University to accept the position of Dean of Engineering at Pennsylvania State College. Prof. Sackett received his degree in civil engineering from the University of Michigan in 1896. He is a member of the American Water Works Association and the New England Water Works Association, and an associate member of the American Society of Civil Engineers. He has been professor of sanitary and hydraulic engineering at Purdue University since 1907. Prof. Sackett has also served as consulting sanitary engineer for the Indiana State Board of Health, and for various state institutions and corporations.

Mr. Sydney B. Williamson, Chief of Construction of the U. S. Reclamation Service, has been placed in charge of the executive offices of the Service which have been established at Denver. Mr. Williamson is the engineer who under Colonel Goethals built the Pacific end of the Panama Canal. Mr. Williamson is to be the executive arm of the service in the field. All matters are to go through him to the Reclamation Service in Washington, where an office will be maintained in charge of Director and Chief Engineer Davis, Chief Counsel King, and Comptroller Ryan, by whom all matters of policy will be determined. Their orders will be carried out by Mr. Williamson. Secretary Lane has felt for a long time that the executive offices were too far removed from the projects themselves to have the work carried on with the greatest efficiency, the least friction, and the least expense. Mr. I. D. O'Donnell, supervisor of irrigation, will be retained in the field as expert on irrigation, cultivation of irrigated lands, development of markets, and all questions affecting the welfare of settlers and water users.

Mr. F. M. Billings has entered into partnership with Mr. L. R. Johnson for the practice of civil engineering under the firm name of the Billings-Johnson Engineering Co., with offices at 652 Spreckels building, San Diego, Cal. Mr. Billings is a graduate of the University of Arkansas, class of 1903. In 1905 he was connected with the Quartermaster's Department, and later with the U. S. Engineering Department at Fort Washington, Md. Following this he was engaged in railroad work in the west and in the latter part of 1906 entered the U. S. Reclamation Service, in connection with the building of the Huntley project. After some months he resigned and became chief engineer and general superintendent for the contracting firm of Hughes & Olsen, who were building the main canal and tunnels for this project. From there he went to Manzanillo, Cuba, where he had charge of the location of extensive highways for the Cuban government; and later of construction work for the Oliver Cuban Construction Co. For the past two and one-half years Mr. Billings has been in Spain for the Pearson Engineering Corporation, on its Ebro irrigation and power development project.

Mr. Johnson is a graduate of the Cincinnati Technical School and of the civil engineering department of Cooper Union Institute. He was connected with the engineering department of the Central Railroad of New Jersey for a time, and later in the estimating department, New York Central Railroad. For two years he was with J. G. White & Co., at Iloilo, P. I., as assistant and office engineer on construction of the Philippine Railway. In 1911 he went to Spain for the Pearson Engineering Corporation, where he established and was the responsible head of the Hydrographic Department, Cia. Riegos y Fuerza del Ebro, S. A., until the suspension of operations in September last.

Mr. Herbert M. Wilson, engineer in charge of the Pittsburgh Experiment Station of the United States Bureau of Mines, has resigned from the government service to become the director of a newly formed organization to be known as the Coal Mine Insurance Association. Mr. Wilson was closely associated with Director Joseph A. Holmes in the inception and development of the Bureau of Mines. Early in 1907, when Secretary James R. Garfield added a technologic branch to the United States Geological Survey, Director Charles D. Walcott of the Survey selected Joseph A. Holmes as chief of the new division and Mr. Wilson was appointed as his principal assistant. With the creation of the Bureau of Mines, Mr. Wilson became engineer in charge of the Pittsburgh station, a position which he has held ever since. Mr. Wilson was educated in mining as well as in civil engineering, graduating from the School of Mines, Columbia University, New York. He has spent the last eight years in developing mining experiments, including the use of explosives, experimental investigations in electricity and lighting, and especially in the mine-safety, mine-rescue and first-aid operations of the Federal Bureau of Mines. He is on the advisory council of the Underwriters' Laboratory, Chicago; is one of the organizers and is on the executive committee of the National Safety Council, and was the first president and is now the secretary-treasurer of the American Mine Safety Association. The Coal Mine Insurance Association, of which Mr. Wilson is to be the director, is a combination of ten American and British insurance companies that have associated themselves for the joint underwriting of coal-mine accident insurance.

Mr. George H. Biles, engineer of maintenance of the Pennsylvania State Highway Department, has been promoted to the position of second deputy state highway commissioner, made vacant by the resignation of Mr. E. A. Jones. Mr. Biles will also continue in charge of the maintenance division. George H. Biles was born in Philadelphia in 1879 and educated in the public schools of that city. In 1897 he took a technical course in engineering under I. W. Hubbard and Allan W. Fuller, covering a period of two years, at the same time being engaged as apprentice in the Fifth Survey District, under Walter Brinton, and working on other public and private engineering and surveying enterprises to pay tuition. He entered competitive civil service examination and was appointed chainman on a special corps of the Department of Public Works of Philadelphia, advancing to rodman, transitman, draftsman, and, in 1904, qualifying for principal assistant engineer.

In June, 1905, he was appointed chief draftsman in the State Highway Department, revising the system in the construction and drafting divisions, taking advanced steps in modern concrete reinforcing, applicable to bridge design, and establishing new methods of calculation and other features which are still in force. He was made division engineer in charge of the central and a portion of the eastern counties of the state in 1906, taking up the early experiments for the state in bituminous road materials and reporting the results of certain methods of construction to the Committee on Bituminous Materials of the American Society of Civil Engineers. As division engineer he laid out and supervised the construction of many miles of the state's finest highways, designing and constructing the famous Lewistown Narrows' Model Road, the first built under the Sproul Main Highway Act, and the River Drive out of the city of Harrisburg.

George H. Biles, Second Deputy State Highway Commissioner of Pennsylvania.

In December, 1912, he was assigned assistant to the chief engineer and in April, 1913, was appointed engineer of maintenance in charge of all the state highways and state-aid roads, approximating ten thousand miles. He organized the Division of Maintenance, standardizing and systematizing all the maintenance operations, purchasing machinery and equipment to meet the requirements of the division's forces and introducing scientific cost accounting and advanced business methods in all this work. In May, 1913, he passed civil service, with honors, for the position of assistant engineer to the Chief of the Bureau of Highways of Philadelphia. Being a close student of highway work, Mr. Biles has written and compiled, in book form, valuable information for use of road builders, with detailed instructions to the employes of the department in the construction, repair and maintenance of the various classes of highways. In addition to this he has prepared many technical papers and addressed highway and other conferences on the various phases of this subject.

OBITUARIES

John Simpson Gibson, secretary and treasurer of the Passaic Valley Sewerage Commission, died June 5 at his home in Newark, N. J.

Angus McCallum, a retired contractor of Grand Forks, N. D., who built the first railroad bridge across the Red River of the North for the Great Northern, died June 8, aged 83.

John Grant, paving contractor of Omaha, Neb., died June 5, aged 75. Mr. Grant has been a resident of Omaha since 1882, and was for many years the representative of the Barber Asphalt Co. When that company withdrew from Omaha, Mr. Grant organized the Grant Paving Co., continuing in the asphalt business and adding cement stone work.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces an examination as follows:

Illuminating Engineer; $1,200 per annum; not less than three years' drafting experience in connection with illuminating engineering and electrical work, or graduation from technical school and six months' practical experience. July 7-8.

NEW CATALOGUES

Road Oiler.—Paper, 5x8 ins.; 8 pp. Studebaker, South Bend, Ind.

Catalogue No. 1007, describing the Studebaker Gravity Road Oiler. Gives details of construction and operation, price list and list of extra attachments. Illustrated.

Cast Iron Pipe and Specials.—Paper, 8½x 11 ins.; 48 pp. R. D. Wood & Co., Philadelphia, Pa.

Sections and tables of standard cast iron pipe and special castings, based on specifications of American Society for Testing Materials and American Water Works Association. Describes briefly several especial devices, with half-tone illustrations.

Air Pumps.—Paper, 6x9 ins.; 22 pp. and inserts. Harris Air Pump Co., 224 W. McCarty St., Indianapolis, Ind.

Form 14, loose leaf bulletin, describing 20th Century pneumatic pumping system, and Harris air lift pumps. Points out the advantages of the air lift system, and the special features of the Harris pump, increased yield of well, method of cleaning wells, etc. Tables and data relating to pipe dimensions, friction of water, flow of air, etc., are also included. Illustrated.

CATALOGUE REVIEWS

Blast Hole Drills.—Paper, 8x10½ ins.; 64 pp. Armstrong Manufacturing Co., Waterloo, Iowa.

"Special Blast Hole Drills" is the title of the new Armstrong catalogue, B1, fresh from the press. The book comprises a great deal of data and general information on the subject and explains in detail the application and qualification of Armstrong equipment. Exhaustive cost and operating data are given and the cumulative profits resulting from the adoption of special blast cable drills by quarry operators are pointed out. Comparative costs of piston and cable drills are shown.

The requirements of the special equipment necessary for blast hole purposes are explained, and important operating features of Armstrong traction drill fully described and shown by photograph. Specifications for the tractor, tool and cable equipment and standard taper joints, drill operator reports, price list of necessary tools, description of special operating engine and its parts, letters of reference from users of the drills and photographs of actual operations are all included.

The book contains a mass of information and interesting illustrations. It is typographically well done, presenting a somewhat colorful appearance owing to the frequent use of the distinctive Armstrong trade mark, which tops each page.

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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An Interesting Example of Reinforced Concrete Construction.

If well designed and properly built, reinforced concrete can be used efficiently in much the same manner as is steel construction fireproofed, although when under direct tension it is used to greatest disadvantage. In building construction, unless the architect has a thorough knowledge of reinforced concrete, the structural engineer is likely to find his problem of designing the framework to conform to the architectural design a very difficult one. In many cases reinforced concrete can successfully compete with fireproofed steel construction, even when low cost is the governing factor, although considerations other than cost should be considered by the owner.

In the "Buildings" section of this issue we are publishing an article on the design and construction of the Chicago Hebrew Institute, an interesting example of reinforced concrete construction, and one built in competition with fireproofed steel construction. In this structure there are used: Both beam-and-slab and flat-slab floors; a concrete girder curved in two planes; a running track cantilevered from the columns; columns which end in cantilever brackets; thin girders which serve both as girders and partitions; curved roof girders which terminate in long supporting legs, or columns; and practically every form of construction possible with the use of structural steel.

It is true that some of the intricate constructions used are due entirely to the *requirements* of the *architects,* but it is also true that these problems were solved efficiently with reinforced concrete constructions. The erection of this building also involved a number of interesting construction problems, especially in the economic use of forms and falsework. A careful study of the design and construction features of this building may profitably be made by engineers and architects, as the structure offers more than ordinary problems in the use of reinforced concrete.

More Sewer Gagings Needed for Small Cities.

The volume of published data recording the results of actual measurement of flowing sewage is not large and such gagings are, as a rule, from the larger and the secondary cities. Such data pertaining to cities of 25,000 population and under are meager. For villages there are very few sewage flow records in a form readily available to engineers.

The old method of predicating the design of sewer sizes upon the assumption that the flow of sewage will equal the water consumption is falling into disrepute, and a more dependable guide is not yet generally available. In this issue we publish an account of the gagings made at Berkeley, Calif. It is interesting to note that in the residential district there gaged the water consumption was 50 gals. per day, while the sewage flow was only 34 gals. per day. Since it is desirable to keep sewer sizes as small as possible consistent with the requisite carrying capacity and freedom from clogging, both for economic and sanitary reasons, we urge the making of more gagings in sewers in small cities and towns.

Consulting engineers employed by small cities to design sewage treatment plants seldom gage the flow of sewage accurately even when the town is and has been well sewered for a long time. The flow is generally estimated from the population and water consumption. We believe sewage plant efficiency in such places would be increased by more care in design with reference to the actual flow to be handled. Many disposal plants are made too small from lack of funds or from underestimating the total sewer discharge, including infiltration, and other plants are made needlessly large from overestimating the flow. In many cases the city engineer would doubtless be willing to gage the sewers in co-operation with the consultant, preparatory to the design of the treatment plant. The requisite apparatus need not be expensive and the taking of records is not necessarily burdensome.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

The major portion of the sewage collecting system is usually constructed in a single season in small cities. This usually renders impracticable the gaging of district sewers for data to use in designing other district sewers in the same city. For this reason gagings of existing systems will have to be applied in the designing of new systems in other localities.

In thinking of agencies available for the making of such gagings one's thought readily turns to the student investigator. About 130 educational instiutions in this country are offering a degree in civil engineering. If two students in each institution work on sewer gagings each year for two or three years engineers will have available a large number of data on this subject. Senior engineering students are well qualified to make the necessary installations of measuring devices, to take off the readings and to compile the records. We suggest that thesis work along this line be undertaken in all parts of the country.

A Co-operative Organization of Engineers.

Any profession, to be most successful, not only must consist of men highly trained in the principles and practice of that profession, but its organization must be such that the general public is made conversant with its aims and accomplishments. Until principles are well established and are generally understood by the members of a profession, it is only natural that societies should be formed —both local and national—which are essentially technical in character. Even after principles and rules of practice have been established it is generally desirable that a national society—with entrance requirements purely technical in character—be maintained in order to furnish a convenient means of classifying the membership and of disseminating knowledge. These technical societies, however, from the very nature of their organization, are not well fitted to do the general publicity work which is so essential if the profession is to secure quick recognition by the general public. Some professions—like medicine and law—require little publicity work except that given by individual members in the regular conduct of their business, as the members of such professions generally deal directly with those engaged in other lines of work. It is interesting to note, however, that even these professions are constantly being given free advertising in one form or another by our newspapers.

In general, engineers in the regular conduct of their business deal either with other engineers or with an extremely limited class of men engaged in other lines of work. In this respect they are particularly unfortunate, as they miss the opportunity to secure recognition from others and also fail to secure the benefits of close intercourse with other men. Although these natural handicaps are evident, engineers have been exceedingly slow to recognize the need for educating the public to a realization of the aims and accomplishments of the engineering profession. Part of this inaction was to be expected, because it is only within recent years that the principles and rules of engineering practice warranted its recognition as a leading profession. Such is no longer the case, and we believe the time is ripe for co-operative action on the part of engineers. This action can probably best be secured by the formation of a society of engineers—national in scope—whose main object will be the consideration of matters not essentially technical. We believe the formation of a new society is advisable as the form of organization adopted by our existing societies is such as to promise little action along co-operative lines in the immediate future. It is highly desirable that existing societies co-operate with the new society, but from the nature of the work to be done a different form of organization is needed. As the main purpose of all engineering societies is to advance the interests of engineers, the new society should include in its membership those belonging to existing engineering societies, engineers who have no society affiliations, and anyone interested in engineering work.

A call has been issued by F. H. Newell, formerly director of the U. S. Reclamation Service and now head of the civil engineering department of the University of Illinois for engineers, to take part in a preliminary meeting, the purpose of which is to consider the organization of a co-operative movement among engineers. It is proposed to hold this preliminary meeting at Buffalo on June 23 or 24, 1915, at the time of the annual meeting of the American Society of Mechanical Engineers. As it is desirable that a representative body of engineers take part in this meeting it is requested that as many as possible attend it and be prepared to offer discussion. Even though it may be impossible to attend this preliminary meeting it is hoped that engineers and others interested in engineering will give the matter of organization and procedure careful thought, in order that quick and effective action may be possible.

Reinforced Concrete Floating Caissons for Marine Construction.

The multiplication of designs of reinforced concrete submersible caissons and the present extensive construction of such caissons are among the most notable developments in the use of reinforced concrete. American engineers moreover may justly credit themselves with an important part in this development, and this with more pride than usual, since in magnitude and boldness of marine construction European engineers have much greater opportunities for leadership. The first patent for reinforced concrete caissons was granted to an officer of the U. S. Engineer Corps, Lieut. Col. W. V. Judson, in 1901, and no engineer, perhaps, through technical articles and by actual employment of reinforced concrete caissons has done more to establish this utility as a means of marine construction. It was in Europe and not in America, however, that first use was made of caissons of reinforced concrete floated to position and sunk to sea bottom.

The place that the reinforced concrete caissons has occupied in marine construction is best demonstrated by citation of examples. Because they have not been extensively written about and because the Algoma, Manitowoc and Milwaukee reinforced concrete caisson breakwaters were most thoroughly written about by their designers, other examples of submersible caisson work in the United States have become subordinated in recollection. The caisson structures named were constructed in or prior to 1909. Since then such caissons have been employed by United States engineers for breakwaters for Racine and Sheboygan harbors on Lake Michigan, for light house structures on the Panama Canal, Lake Michigan, Detroit River and other places, and are planned for the new Chicago breakwater. Canadian engineers have also built or are building caisson structures at Goodrich Harbor, on the Welland Canal, and at Vancouver Harbor. The new Milwaukee water supply tunnel intake is substantially a caisson floated to place and sunk. Doubtless a careful inventory would bring other examples to the credit of this list, but the examples named establish the fact of prevalent and successful use of reinforced concrete caissons for marine construction in America.

In Europe, as stated above, actual construction of reinforced concrete caissons preceded their construction in America. They were used at Barcelona in 1905 and previously at Balboa and also at Rotterdam in 1905. Then follow records of their use in Denmark, at Toulon, Paris and Havre in France; in Egypt, at Alexandria; at Genoa, Italy; at Taupse, in Russia, and, finally, on the very greatest scale anywhere except possibly at Rotterdam, in the new harbor works at Kobe, Japan. Again it may be noted that this list would doubtless be lengthened were exhaustive search made for all examples.

One of the curious features of the development of the concrete caisson in marine work is that there seems to be evident no progressive increase in size. About as large caissons were built at Rotterdam in 1905 as have since been built anywhere. These facts can, perhaps, best be observed from the accompanying tabulation. The chronology is only approximate, but is close enough to accuracy to demonstrate the facts. Another fact to be observed is that while the pioneer invention of the reinforced concrete caisson belongs apparently to the United States, the most extensive use of such caissons has been in other countries. Canadian engineers in particular, have lately been doing some extraordinarily heavy caisson construction in their canal and harbor works. In a measure this Canadian work owes its inception to the success of Col. Judson with his breakwaters at Algoma and Milwaukee, but its latest developments are the work of native engineers.

Compared with practice abroad reinforced concrete caisson construction in the States and in Canada shows a distinctive peculiarity. While the European builders have sought lightness of structure by thin walls those of America have favored as heavy a construction as the required condition of buoyancy permitted. Few and thick walls and partitions are the practice in America; thus reducing the amount of form work and the amount of filling concrete to be deposited under more adverse conditions after the caisson has been sunk.

The success with which reinforced concrete caissons have been used in marine construction raises the question why progress in their use has not been made rapid. Col. Judson attributes this slow progress to the following circumstances:

(1) Engineers have been hesitating very generally to use reinforced concrete in sea water.

(2) In fresh water timber always covered is everlasting, and in some cases timber is still cheaper than concrete.

(3) For breakwaters caissons can not compete with rubblemound work where stone is cheap.

(4) The use of caissons makes necessary a great deal of careful and laborious preliminary study and work in the office, whereas the pigeon holes are full of plans for other kinds of structure.

(5) While a concrete caisson pier or breakwater may in the end be cheaper and better in a given locality than one of another type, yet for caisson work the initial expense and trouble for special plant are great, and this fact acts as a deterrent.

(6) Finally, there is the general objection to adopting anything new. Civil engineering is largely a matter of following precedents, and perhaps there are not yet enough precedents afforded by existing caisson structures to attract the average engineer to the use of them.

It is the concluding reason that has led us here to summarize briefly the "precedents" already afforded marine engineers. In this one respect the reasons given for the tardy adoption generally of reinforced concrete caissons for harbor lack much force.

Location.	Length.	Width.	Height.	Date.
Barcelona	46	20	23	1905
Rotterdam	120	30	4½	1905
Rotterdam	120	21	30	1906
Rotterdam	134½	32¾	31 5/6	1911
Denmark	32¾	...	25	....
Toulon	77	48½	51 11/12	1909
Paris	34½	14½	14	1911
Havre	82	19.7	18.9	....
Alexandria (Polygonal)	41	37	24	....
Genoa	17¼	13 11/12	36	1911
Taupse	86	21	22	....
Kobe	119	35-40	24-30	....
Goodrich	100	35	26	1911
Welland Canal	111	38	34	1914
Algonia	24	15	12⅓	1908
Manitowoc	24	14	11⅓	1908
Milwaukee	54	15	17	1910
Huntingdon Harbor	30	26	16	1910
Colon, Panama	45	45	...	1912
Detroit River	35	22	...	....
Brandy shoal circular	45	45 ft. diameter		
Chicago	20	16	8	1915

WATER WORKS

The Steam-Turbine-Driven Centrifugal Pumps of the Toronto Water Works.

(Contributed.)

The first large DeLaval steam-turbine-driven centrifugal pump for municipal water works service was installed three years ago in the Ross Pumping Station of the Pittsburgh water works. The adoption of this form of pumping unit has proceeded so rapidly in these three years that the total capacity of municipal water works pumps built or contracted for by the DeLaval Co. now exceeds 600,000,000 gals. per day. In response to the editor's request for a description of a recent installation of this type the following description of the Toronto pumps has been prepared for this journal by The Geo. H. Gibson Co., Advertising Engineers, New York City, as agent for the DeLaval Steam Turbine Co.

THE JOHN STREET PUMPING STATION.

The two pumping stations of the Toronto Water Works epitomize, it might be said, the development of water works pumping machinery in America, although at the present time some of the oldest units are being discarded in favor of more modern and more economical units. The John Street Pumping Station, which is the main station, supplies all sections south of College and Gerard Sts., and delivers water to two large mains, one going to the reservoir in the northern part of the city at a pressure of 20 lbs., and the other to the centrifugal pumps in the High Level Pumping Station, about three miles north. It contains two 10,000,000-gal. horizontal compound Worthington duplex pumps which, though installed about 25 years ago, are still used at certain periods. There are also two 15,000,000-gal. vertical triple-expansion high duty reciprocating pumping engines built after Allis-Chalmers designs by the John Inglis Co., of Toronto, installed eight and six years ago, respectively, and four 13,500,000-gal. single-stage centrifugal pumps, operating against a head of 110 lbs. and driven at 750 r. p. m. by Canadian-Westinghouse 1,500-HP. motors. The latter pumps were installed about two years ago and are operated with Niagara Falls power. There are also two 5,000,000-gal. centrifugal pumps directly connected to steam turbines, and two other pumps of the same capacity and make, directly connected to Westinghouse motors, all intended for high pressure fire service.

With a view to increasing the capacity and economy of this station specifications were issued in October, 1912, for machines of three different types: (a) a self-contained vertical

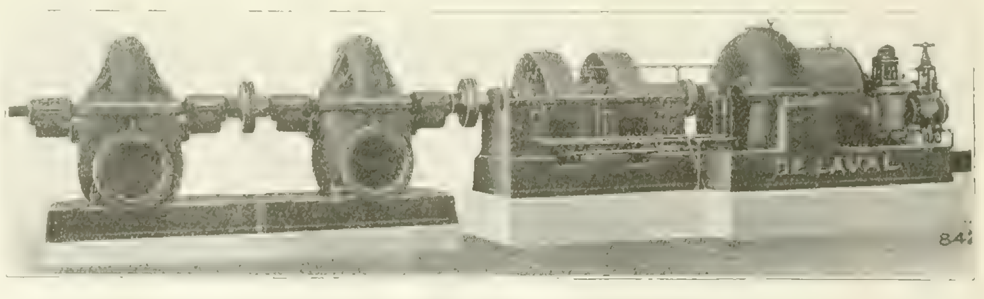


Fig. 1—View of De Laval Centrifugal Pumps Driven by De Laval Geared Multi-stage Turbine at Toronto Water Works.

(Capacity 15,000,000 gals. per day—head 268 ft.)

triple-expansion fly-wheel plunger pumping engine with jacketed steam cylinders; (b) a centrifugal pump driven by a triple-expansion condensing engine, running at a speed of not over 350 r. p. m., and (c) a centrifugal pump driven by steam turbine, the pump speed not to exceed 750 revolutions; the capacity in each case to be not less than 15,000,000 Imp. gals. of water for 24 hours against a pressure difference of 105 lbs. per square inch between the suction and discharge mains. It was provided in the specification that a duty in excess of 100,000,000 ft.-lbs. per 1,000 lbs. of saturated steam should be guaranteed with a bonus of $1,500 for each 1,000,000 ft.-lbs. in excess of the guarantee, the total bonus not to exceed $10,000, and a penalty of $2,000 for each 1,000,000 ft.-lbs. less than the guarantee, a deficiency of more than 5,000,000 ft.-lbs. below the guaranteed duty to render the pump subject to rejection. It was further provided that the steam pressure should be 150 lbs. gage at the boiler, and that the steam should not contain more than 1½ per cent entrained water, also that the steam consumed by the auxiliary pumps, jackets, reheaters, air pumps, air compressors, boiler feed pumps, all of which were to be supplied by the contractor, was to be included in figuring the duty.

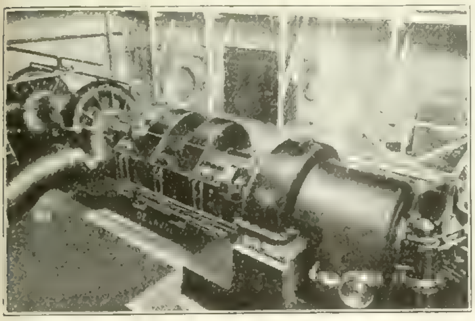


Fig. 2—View of One of Two 24,000,000-gal. De Laval Geared Turbine-Driven Centrifugal Pumping Units, Toronto Water Works—Head 268 Ft.

The decision as to the type and make of pump was made on the basis of net economy, or lowest cost per gallon of water handled, that is, interest and depreciation charges on the cost of machinery, foundations and buildings and expenses for labor and supplies were taken into consideration as well as steam consumption. By requiring the contractor to supply the condensing equipment and by charging him with the head consumed in friction in the condenser and with the steam required for operating the condenser pumps, full opportunity was given to the turbine manufacturer to take advantage of the better use which the steam turbine can make of high vacuums as compared with the reciprocating engine.

The contract was awarded to the Turbine Equipment Co., Ltd., of Toronto, representing the DeLaval Steam Turbine Co., of Trenton, New Jersey, for a 1,400-HP. steam turbine designed for a speed of 3,600 r. p. m, driving, by means of double helical speed-reducing gears, two 24-in. centrifugal pumps to operate at 600 r. p. m. The turbine is of the impulse pressure-stage type and contains 14 stages. The gear is of the three-pinion bearing type and is connected to the turbine and to the pump shaft by flexible couplings. Both turbine and gear are lubricated by a gravity system, an oil pump attached to the governor shaft forcing the oil through a cooler to an overhead tank from which it runs to the bearings. The larger gear bearings and the pump bearings are ring oiled.

The two pumps are of the single-stage double-suction type, and are operated in series, that is, the discharge from the first pump is carried to the suction of the second pump. The pumps are primed by a single steam ejector connected to the top of each pump casing.

The condenser, built by the C. H. Wheeler Mfg. Co., is of the water works type, in which the steam is inside the tubes and the water outside, and contains 1,500 sq. ft. made up of 1-in. brass tubes each 7 ft. x 2 ins. long. All of the water handled by the main pump passes through the condenser. The air pump is of the wet vacuum type, the steam end being of the ordinary slide-valve type, controlled by a throttling governor. The steam for driving the air pump is taken from the main supply pipe between the separator and the steam turbine. As no oil is allowed to reach the inside of the turbine, the condensed steam is passed into the hot well and delivered to the boilers by a triplex, single-acting boiler feed pump driven by chains from the main pumping unit.

ACCEPTANCE TEST.

The acceptance test on this pump was run on Nov. 30 and Dec. 1, 1914, under the supervision of Prof. Robert W. Angus, of the University of Toronto, assisted by senior students from that institution. The contractor was represented by Mr. C. R. Waller, Chief Engineer of the DeLaval Steam Turbine Co., and the purchaser by Mr. McRae, Chief Engineer of the pumping station. Throughout the test, which was of 24 hours' duration, suction and discharge pressures, Venturi meter and condensate weight readings were taken every 7½ minutes, while the steam main and nozzle pressures, vacuum, speed, and calorimeter readings were taken every 15 minutes. All gages were calibrated both before and after the trial and the scales examined and certified by a Government inspector, The barometric pressure during the test was obtained from the records of the Meteorological Office. The principal final results were as follows:

Steam pressure in main—148 lbs. per sq. in.
Steam pressure at turbine nozzles—137.4 lbs. per sq. in.
Absolute condenser pressure—1.06 ins. of mercury.
Pressure difference on pump—114.1 lbs. per sq. in.
Moisture in steam—1.05 per cent.
Water delivered, imperial gals. per 24 hours—18,373,000.
Water horse power—1,016.4.
Steam per water horsepower per hour—Lbs., 15.18.
Duty developed per 1,000 lbs. of steam used—130,499,000.
Duty guaranteed—118,500,000.

Since placing the first contract two more units, each capable of delivering 24,000,000 Imp. gals. per day against 260 ft. head have since been ordered for the same station, from the Turbine Equipment Co., Ltd., also two DeLaval pumps, one of 20,000,000 gals. capacity against 106-ft. head and one of 7,500,000 gals. capacity against 266-ft. head, have been ordered for the High Level Pumping Station.

HIGH LEVEL PUMPING STATION

The High Level Pumping Station is situated in the northern part of the city, about three miles in a straight line from the main pumping station, and supplies the district north of College St. to the Canadian Pacific R. R. tracks, and north of Gerard St., in the east of the city. This pumping station, like the main station, exhibits more or less the history of pumping engines, as it contains a Holly vertical triple-expansion pumping engine, having a capacity of 6,000,000 gals., and a similar pump built by the John Inglis Co., of Toronto. There are also two Blake-Knowles horizontal cross-compound pumps having a capacity of about 4,000,000 gals. All of these pumps were installed about eight or ten years ago, and two years ago eight electrically-driven centrifugal pumps were installed. An extension is being made to this station for housing the two turbine-driven centrifugal pumps, also two centrifugal pumps directly connected to Bellis-Morcom steam engines.

The DeLaval turbine-driven centrifugal pumps installed or under contract for the City of Toronto alone aggregate 90,500,000 gals. per day capacity and 4,390 water horsepower.

Developments in the Marshall, Texas, Water Works in Recent Years.

(Staff Abstract.)

During the past 15 years the water system of Marshall, Texas, has experienced a great development. The population of the city, as given by the federal census, was for the years 1890, 1900 and 1910, 7,200, 7,850 and 11,450 respectively. An account of the growth of this system is of general interest as showing the point of completeness to which water systems can be brought in towns of this size. It is especially worthy of note that all services are now metered.

The first system, costing $62,000, was placed in operation in 1889. Little or no improvement was made until 1900. The original installation consisted of 20 miles of mains of 4 to 10-in. diameter, 65 fire hydrants, 400 services, 18 or 20 meters, a 15x125-ft. standpipe, a 28x50-ft. frame pumping station building, two 54-in. x 14-ft. tubular boilers of 60 HP., two Dean of Holyoke compound duplex pumps 12 and 18-in. x 7-in. x 10-in. of plunger and ring pattern, rated at 500,000 cu. ft. per day, and 28 4 and 6-in. wells. There was an 8-in. main from the pumping station to the standpipe and a 10-in. main from the standpipe to the city.

The suction was connected direct to wells 8 ft. below ground level. These wells when first drilled would flow, making it necessary to put a valve in the suction line to relieve the pressure when not pumping, to avoid injuring the wells. The valve was located in the bed of a creek where the excess well water could get away. In 1902, to save this water in the event of fire, a reservoir was constructed.

Fig. 1—View of Old Frame Pumping Station at Marshall, Tex.

In 1900 the water consumption amounted to about 50,000 gals. per 24 hours. In 1903 it was necessary to drill 20 additional wells. These were 4-in. gage wells, and the same year a steel water tower of the same height as the standpipe, 125 ft., was erected. Its capacity is 160,000 gals.

In 1907 the city constructed a sanitary sewerage system, making it necessary to increase the water supply. Five 10-in. wells were drilled, ranging in depth from 348 to 610 ft. These wells are pumped by air furnished by a Rand two-stage cross compound condensing engine of a capacity of 535 cu. ft. per minute.

The size of the suction line has been increased and shallow wells have been added until now there is about 1¼ miles of suction line pumping direct from 73 wells.

In 1907 the pumping capacity of the plant was increased by the installation of two Henry R. Worthington vertical compound duplex condensing engines with surface condenser rated at a capacity of 1,000,000 gals. per 24 hours.

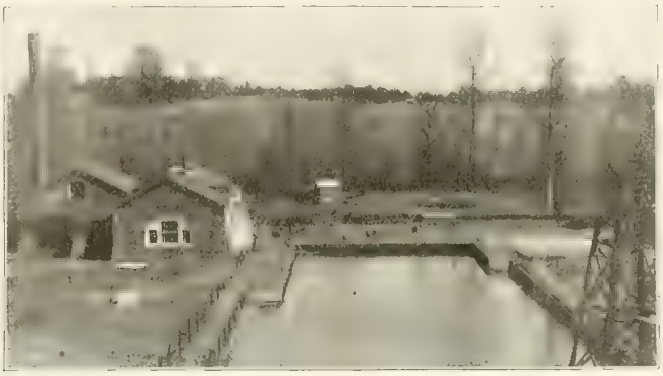


Fig. 2—View of New Reinforced Concrete, Fireproof Pumping Station at Marshall, Texas.

Within the last ten years the two old boilers have been replaced with three new boilers of 200 HP. capacity. In the year 1910 the old power building, shown in Fig. 1, was replaced with the concrete building shown in Fig. 2. The boiler room is 32x34 ft., the engine room and machine shop 28x70 ft. Under the same contract a 10-in. main was laid parallel with the 8-in. main between the station and tower and the standpipe, which greatly reduces friction.

To show the growth of the water works the following comparative figures for the years 1900 and 1915 are given:

	In 1900.	In 1915.
Miles of main................	20	35
Fire hydrants	65	185
Services	400	1,000
Meters	20	1,000
Standpipe capacity, gals....	160,000	*320,000
Pumping capacity, gals.....	1,000,000	3,000,000
Boiler power, hp.............	120	200
Revenue	$8,000	$22,588.59
Value of plant................	$62,000	$183,734.97
Water consumption, gals per 24 hours...............	50,000	500,000

*Tower and Standpipe.

ACKNOWLEDGMENT.

The information here given is from a paper by Ben F. Meyers, Superintendent of Water Works at Marshall, Texas, before the annual meeting of the Southwestern Water Works Association.

A Mercury Column Alarm for Standpipes Successfully Employed at Ripon, Wis.

(Staff Abstract.)

The Ripon Light and Water Co., of Ripon, Wis., was greatly troubled for years by the overflowing of its water standpipe. Since the standpipe is located in the residential district its overflow caused a great deal of complaint from nearby property owners who sometimes threatened damage suits. The company was also annoyed by the freezing of the overflow on the exterior of the standpipe.

There were three major reasons why this overflow occurred in the manner described and why it continued so long. (1) The standpipe is located nearly a mile from and out of sight of the pumping station. (2) The only means of telling when the standpipe was full was by the pressure gage at the pumipng station, and the indications of this gage would vary so greatly with the speed at which the pumps were running, the amount of water being used from the mains, etc., that it was not very reliable as an indicator and unless the pumps were stopped at a point considerably below full standpipe the engineer could never be sure that he was not running it over. (3) On account of the topography of the city, it was quite necessary to fill the standpipe almost to the top at every pumping to avoid an unnecessary amount of stopping and starting of the pumps and an increased pumping expense.

Many schemes were tried for correcting this condition, but with little success. A float making an electric contact was found impracticable on account of trouble with ice and excessive maintenance difficulties in other ways. A spring pressure gage making an electric contact was also tried but on account of danger from freezing this gage had to be located in a damp valve pit underneath the standpipe, and the contacts consequently corroded and went out of business, and the gage was also continually getting out of calibration.

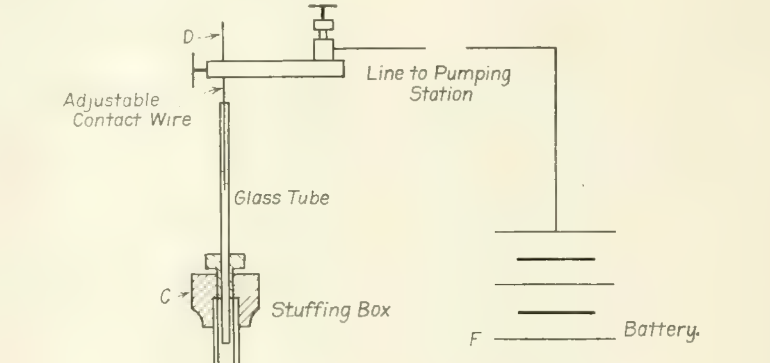


Diagram of Elements of Mercury Column Alarm for Prevention of Standpipe Overflows at Ripon, Wis.

The idea of a mercury column alarm then suggested itself, and after several attempts the manager succeeded in constructing one which has been in continuous service for almost nine years, and it has never failed to operate unless a wire to the pumping station has in some way been broken.

The accompanying drawing shows the general principle upon which this gage is made and how it operates. A tap is made in the pipe leading into the standpipe on the standpipe side of the valve controlling same, so that the gage will never be subjected to excessive fire pressures.

This tap is connected by means of a regular corporation connection to the top of the mercury chamber "A." Extending down into the mercury chamber is a small iron pipe "B" reaching nearly to the bottom, and this pipe extends vertically to a pre-determined height, and about 6 ins. of glass tubing is connected to the top thereof by means of a stuffing box "C."

This glass tubing is placed at such a height above the mercury chamber that at the time the standpipe is full the mercury column will stand at about the center of the glass tube. A metal contact "D" is arranged to slide up and down in this tube and this is connected to the wire leading to the pumping station, and the electrical circuit completed by the bell "E," the set of batteries or bell ringing transformer "F" and the wire "G" attached to the water main at the station, this main making the return circuit.

The operation of the alarm is simplicity itself, the weight of the water column in the standpipe raising the column of mercury in proportion to its specific gravity until the mercury touches the contact "D," when the bell rings at the station. The specific gravity of mercury being about 13.6, a 100-ft. standpipe would require a mercury column something over 7 ft. high.

This alarm has a number of advantages over others. It is almost infallible, provided that the joints are made perfectly tight. It never has to be calibrated and is independent of barometer and practically so of temperature. The latter statement is not strictly true, but it has been found that the gage operates perfectly at all temperatures from 100° above zero to 40° below.

The fact that 1 in. of mercury is practically equivalent to 1 ft. of water makes it easy to set this gage so that the point of ringing the bell at the pump house will not vary 1 in. in the standpipe, which cannot be said of an alarm based on any other principle.

The entire outfit can be made by anyone at an expense not to exceed $20 or $25 outside of the line wire.

About the only precautions recommended are: Be sure to use an iron mercury chamber and iron pipe. Ignorance of the fact that mercury would attack brass was the cause of much grief at Ripon, and led to the loss of large quantities of mercury. The final mercury chamber was made out of a short section of 2-in. pipe and a riser pipe out of ⅛-in. ordinary black pipe.

ACKNOWLEDGMENT.

This description of the mercury column alarm for the Ripon standpipe is from a paper on the subject before the American Water Works Association by W. E. Haseltine, manager of the Ripon Light and Water Co.

Some Suggestions on Accounting for Municipally Owned Water Works.

(Staff Abstract.)

Probably the majority of private water companies have some sort of accounting system which enables them to obtain information relative to the cost of operation and maintenance, their assets and liabilities, their profits and losses, and other information of a like character. While their accounting methods are not always modern, in fact many of them are not, they are of a much higher average standard of completeness than the methods employed by municipal water departments.

While private water companies usually endeavor to show the operating and maintenance costs, assets and liabilities, profits and losses, and similar information to inform the officers of the actual financial condition of their business, municipal works usually show nothing more than records of receipts and disbursements supplemented by a few auxiliary records. The latter are begun when it becomes impossible for the superintendent to keep the necessary information in his head. Municipal plants seldom make a balance sheet or a statement of assets and liabilities, but follow the old methods and imagine that modern methods are not applicable to municipal affairs. Expert accountants agree, however, that methods employed by private corporations are applicable to municipal plants and that revenues accrued and expenses incurred are no more fictitious in a municipal business than in a private corporation. If city officials can be made to realize the truth of this and the necessity of applying modern accounting systems to municipal works, and learn the advantages to be secured therefrom, very little difficulty will be experienced in keeping comprehensive accounts for municipal utilities like a water works.

It would be impracticable to give here in detail a method of accounting that would apply to all water works, so only a general outline of a system will be attempted which can be modified to meet the peculiar conditions of each individual concern.

Every water works should keep a clear and concise record of its mains, taps, services, meter locations, etc., showing dates installed, sizes, material and other information to facilitate the work of the department and to give a permanent record that will be serviceable to the public and to subsequent city officials and superintendents.

A meter record should be adopted which will contain a general description of each meter, stating its manufacturer, date purchased, size, type, cost, etc., and giving a record of tests made from time to time, repairs made and costs of same, together with the service rendered. These data will comprise a complete history of and show the life and cost of maintenance of each meter and give information for comparison as to the durability, accuracy, etc., of the different makes of meters. This enables officials to make future purchases intelligently and to the best possible advantage.

For individual accounts the self-proving ledger is usually the most satisfactory, especially where meters are used, and should contain special columns for readings of meters connected, meters disconnected, present readings, quantity consumed, amount billed, cash payments, other credits, advance payments and delinquents and any other special columns desired. By this method all meter readings can be proved as one reading and loss or gain from erroneous readings are made impossible. A check of collections with the amount billed is obtained and advance payments and delinquents are carried forward into their respective columns. The totals of all the columns should be summarized into a statement from which necessary totals may be taken to the general ledger.

In this way the financial statement will be supported by the summary statement and the summary statement is likewise supported by the individual accounts.

Receipts for water rates would better be kept in a special cash book and the totals each day posted in the general cash book. Much time can be saved by using a special split adding machine and a loose leaf cash book. A good method is as follows: All water bills should be mailed on postal cards with a stub to be clipped when bill is paid. These stubs contain the name of the consumer and the amount of his bill together with the folio and line of the water ledger on which the account is kept. The stubs are sorted and arranged in the order in which they come in the water ledger. They are then run on the cash book with the adding machine, only the reference numbers and amounts being listed, and from this reference the posting is done to the ledger. Each year, or as often as is desired, the cash book sheets can be taken to a bindery and made into a permanent record of cash collected from water rates covering the period.

For the purpose of distribution of expenditures a voucher or claim register is necessary and should be arranged in special order for the general division of expenditures under which heads may be grouped the various subdivisions of same. The following general divisions or subdivisions can be modified to suit an ordinary plant: (a) Pump and filter house, under which are grouped such expenditures as plant wages, equipment: repairs and renewals, building repairs and renewals, filter supplies, electric power for pumping, electric power for agitators, light and heat, telephones and miscellaneous. (b) Distribution and maintenance under which are grouped: Mains, meters, tools, feed and maintenance of teams and wagons and supplies. (c) General expenses under which are grouped office salaries, wages, printing, stationery and postage, extra expense cleaning river, etc. (d) Fixed charges under which are placed: Interest on bonded debt and sinking fund if these are paid out of revenues from earnings. (e) Expenditures not chargeable to operation under which are placed any expenditures for additions and betterments of a capital nature which are not properly chargeable to operation. By segregating operating disbursements from capital disbursements the public can readily see what amount of revenue is used for operation and maintenance and what for fixed charges and capital investments.

The general ledger should be such as will enable the department to show at all times in a clear and comprehensive manner the true financial condition of the business including operating and maintenance accounts, capital accounts, etc., the same as would be required by a private concern doing a similar service.

If collections are deposited direct with the city treasurer it will probably be necessary to show on the credit side of the cash book the deposits to the treasurer and if the water department desires to have a record of the balance of cash in the water fund at any time, it can easily be done by a special record showing on one side totals of deposits with the city treasurer for a given period and on the other side a total of warrants issued for claims approved for the same period. If the city clerk has a clear record of this it may not be necessary for the water department to keep it. In fact, if a municipality has a modern system of accounting the water department will be relieved of a great deal of worry in regard to the actual labor of keeping the accounts, but the superintendent should familiarize himself with the methods used and the results obtained if he expects to operate his department economically and efficiently. He should know what it costs for treating and filtering water, and for pumping the same. If the cost is greater than it should be in comparison with other plants and approved standards of efficiency, he should know where the trouble is, whether it is due to unscientific treating and filtering, or in the firing of boilers, or from low pump efficiency, or from any other of the numerous causes, and this should be a matter of record in order that the errors may be corrected as soon as possible. It is only by reports compiled and supported by positive records that he can expect to convince the proper authorities of his needs to remedy the defects. The writer once heard a water superintendent remark that he had the best water system and most economical plant in the state and upon being asked the cost of water delivered to the consumer, had no idea what it was, and did not know even the approximate cost of operation and maintenance of a single department of his system. This may be an unusual case but it serves to illustrate the necessity of accurate records.

To install an adequate accounting system where one does not exist, it will be necessary of course to take an inventory of all lands, buildings, machinery, equipment, mains, meters, tools, etc., cash on hand, accounts receivable, bonded debt, unpaid warrants, bills payable and surplus and enter them upon the general ledger.

If the water used for fire hydrants, street sprinkling and other departments of the city government is not paid for out of their respective funds, a reasonable rate can be fixed and credit taken on the books and where sinking and interest is not paid out of revenues but by tax levy this should be charged against the business, and by a comparison of these various debits and credits or by results as shown by the balance sheet, information can be secured which will be beneficial in fixing a just and equitable rate to charge the water users. Such a rate should always be based on the actual cost of running the plant after all things are considered in connection therewith. The question of depreciation should also be considered but the basis for determining depreciation will not be considered here. However, if accounting methods are improved, the information to be obtained therefrom will greatly facilitiate the work of determining, in the future, the life of the different departments of a water works system and constitute a basis for fixing depreciation.

The system of accounting should not be too complex but should be so simple that the ordinary bookkeeper can comprehend it and keep it going after it is once started. This caution should be especially observed in the smaller towns where expert help cannot be obtained on account of limited funds.

ACKNOWLEDGMENT.

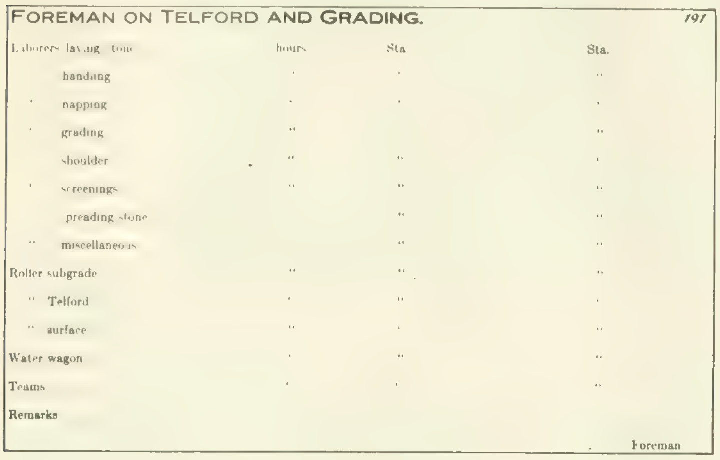
The foregoing discussion is from a paper on this subject, before the recent annual meeting of the Southwestern Water Works Association, by Mr. C. C. Clothier, Commissioner of Public Utilities of Guthrie, Okla.

ROADS AND STREETS

An Efficiency System for Road Contractors.

(Contributed by John H. Hammond, Richmond Hill, N. Y.)

The troubles of the road contractor are many. Not the least of these is "How to obtain and keep a satisfied force working in an efficient manner in a far out of the way country place where conditions are, at best, not what they should be." The following set of cards was worked out in the first instance for use in constructing roads for the state of Pennsylvania, and proved so successful in accomplishing the object sought that it may be of use to others engaged in similar work where conditions are nearly like those present in this work. The state engineer's survey of roads consists of running a center line and making a cross section of the surface, leaving in place numbered station stakes 100 ft. apart for the whole length of the road, with plus stakes to locate culverts, cross-roads, etc. These station stakes are made the base of measurements for cards, and before beginning work we carefully find out their location and see that their marks are legible. As our forms follow the usual activities of the work, it seems necessary to review, briefly, the general way in which they are carried on and then show how our cards fit into the work and what we have realized by their use on several contracts.

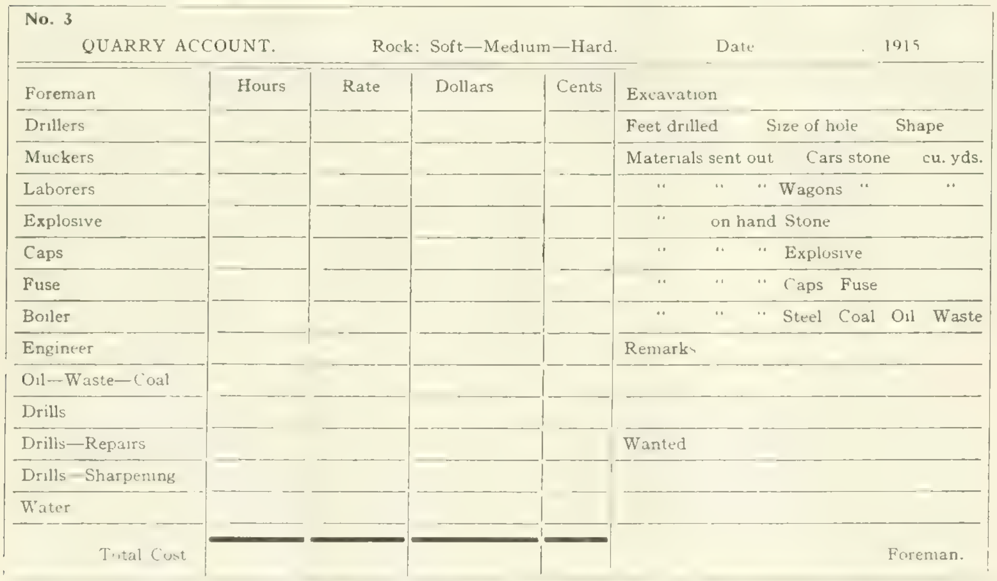


FOREMAN ON TELFORD AND GRADING. 191

Laborers laying stone	hours	Sta	Sta.
handling	"	"	"
" napping	"	"	"
" grading	"		"
shoulder	"	"	"
" screenings	"	"	"
spreading stone		"	"
" miscellaneous		"	"
Roller subgrade	"	"	"
" Telford	"	"	"
" surface	"	"	"
Water wagon	"	"	"
Teams	"	"	"
Remarks			

Foreman

Card 1.

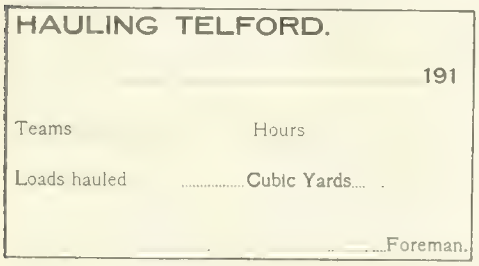


No. 3

QUARRY ACCOUNT. Rock: Soft—Medium—Hard. Date 1915

Foreman	Hours	Rate	Dollars	Cents	Excavation
Drillers					Feet drilled Size of hole Shape
Muckers					Materials sent out Cars stone cu. yds.
Laborers					" " " Wagons " "
Explosive					" on hand Stone
Caps					" " " Explosive
Fuse					" " " Caps Fuse
Boiler					" " " Steel Coal Oil Waste
Engineer					Remarks
Oil—Waste—Coal					
Drills					
Drills—Repairs					Wanted
Drills—Sharpening					
Water					
Total Cost					Foreman.

Card 3.



HAULING TELFORD.

191

Teams Hours

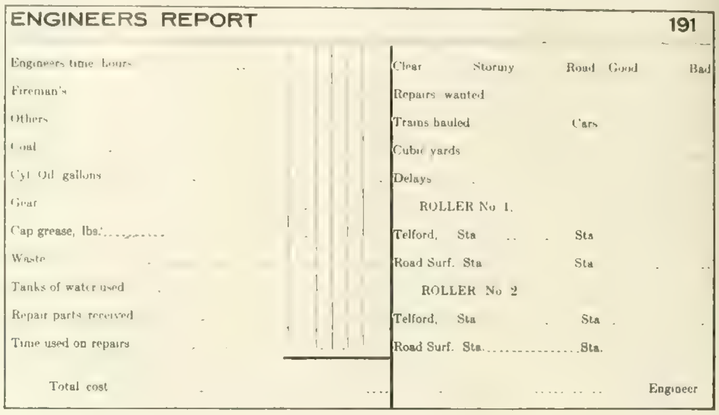
Loads hauled ....Cubic Yards....

.....Foreman.

Card 4.

The activities in road work are usually conducted in about the following manner, varying in the different works in accordance with the conditions. If the excavation is heavy it controls all the following work, and a gang or gangs of laborers large enough to clear the way to rough grade is started and made to contain men and machinery enough to keep ahead of the actual building work. The next activity is making shoulders and close grading the roadbed to sub-grade. This gang, like all the gangs, should contain only so many men as can keep their work up to the controlling activity. After the close grading gang the roadbed must be rolled with a steam roller, then the telford layers and nappers, and the steam-roller after them to consolidate their work, followed by the hauling, spreading, rolling, and watering of the top course, its usual coat of useless stone screenings, the final finish of the road with its gutters and shoulders banked to hold the stone-work in place.

During the above outlined progression, stone must be gathered for the telford base, either from adjacent fields or by opening a quarry. Teams will be required on each of the activities and water must be obtained and carted to the work for finishing the road, and for the use of the rollers and traction-engines which will be used to haul the crushed stone from the nearest railroad station if the stone is brought from a distance. A gang will now be necessary to unload stone from the railway cars into the contractor's wagons or cars, and the foreman of this gang must keep strict account of the arrival and departure of all cars and what material they were loaded with. Where large culverts are to be built in sufficient quantity, a foreman and gang are usually assigned to this work; and, wherever practicable, it should be completed before or during the excavation period, so that the banks over the structure may have time to settle before the road is built over them. The office force necessary for such work is usually the contractor who may act as superintendent, a bookkeeper who has charge of all supplies, and a timekeeper.



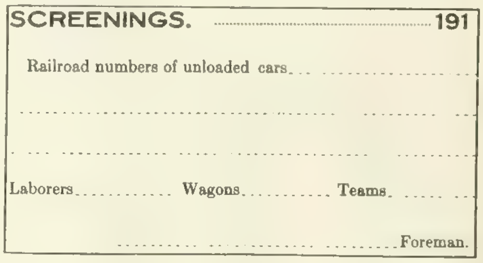
ENGINEERS REPORT 191

Engineers time hours
Fireman's
Others
Coal
Cyl Oil gallons
Gear
Cap grease, lbs.
Waste
Tanks of water used
Repair parts received
Time used on repairs
Total cost

Clear Stormy Road Good Bad
Repairs wanted
Trains hauled Cars
Cubic yards
Delays
ROLLER No 1.
Telford, Sta Sta
Road Surf. Sta Sta
ROLLER No 2
Telford, Sta Sta
Road Surf. Sta................Sta.
Engineer

Card 2.

In forming any kind of an efficiency system many things must be taken into account, as opposition is to be expected from the employes as soon as any way is devised to force an account at the close of each day of the amount of work done on that day and the men are made to perform a full day's work. The location of the work must be considered, as it will hardly pay to bring men to your work at considerable expense from a long distance and have to fight a contractor on a nearby contract to keep them, and then force them away from you by an efficiency system which they hate and do not have to put up with. After a considerable amount of study of average conditions, the eleven report cards which are offered with this article were designed. The object sought by these cards was to give the contractor each morning an accurate account of the work done each day, to show the progress made at each point, weak spots that require attention, and the efficiency of each foreman and gang of workmen. It



SCREENINGS. 191

Railroad numbers of unloaded cars..........

Laborers............ Wagons........... Teams.......

..................Foreman.

Card 5.

was not expected that the men would become mere machines whose every motion could be studied and corrected until the maximum of work was obtained. The object sought was a steady average output fair to the contractor and the men which could be maintained without exhaustion or friction, and was certain to show satisfactory results. Foremen engaged in this class of work are not generally men of educational attainments, although not by any means lacking in general intelligence, yet any cards made for their use must be as simple as they can be and retain the essential features of a direct statement of facts in accordance with the conditions on their work at the close of a day. There should be as little writing as possible, figures, and measures which are recorded in figures, seem to be much easier for them, and more likely to be done accurately. The principal thing to be attained is to make the cards or other records in such a manner that no false statement is possible without its being discovered and coming back to the maker for correction, thus involving a certain amount of disgrace, and, if repeated, dismissal from the work.

WATER WAGONS. 191

Laborers on pump .... hours ....

Teams on wagons ....

Roller No. 1 .... Roller No. 2 ....

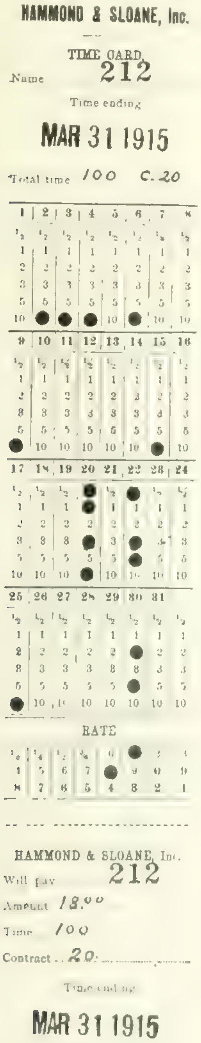
Engine ....

Gallons pumped .... Tanks ....

Remarks ....

.............................Driver.

Card 6.



HAMMOND & SLOANE, Inc.

TIME CARD.
Name 212

Time ending

MAR 31 1915

Total time 100 C. 20

1	2	3	4	5	6	7	8
½	½	½	½	½	½	½	½
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
5	5	5	5	5	5	5	5
10	●	●	●	10	●	10	10
9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
½	½	½	½	½	½	½	½
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
5	5	5	5	5	5	5	5
●	10	10	10	10	10	●	10
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
½	½	½	●	½	●	½	½
1	1	1	●	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	●	3	●	3	3
5	5	5	5	5	●	5	5
10	10	10	●	10	10	10	10
25	**26**	**27**	**28**	**29**	**30**	**31**	
½	½	½	½	½	½	½	½
1	1	1	1	1	1	1	1
2	2	2	2	2	●	2	2
3	3	3	3	3	3	3	3
5	5	5	5	5	●	5	5
●	10	10	10	10	10	10	10

RATE

⅛	¼	½	¾	0	●	2	3
1	5	6	7	●	9	0	[illegible]
8	7	6	5	4	3	2	1

HAMMOND & SLOANE, Inc.
Will pay 212
Amount 18.00
Time 100
Contract 20

Time ending

MAR 31 1915

Card 7.

The foreman using card No. 1 of this set of cards, who attempts to show more work done at the close of the day than was actually the case, must show less work the next day or be caught by the stationing on the cards of the other foremen who are all working along the same line on different activities, which, on being reviewed in the office the next morning, would at once show that an error had been made and cause an investigation by the contractor or his superintendent. There seems to be little or no incentive to collusion among the various units to lower the efficiency of the whole force as each one knows that his individual effort is being judged by his own report card on which is shown all that he has done and on which the cost of his force is being figured and compared with other gangs, and if the comparison is unfavorable, he will soon lose his position. There is also an element of mystery which we foster about the matter which often leads the more ignorant to imagine that much more knowledge is obtained from the cards and their cross reports than is really the case.

No. 8
HAMMOND & SLOANE, Inc. TIME CARD.

Name	Time	Name	Time	Name	Time

DATE. 191 JOB Timekeeper.

Card 8.

No. 9
From J. E. BAKER CO., York, Penna. Date 1915

The following car loads of materials have been shipped to you this day from our quarry at Hellam via P. R. R.

Initial	Number	Materials	Destination	Remarks
P. R. R.	32432	2" C. S.	New Park, Pa.	

Railroad way bills show weights.
Inspect cars before unloading.

J. E. BAKER CO., per.

Card 9.

Card 1 is used by the foreman on all kinds of excavation, telford laying, napping, rolling sub-grade and telford base; also grading, making shoulders, spreading stone and screenings, finishing the road top and gutters, and for reporting the teams, water-wagon, and use of rollers between stations named.

Card 2 is used by the engineers of traction engines and rollers, and shows the supplies and repairs required and used by them and in the case of the rollers the kind of work done and its location. On this card the traction engineer reports the amount of materials hauled, the position of which is shown in the stationing; also to report delays and their cause, the condition of the road and the weather. This card also shows the manager how far ahead of the working gangs the materials are in place, also when repairs are needed in advance of the time when they are called for by an actual breakdown of the machine, thus allowing him to keep these important machines constantly at work and avoid a stoppage of the gangs dependent on its operation for materials. The back of this card is used to give in detail the repairs wanted or any memorandum for which there is lack of space on the front. The cost columns are figured up daily, and shown to the engineer, enabling him to keep a fair average cost, putting plainly before him the cost of any delay on the road or at the terminus of his runs. This was found to be a very good feature and much delay in taking on coal, water, oiling the machinery, cars, etc., was shortened, and a daily average run good for each distance and road was established.

Card 3 is used where a quarry is in operation and gives a fair account of the cost of the work and its condition; also the amount of reserve materials on hand and supplies needed. The cost of operation is given to the foreman each day from the office.

Card 4 is used by quarry foremen when stone is being hauled from the quarry to the road by hired teams, or by any foremen. When hauling stone to the work it is checked by report on card 1 as to position of materials, quantity, and time of teams.

Card 5.—This card was used by sub-contractor hauling screenings and by foremen doing like work, and with the weight of cars given in the bills of lading shows the cost per ton for hauling this material and the amount on the work at all times if taken with card 1.

Card 6 is used by the driver of water wagon to show the cost of that work, and check reports from foremen and engineers made on other cards, and is of great importance in a district where water is scarce and expensive, as it usually is in midsummer season where any waste is going on or unusual quantity of water is being used. The gallons pumped, as referred to on this card, are for full tanks of 600 or 450 gals. and are checked by the receiving foreman, who is charged with the water on his portion of the work.

UNLOADING CARS. 191

LABORERS ON CARS HOURS

FOREMEN ON CARS HOURS

CARS ARRIVED			CARS UNLOADED		
Number	Letters	Time	Number	Letters	Time

FOREMAN

Card 10.

Card 7 is the time card used for all employes working by the hour or day, and is made to suit the conditions of the locality where work is being done. This card is made in weekly, bi-weekly or monthly size, according to the length of pay period in each. The ticket shows the rate of wage and the hours worked. Twenty-one and a half hours may be punched on it on each day, and the figures are so contrived that any number of hours

No. 11

CAR ACCOUNT.

Date Shipped	Initial	Car Number	Material	Weight	Date of Arrival and Placing on Switch				Date Car Released to Railroad Company				Average Acc.		Stone	Freight	REMARKS
					Date	Hour	A.M.--P.M.		Date	Hour	A.M.--P.M.		+	—	@ 0.90 Ton	@ 1.00 Ton	
6/10	*P R P*	[illegible]	*2" C S.*	*74,500*	*6/12*	*8:00*	×	—	*6 12*	*2·00*	—	×	*1 Day*	—	*33.30*	*37 25*	

Card 11.

less than the sum named may be allowed. The double set of numbers under the word rate prevents the difficulty which would arise when a rate of 23 or 32 cts. per hour was used, 23 being punched on the light and 32 on the heavy-faced figures; or if it is desired to punch a rate of 22 or 33 cts. per hour, one figure must be punched from each set. The lower part of the ticket is detachable along a perforated line, the purpose of which will appear in the description of the use of the ticket. This ticket is given to each employe at the beginning of his work, stamped on ticket and stub with his name or number, and with the date of the ending of the pay period; his rate is punched out on the ticket, and the ticket is punched at the close of each day for the number of hours made that day, the amount entered in the timekeeper's book. Payment will be made only for the hours punched from the ticket, and advances of cash or commissary supplies must be entered on the back of the ticket in order that they may be deducted from the man's pay. The ticket is a voucher and shows the amount due at any time. On the close of the last day of a pay period the time and money due, represented by punches on these tickets, is figured up by the timekeeper and entered on the stub in the presence of the workman and his foreman, and the stub detached and given to him, while the ticket is turned in to the bookkeeper to use in making up his pay roll, and is checked over with the timekeeper's book. The stub in the hands of the man is his voucher for pay and must be handed to the paymaster on pay day. When pay periods are monthly they are made to run from the 1st to the 31st of each month, and pay day is on the 5th of the following month, giving five days to check over tickets and make the necessary accounts. This ticket became very popular with the workmen, and an attempt to return to the brass check system on account of running out of tickets nearly caused a riot.

Form 8 is the timekeeper's field book, which makes a duplicate record by using a carbon sheet. The white sheet is detached and sent to the office each day and the yellow sheet, as copy, remains with the timekeeper, so that he may at any time compare the men's tickets with his book, yet he may not make any change without referring the matter to the office. As these sheets from the timekeeper come to the office daily, they are compared with the reports of the foremen and entered in the office time book, and at the end of the month, when the men's tickets are returned, the bookkeeper is ready to check over his book with them and eliminate any errors. It may be asked what is to prevent the timekeeper from honest errors or punching extra hours on the cards for a gift, but against these possibilities we have the daily report of the foreman, who will not permit any extra time or allow errors that act against his economical conduct of the work on which he is, in a way, on trial to keep and better his position.

Card 9 is a postal card used by the quarry man furnishing top-course stone, and enables the contractor to know what material is on the road.

Card 10 is used by the foremen in charge of unloading cars at the railroad depot, and shows the arrival and departure of full and empty cars and is used in connection with form 11, the general car report card or book.

Form 11.—This form is compiled from cards 9 and 10 and from railroad and stone contractors' bills. It gives the contractor a quick view of the stone situation and its cost.

The cards have been gotten up with regard to cost by putting as little printing on them as would answer the purpose, and in use have proved quite simple and easily handled. It is not claimed that they are perfect, but they make for an orderly way of doing work and promoting efficiency.

Allentown-Bethlehem-Easton Road.—The cement industries of Eastern Pennsylvania and public-spirited citizens in Lehigh and Northampton counties have entered into an agreement with the State Highway Department of Pennsylvania to furnish sufficient cement to build a road twelve miles in length, running from the borough line of Allentown to the borough line of Bethlehem and continuing from the borough line of Bethlehem to Easton. According to the estimates of the State Highway Department, this will require upwards of 40,000 barrels of cement. Plans are under way also to have these citizens furnish, in addition, the amount of stone which will be necessary to construct this improved highway.

The proposition was made that the State Highway Department do the necessary grading and pay the expenses of such engineering changes as might be necessary and build the road. A letter was drawn up to the Commissioner pledging the cement industries to furnish 40,000 barrels of cement, or such part thereof as might be needed for use on the road. Another letter was drawn up pledging the Lehigh Valley Transit Company to furnish $1,000 worth of transportation for the freighting of the cement. The members of the delegation agreed to take up the project of furnishing the necessary stone and promised to advise Commissioner Cunningham of this at an early date.

Cost of Building a Rod of Fence in North Dakota.—The cost of building fence on the ordinary farm in North Dakota is relatively high, as all materials, including posts, must be imported. The figures given in the following table are averages secured from investigational work on many North Dakota farms:

Distance between posts.	Number of barbed wires.	Cost per rod.
1 rod	2	$0.322
1 rod	3	.369
1½ rods	3	.290
1½ rods	4	.335
2 rods	3	.254
2 rods	4	.297
2½ rods	3	.230
2½ rods	4	.274
3 rods	3	.215
3 rods	4	.257
3 rods	5	.300

This table shows cost of construction, and includes all expenses for material and labor. No data are available at present to show relative depreciation and cost of upkeep, but wire undoubtedly lasts much longer than ordinary posts.

It will be observed that it costs less to use four wires with posts two rods apart than to use two wires with posts one rod apart. In fact, the entire table shows the low cost of wire as compared with posts. The question as to which type is best must be determined largely by the use to be made of the fence.

DRAINAGE AND IRRIGATION

Construction Methods and Costs Sacramento Valley Irrigation Project.

Contributed by P. A. Welty, Supervising Engineer, now of Paso Robles, Cal.

I.

The lands (Fig. 1) of the Sacramento Valley Irrigation Co. consist of about 180,000 acres on the west side of the Sacramento Valley from Hamilton City to Williams, a distance along the main canal of about 60 miles. This canal runs about parallel to the river approximately 12 miles from it, and crosses the drainage of the foothill country to the west. Many kinds of soil are found—clay, sand, gravel, silt, adobe, etc.—most are rather hard, resist erosion, and excavations stand up well without shoring or sloping except in new fills or in the sandy soils along the river front. The slope of the country is about 5 ft. to the mile. Floods during the rainy season cause damage unless ample openings are provided, the runoff being considerable but of low velocity.

Six inch contours were taken over the company holdings and a well designed system of irrigation and drainage was constructed. Every 20-acre or 40-acre tract has water delivery on the basis of 5 cu. ft. per second to 40 acres, also every 40 acres is provided with a drainage outlet. The entire lands of the company were not contiguous and this condition caused many complications and litigation with the adjoining land owners in the construction of the system. It being in an old settled community the laws of the land and customs of the people required more thorough and detailed work than is necessary in a new country on a tract entirely under one ownership.

GENERAL PLAN OF CONSTRUCTION.

The portion of the valley operated in was divided for construction work into several units of acreages varying from 8,000 to 40,000. The numbering system applied to structures is explained by Figs. 2 and 3. The sections, or square miles, of the valley west of the river beginning far enough north to cover the company's operations, were numbered from the river, westward toward the foothills; then drop a row and back towards the river and so continued until the entire territory was numbered. This number, of any particular square mile, is then the first or prefix number of the structure number, thus 188-252, i. e., Headgate 252 on square mile 188, or map 188, in the company's office. The system was of great convenience and utility in construction, maintenance, and operation. The different units, or parts of units, were each in charge of an assistant or division engineer who had charge of the surveys and subdivision, design of the canal and drainage system, and earthwork and road construction. As this earthwork progressed over any part of a division or along several miles of canal, etc., and the earthwork became completed, this area would be turned over to the structure department for structure installation. About 64 structures per square mile were required.

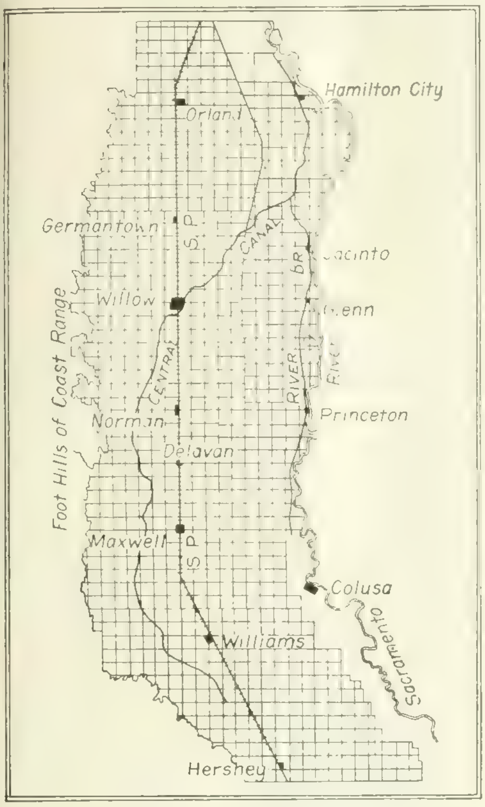


Fig. 1—Map of Land of Sacramento Valley Irrigation Company.

The assistant engineer furnished a competent instrument man acquainted with the lines and grades on his division to stake out the structures in the order directed by the writer. When the instrument man staked the structure he "flagged" the site with a lath with the structure number on it. If any concrete work was to be done he also noted on the back of the lath the cubic yards of gravel wanted. The hauling of materials was thus greatly facilitated; the teamsters, whether force account or contract, were given a sketch of a certain country "flagged" as described, and practically none of the material had to be rehauled on account of error in delivery.

Timber structures framed and bundled in the yard were labeled and so hauled; corrugated iron in car load lots of various diameters and lengths were numbered with stencil by the factory per requisition. This assisted in checking invoices and the material was ready to haul direct. Appliances for head-gates, etc., were ordered marked per lists of structure numbers When a structure was built the foreman tacked the structure-number-lath to the structure which later served the workman as a guide to the proper number and name to be painted on in black over a white background. The road, lateral or drain, name was also placed on the structure. Many of the concrete structures were marked by casting the name and number in the concrete. Permanent bench marks were set on structures at least every one-fourth mile. The marker was an aluminum disc 2½ ins. in diameter with a round headed copper nail, the head being the point on which the elevation was taken. The copper nail was either set in the concrete or driven into the larger frame structures. The discs were stamped "Sacramento Valley Irrigation Project"—"Bench mark" and a space was provided for the elevation which was stamped thereon with a steel die after it was read and checked by the levelman. The larger checks had gage rods set and all were marked with an elevation of "Water Service" or "Checked Water Service" which was the maximum height water was designed to be raised in order to irrigate the adjacent land.

ORGANIZATION FOR STRUCTURE WORK.

Most of the structure work was done by company force account. Bids were frequently asked but on account of the small average size of the structures, excessive and difficult excavation and scattered locations, the bids were usually quite high. The contract work which was done was usually as high as or higher than the force account work. Another reason for high bids was the California state law requiring 25 per cent holdback for 31 days on all contracts. The company did not expect a contractor to make 25 per cent so he had to have considerable capital when his contract was of long duration.

The foremen were practical men, most of whom were developed on the job and remained for some time. With the data given on the structure card the foremen needed few stakes; usually a top of wall grade, weir grade and length of wing and angle of wing-wall with levee were about all that were required for irrigation structures. Bridges required even fewer stakes. Grade stakes were set off to one side and the foremen carried the grade over to the work with spirit level and straight edge. Line stakes for walls were set by agreement 24 ins. outside worklines so that they might be preserved.

TIMBER STRUCTURES.

The usual crew was 6 men as follows: 1 foreman at $3.75 per day, 2 muckers at $2.50 per day, 2 helpers at $2.50 per day, 1 teamster, wagon and team at $4.25 per day. The crew was easily moved about the country. It usually did all dimensioning in the field. The teamster hauled out the material and assisted at the work when not otherwise busy. The crew could complete 10 single span bridges, 17 ordinary box culverts or 5 of the double wall delivery gates in one week. The crew did not grade bridge approaches as a small scraper outfit followed and did this work This crew needed the following equipment:

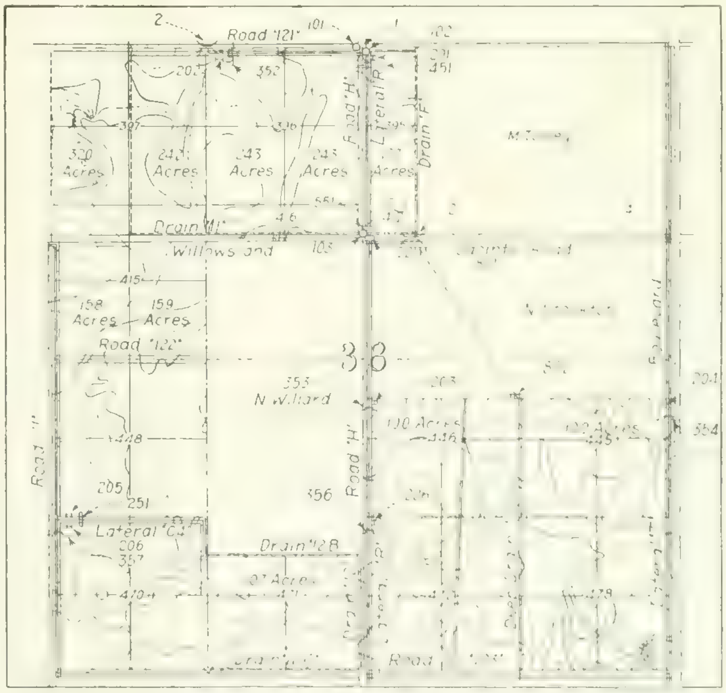
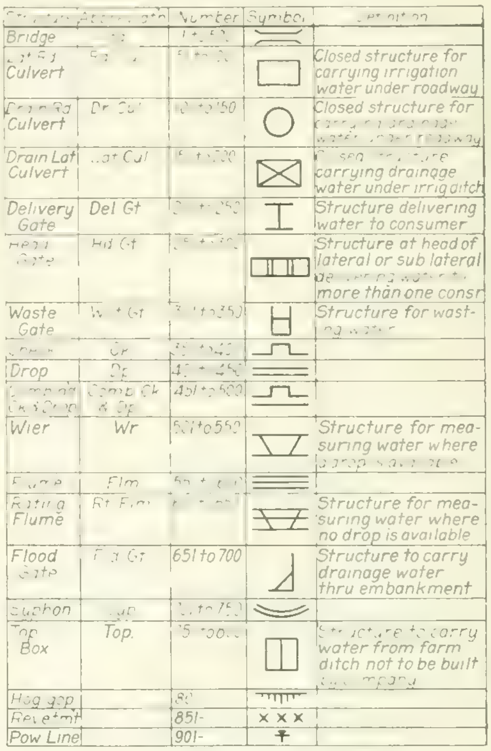


Fig. 2—Square Mile Map of Sacramento Valley Irrigation Co.

(This square mile is fairly typical of the country developed. It happens there are no laterals on ridge locations on this section—all are land-line locations. The percentage of non company lands shown on this sheet is not typical, it is too great a proportion. This map is a photo of the maps on file in the offices, which were 200 ft. to the 1 in. and were bound in books 36 ins. square. The structures and numbers were shown thereon in red.)

In addition to a carpenter's essential tools such as saws, level, hammers, square, brace and bits; a cross cut saw, a stake maul, 8-lb. sledge, chopping ax, hand ax, spike maul, crowbar, 16-ft. straightedge, 50-ft. tape, 2 picks, 2 mattocks, 4 round point, long handled shovels, 50 chalk line, 1 mason bob, water can.



Structure	Abbreviation	Number	Symbol	Definition
Bridge	Br	1 to 50	≍	
Lat Rd Culvert	Rd Cul	51 to 100	▭	Closed structure for carrying irrigation water under roadway
Drain Rd Culvert	Dr Cul	101 to 150	○	Closed structure for carrying drainage water under roadway
Drain Lat Culvert	Lat Cul	151 to 200	⊠	Closed structure carrying drainage water under irrig ditch
Delivery Gate	Del Gt	201 to 250	I	Structure delivering water to consumer
Head Gate	Hd Gt	251 to 300	▥	Structure at head of lateral or sub lateral delivering water to more than one consr
Waste Gate	Wst Gt	301 to 350	⊔	Structure for wasting water
Check	Ck	351 to 400	⎍	
Drop	Dp	401 to 450	═	
Combined Ck & Drop	Comb Ck & Dp	451 to 500	⎍ ═	
Wier	Wr	501 to 550	▽	Structure for measuring water where a drop is available
Flume	Flm	551 to 600	≡	
Rating Flume	Rt Flm	601 to 650	▽	Structure for measuring water where no drop is available
Flood Gate	Fld Gt	651 to 700	◿	Structure to carry drainage water thru embankment
Syphon	Syp	701 to 750	⌣	
Top Box	Top.	751 to 800	◫	Structure to carry water from farm ditch not to be built by company
Hog gap		801-	┬┬┬	
Revetmt		851-	× × ×	
Pow Line		901-	⊤	

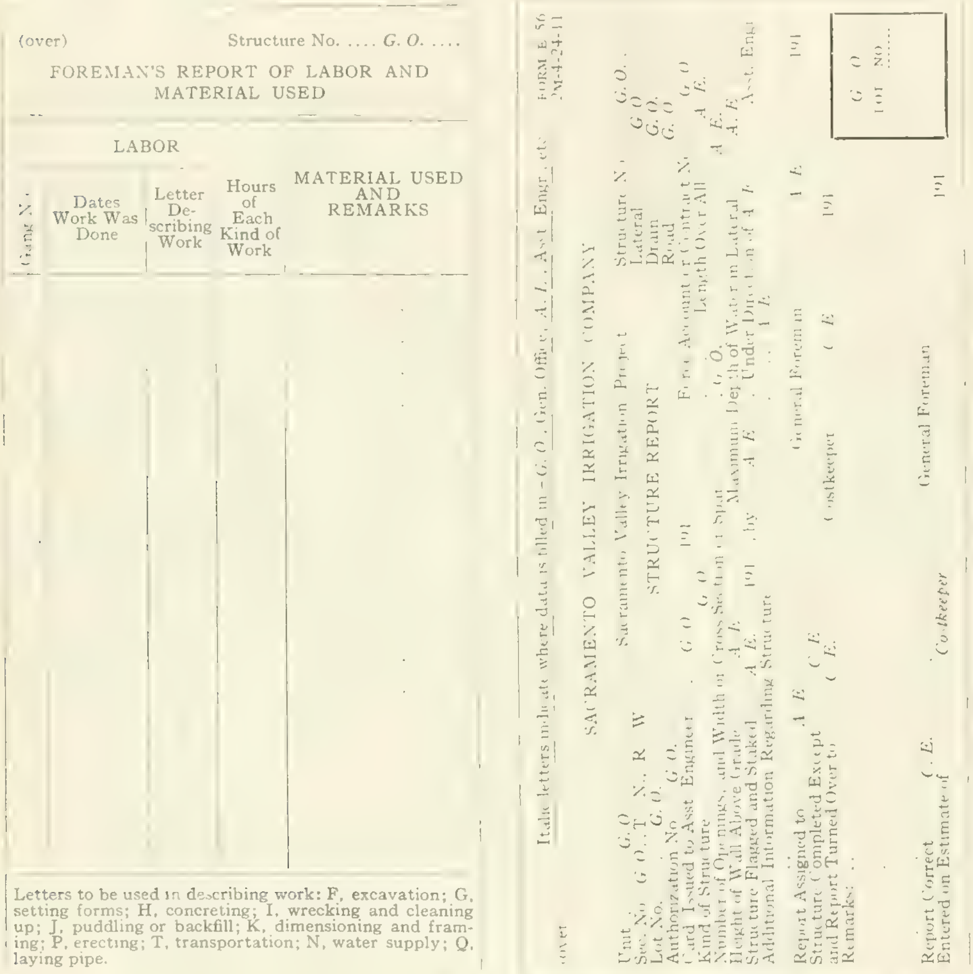
Fig. 3—Diagrams Showing Standard Structure Symbols, Sacramento Valley Irrigation Co.

In the beginning of the work some small tools had to be furnished as none of the "Bo" laborers, which were the only laborers obtainable in the Valley then, had tools or would buy any. As the work progressed a few men were gradually developed who were not "Short

Stake" men but remained and became straw-bosses and acquired some tools.

Another method tried by contractors was to have several small crews doing but one class of work. In the material yard a crew sawed out and framed the structures into wings, sides, and bottoms so they could be hauled to the field on deck wagons. The yard gang did this work at $2 per structure for any delivery date or check for a canal of 6 ft. or less bottom width. The excavation crew, two men, made the excavation for the structure at from $3 to $5 each according to the soil. The installing crew of three or four men and the backfilling crew of four to eight men usually worked by the day. The installing crew could place five or six gates per day. One contractor had a gasoline sawrig for cutting his timber. This would have been very successful if the equipment had been in good repair.

One fault on the special crew method, whether contract or force account, was that the crews did not answer to one head and were inclined to slight their work when making a "run" and hold up the following crew. The multiple crew is favored when work lays contiguous, the small crew for scattered work. Operating messes was expensive and worrisome to small contractors and if the contractor had no mess on the work it frequently meant lost time going to and from work.



(over) Structure No. .... *G. O.* ....

FOREMAN'S REPORT OF LABOR AND MATERIAL USED

LABOR				MATERIAL USED AND REMARKS
Gang No.	Dates Work Was Done	Letter Describing Work	Hours of Each Kind of Work	

Letters to be used in describing work: F, excavation; G, setting forms; H, concreting; I, wrecking and cleaning up; J, puddling or backfill; K, dimensioning and framing; P, erecting; T, transportation; N, water supply; Q, laying pipe.

Italic letters indicate where data is filled in – *G. O.*, Gen. Office, *A. E.*, Asst. Engr., etc. FORM E 56 2M-4-24-11

cover

SACRAMENTO VALLEY IRRIGATION COMPANY

Sacramento Valley Irrigation Project

STRUCTURE REPORT

Unit *G. O.*
Sec. No. *G. O.*, T. N., R. W.
Lot No. *G. O.*
Authorization No. *G. O.*
Card Issued to Asst. Engineer *G. O.* 191
Kind of Structure *G. O.*
Number of Openings, and Width or Cross Section of Span *G. O.*
Height of Wall Above Grade *A. E.*
Structure Flagged and Staked *A. E.* 191, by *A. E.*, Under Direction of *A. E.* Asst. Engr.
Additional Information Regarding Structure *A. E.*

Structure No. *G. O.*
Lateral *G. O.*
Drain *G. O.*
Road *G. O.*
Force Account or Contract No. *G. O.*
Length Over All *A. E.*
A. E.
Maximum Depth of Water in Lateral *A. E.*

Report Assigned to *A. E.* General Foreman *A. E.* 191
Structure Completed Except *C. E.*
and Report Turned Over to *C. E.* Costkeeper *C. E.* 191
Remarks:

Report Correct *C. E.* General Foreman
Entered on Estimate of *Costkeeper* 191

G. O.
LOT NO. ....

Fig. 4—Structure Report Card, Sacramento Valley Irrigation Co.

CONCRETE WORKERS.

Observations over two years of both contract and force account work proved that the best sized crew was from 10 to 15 men; the foreman got $4 to $4.50 per day, the straw boss $2.75 and three or four men at $2.50 per day did all excavations from the stakes; the form setters usually two or three men at $2.50 per day followed under a carpenter ($2.75 to $3.50 per day) who set all forms, placed reinforcement and runways, etc. The concreters, usually six men, at $2.50 per day, followed and mixed and poured the concrete. Where the six or seven concreters had fairly steady work at pouring they averaged 1.75 cu. yds. per man per day, but the average per man per day for the entire crew, usually 15 men, was about 0.6 cu. yd. Mixers were used only on the larger structures; a comparatively large force was required in the numerous operations and there being no roads passable for mixers along the work, they did not pay. Most of the structures run from 1 cu. yd. to 25 cu. yds., the main canal works being larger. With good roads a portable mixer can be moved one mile to pour 3 cu. yds. and three miles to pour 5 cu. yds. of concrete economically. As soon as the concrete had set the form setters dropped back and wrecked forms which the teamster hauled ahead. One man remained behind and pointed up edges and any "faults" which had developed. None of the walls were plaster coated, they were rubbed down with a carborundum brick or block of concrete and painted with a wash of thin neat cement. Some walls were finished with so-called "sand wipe." The concreting crew needed the following equipment:

3 gravel or muck barrows, 3 scoop or concrete barrows, 8 long handled, round point shovels, 8 long handled, square point shovels, 1 tiling spade, 2 mattocks and handles, 8 picks and handles, 1 8-lb. sledge, 2 chopping axes, 2 hand-axes, 2 2-lb. claw-hammers, 2 14-in. pipe wrenches, 1 10-in. monkey-wrench, 2 pair wire-cutting pliers, 1 No. 7 cut-off saw, 1 No. 5½ rip-saw, 1 brace and 2 bits (1 in. and ½ in.), 1 30-in. spirit level, 1 16-ft. straightedge, 1 mason bob, 2 lbs. chalk line, 50-ft. steel tape, 1 square, 1 9-in. trowel, 1 pointer trowel, 1 edger, 1 float or plasterer's trowel, 2 whitewash brushes, 1 carborundum brick, 1 barrel, 1 flat 10-in. file, 1 6-in. three-square file, 1 6-ft. zig-zag rule, 6 3-gal. galvanized iron buckets (heavy), 2 5-gal water cans (milk cans), 1 Gould force pump and assorted lengths of suction pipe extensions with 50 ft. 1-in. cotton hose, 1 4-in. post augur with 8 pieces pipe cut and threaded for handle extensions, tampers and rammers, 1 wagon and team, 1 plow No. 5, 1 slip, and in dry areas a tank wagon and force pump.

Concrete work in the Valley required much water. The tops of walls were covered with burlap sacks or earth and wetted down several times per day. Forms in summer could be removed in 24 hours except for slabs and arches. The dry wind and heat, frequently 115°, necessitated that walls be kept wet down for seven days. This was rather expensive where water had to be hauled. All the above described work was immediately under one foreman, having separate crews to do each step. The crews became proficient at their parts but would slight something frequently in making a record and be on ahead and the next crew would have to do some of their work before proceeding. The personnel of the crews changed so rapidly that with the exception of foremen and carpenters one could seldom place any responsibility. New men hired were put mucking and if they showed any ability and desire to "stick" they soon got better work. As a rule a mucker was a mucker and wanted nothing better. A good teamster was the most valuable common laborer on the crew. He could be busy every minute and at longer hours than the rest of the crew, hauling the men, water, materials, forms, grading and going after material orders without the foreman leaving the work. When a foreman's workmen get scattered over a considerable area he may be unable to be on every part of the work enough unless a horse and cart is provided. This with some foremen is a good arrangement, others will "joy-ride."

WATER

For the northern part of the area worked over water for concrete and puddling was obtained very cheaply by boring wells with a 4-in. post augur fitted with extensions cut 30 ins. long and threaded. Water was hit in a gravel stratum underlying the valley floor at from 6 ft. to 30 ft. Each crew had a Douglas pump and some crews had a force pump, with suction pipes in varied lengths which they lowered into these wells and pumped their water on each job. No casing was needed as the bored hole stood up in some cases for months; no well or sand strainer was needed as the water was clean and pure. On about half of the work one could get water this way much cheaper than by hauling, even if the yardage of concrete in the structure was as low as 5 cu. yds. To bore these wells cost less than 25 cts. per foot. When crews working in territory in which one could not bore the wells water had to be hauled; frequently water could be got from a canal or a drain and in the winter from standing surface water.

PUDDLING.

Where plenty of water was had the back fill was puddled against the structure as soon as it was safe to put the weight against the wall, usually five to ten days after the forms were removed. The concrete crews did this work under the foremen's directions. The puddle must be brought up evenly in layers around the walls. If the soil at the site had no gravel in it an excess of gravel was "spotted" when it was ordered for the concrete. This gravel was mixed in the top-most layer of the puddle; it would prevent soil cracks when sunbaked and help prevent the backfill from pulling away from the wall and allowing seepage along or around it. This trouble is found more with timber structure than concrete. Backfill and puddle will set up to the concrete, not to wood. Where water was scarce the puddling was let go to be done later when water was let into the system or when the winter rains came on. A great many structures were backfilled and puddled in the rainy season this way by diverting rain or runoff water, out over the system from the main canal and puddling structures as work proceeded downstream. Two large areas were left awaiting the completion of the canal system to puddle with canal water in a careful manner, but it so happened that water had to be rushed down early the following season on account of no late rainfall and in the "hurrying up" which ensued a few structures were quickly and poorly puddled and went out. Some structures were puddled by leaving the excavated material in such a manner that any of the rain and surface water would pool about it. After a few rains and trips to the structures by the men they would get them puddled piecemeal. The men did this work rainy days proceeding along the levees. With a clay soil type some structures were backfilled with the earth pulverized to a dust and it proved satisfactory, preventing seepage and soil cracks and squirrels burrowing. This would not do with sandy soil as it would not pack, or with an adobe soil as it could not be pulverized properly or economically. It is very essential that a good job be done backfilling structures, especially around mudsills, curtains, aprons and seep walls, which are to resist water, if loss and damage are to be prevented.

FORMS.

Forms were of 1-in. stuff with 2x4-in. studs properly spaced. Redwood rough is good form lumber, comes sized but costs $6 more per M. than fir, at $22, which was very poor for forms. Redwood worked into panel forms could be used five to seven times, the fir was not worth working into panels unless it was covered with galvanized iron. Nearly all structures were built per drawing, and many others were built with forms covered with 26-gage galvanized iron. These forms were built 2, 3, 4 and 5 ft. high and 6, 8 and 10 ft. long. They were fitted with eye bolts of ⅜-in. round iron to act as cross ties, endgates for plumb or battered walls, gate groove forms, and wing forms; they could be lengthened or shortened or stood on top of each other for increased height. These forms were very handy for single structures or for group arrangements. The cost of the form for material and labor was 14 cts. per square foot area. The carpenters got $3.50 per day of eight hours, as they worked but eight hours in the town where these were made. Their life was good for at least 50 times. They were scraped clean after each job. Forms for casting gate grooves were usually soaked in water previous to using and were sometimes soaped. Some collapsible forms were constructed on the work for syphons and arch culverts 20 ft. to 28 ft. long, sized 1½x2 ft., 2x3 ft., 2x4 ft. They were of 1-in. material covered with galvanized iron and while they were successful there are forms on the market of metal for this very purpose that are far more economical. Forms on this arch about six times used. In place of this type of work would become warped and wrecked in construction later concrete pipe and corrugated iron pipe were used. The excavations as a rule stood up so well in the valley that all footings were cast direct in the trench. The usual method was to excavate roughly down to weir grade an opening wide and long enough to allow a man to walk and work around the forms to be set, below weir grade an exact excavation for footing was made as called for by the engineer or by the plans—across this footing trench the forms were supported on redwood 2x2-in. sticks. The forms were securely set up, with "spreaders" and eye-bolt cross ties, to proper dimensions at one side where the men had plenty of room and were carried to the footing trench and there lined and trued up with the other forms making the rest of the structure or group. The bank was frequently used to cast against and so saved one form in the larger excavations, especially the Main Canal work. This only required a little more care in the excavation lines to get them true. It saved forms, also was better than any job of backfill one could get.

EXCAVATIONS FOR STRUCTURES.

For the smaller structures pick and shovel work was found cheaper than stock, any cut to be opened 6 ft. or more bottom width and 20 ft. or more long, through levee, or on the flat can better be opened with stock. Take the ordinary 5 cu. sec. gate of Redwood, the excavations were usually made in the shape of an H and the muckers moved in all about 14 cu. yds. at 50 cts. or $7. If stock were used they would usually move about 25 cu. yds. counting the side slopes which at 30 cts. would more than equal the shovel work and the dressing up and digging of footings remained to be done. In backfilling there was this extra dirt to replace also. There are unusual soil and weather conditions however, where stock and slips will pay even on small structures.

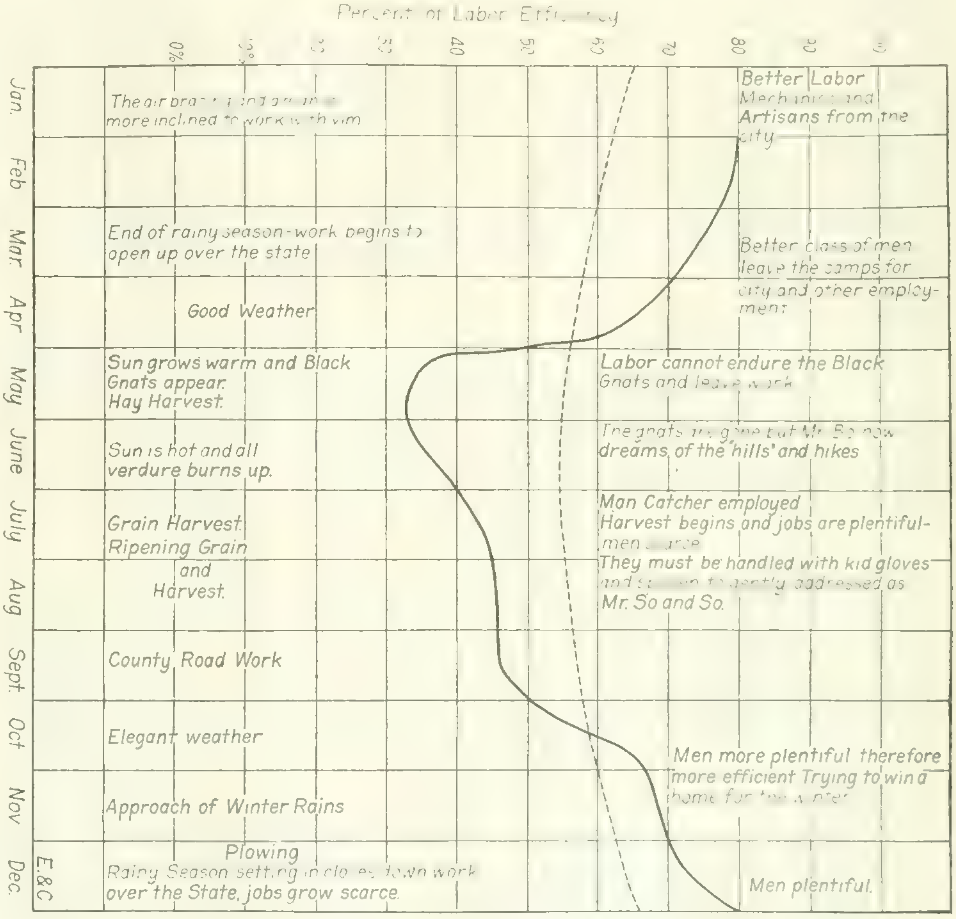


Fig. 5—Labor Efficiency Curve, Sacramento Valley Irrigation Co.

GRADING CREW.

At the large messes a small grading crew was kept of about 10 head of well broken stock, not old 'jugheads." It requires A-1 stock for this work, turning and twisting around and yet not defacing any part of the structure while doing close dumping. The outfit was kept busy, backfilling, excavating for larger structures, connecting up drains and levees to structures and closing gaps left open in road until structures were placed on bridge approaches, etc. A crew like the above could do this class of work for two timber crews and three concrete crews. They needed the following equipment: 1 No. 5 Western plow, 1 No. 2 slip scraper, 1 4-horse Fresno scraper, 2 2-horse Fresno scrapers, 1 low wheeled iron farm wagon, necessary spreaders and fifth chains, 4 earth shovels, 1 clod maul, 2 picks and handles, 10 head stock, 2 mattocks and handles, tool box and lanterns. Crews like this moved dirt scattered in small quantities from 6 cu. yds. to 300 cu. yds. and as far from camp as four miles at an average cost of 27 cts. per cubic yard. Bridge approaches were so figured. Stock with harness cost $11 per head per month. It cost about 80 cts. a day to feed, shoe, stable, repair harness and pay veterinary's fee on a mule. The feed for a mule per day being 30 lbs. wild oat hay and 12½ lbs. rolled barley. The foreman of this crew would get from $3 to $3.50 and the men $2.50.

HAULING GRAVEL.

In some areas where 500 cu. yds. or more of concrete work was in sight and was within 3½-mile haul of a gravel bed or bar a pit and trap dump was put in which would cost about $125 to erect, grade approaches, put up corral for 40 head of stock and set up mess car, bunk cars or tents. About 2,400 ft. B. M. are required which can be reused and is salvage on the above expense. This $125 spread over the gravel hauled out grows less as the yardage increases. Where it was not economical to erect a trap dump and hand loading was resorted to a man was furnished to assist at loading or on short hauls allowed 25 cts. per load extra.

The approaches should not be over 10 per cent grade, six stock and three 2-horse fresnos will be required to load wagons, also it may be necessary to have one "snap" team to assist loaded wagons out of the pit. This arrangement should have 15 or more wagons equipped with gravel racks hauling out of the pit or it will not pay. The straw-boss in charge got $3.25 or $3.50 and labor $2.50. Gravel cost 35 to 50 cts. per cubic yard mile. The wagons held 1 cu. yd. or 1¼ cu. yds. Some gravel was hauled long distances where few turns were to be encountered by using six-up with "long-line skinner" ($2.75) and one wagon and one or two trailer wagons. This saved a driver. Gravel haulers should be camped at the pit if possible to save time going empty at the ends of the day.

HAULING MATERIAL.

All construction materials were bought by the carload and stored in warehouses or yard from which they were hauled out on requisition. Redwood and fir bought at the mill were sap heavy, the work not requiring cured lumber. The redwood weighed 3 lbs. to the board foot and the dimension stuff was quite heavy. Contract hauling on cement, lumber, iron and concrete pipe was found to be the most economical as many of the "skinners" were not reliable or sober and broken reaches, tongues, harness, lost time, etc., proved quite an item with our force account hauling. If a string of wagons was had that warranted a boss to oversee, the force account hauling proved practical. Hauling lumber by contract cost 40 cts. per M. per mile. Hauling cement and similar material 25 cts. per ton per mile, payment made per pound to nearest ¼ mile and a 10 per cent reduction being made if the haul was over 10 miles. The roads were usually good, the average load on 3½ wagon being 2½ tons or 1,500 ft. B. M.; stock usually weighed 1,250 lbs. If the haul was over new roads, or ungravelled ones or in the rainy season, the loads were reduced 50 per cent or four-up put on the wagon. Miscellaneous supplies not covered fairly by the above terms were agreed upon at some lump sum rate. Hauling corrugated iron pipe proved expensive as it is bulky and unwieldy and if soldered care had to be taken in hauling and handling not to spring the joints. In a few cases where the several diameters were desired in a certain vicinity one could telescope them. An average cost was 5 cts. per pound any diameter, and distance up to 12 miles.

Unloading materials from cars cost as follows per M. ft. B. M.: Lumber off flat cars, 30 cts.; lumber out of furniture cars, 45 cts.; lumber out of gondolas, 70 cts. Trucking mixed lumber 100 ft. by two men, sorting and piling in yard, per M. ft. B. M.: Dimension stuff, 4x4-in. and larger, 40 cts.; all other, 60 cts. For same work, 200 ft., add 10 cts. per M. ft. B. M. Trucking cement 50 ft. from furniture car into warehouse and piling 6 ft. high cost ½ ct. per sack. Trucking and piling groceries, crates, canned goods, cost 40 cts. per ton. To unload, roll 60 ft. and pile an average flat car of corrugated iron pipe all diameters to 60 ins. and lengths from 10 to 30 ft., some telescoped, cost $3.50 per car of 12,000 lbs. or 450 lin. ft. Reinforcing iron, ⅜-in. to ¾-in. round bars, 16 to 25 ft. long to move 60 ft. and stack off the ground assorted cost $7.50 per car of 2,500 pieces. Deformed bars cost 30 per cent more.

BUILDINGS

Design and Construction of the Chicago Hebrew Institute—A Reinforced Concrete Structure Possessing Unusual Features.

(Staff Article.)

The Chicago Hebrew Institute, at Taylor and Sibley Sts., Chicago, presents an interesting study of reinforced concrete construction. The building is 96 ft. wide by 231 ft. long with a height, from ground floor to roof, of 52 ft. The reinforced concrete column footings and the outside wall footings extend 5 ft. 1 in. below the level of the ground floor. The main portion of the structure, which has a curved roof, rising to the height of 52 ft., is flanked on each side by a two-story portion, one bent wide, which extends to a height of 21 ft. 6 ins. above the ground floor level. At the rear of the high portion of the building there extends for the full width of the structure, for a distance of 64 ft., a section having the same height as the wings. The outside walls of the two-story section, above grade, are self-bearing, 12 to 16-in., "Dennison" tile walls, with a cement plaster finish on the outside and lined on the inside with yellow pressed brick laid with ½-in. joints of white cement and lime mortar. The pressed bricks have a rough surface, to prevent their being easily defaced. Below grade, the outside walls are concrete. Most of the partitions are made of 4-in., yellow, double-faced, pressed brick, laid in cement and lime mortar and reinforced every five joints with two ¼-in. rods. The second floor of the front portion of the building is occupied by the main gymnasium, this portion being open from the gymnasium floor to the roof, with the exception of a running track which circles the gymnasium and is cantilevered from the reinforced concrete columns. This track is about 15 ft. above the gymnasium floor level. The rear portion of the building contains two swimming pools, a small gymnasium, dressing rooms, etc. The total cost of the structure, including equipment, is about $120,000, of which the cost of the equipment is only a few thousand dollars.

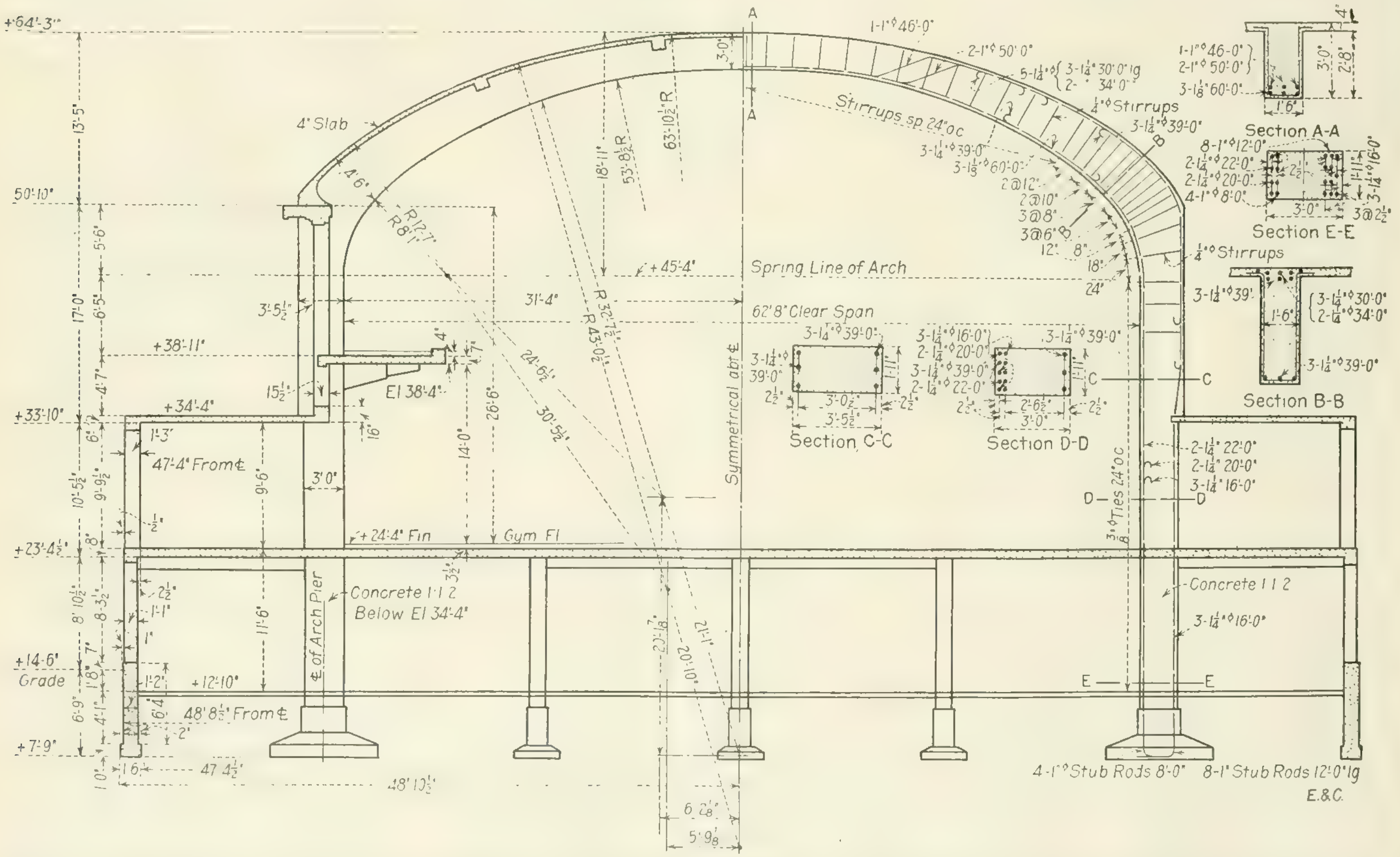


Fig. 1—Cross Section Through Main Gymnasium of Chicago Hebrew Institute, Showing Details of Arches and of Supporting Columns.

STRUCTURAL DESIGN FEATURES.

From an engineering standpoint, the reinforced concrete framework of the building presents a number of interesting features, the architectural requirements being such as to make the structural design somewhat intricate.

Design of Roof Arches and Supports.—Chief among the structural features are the reinforced concrete arches which form a part of the curved roof over the main portion of the building. The legs of these arches are continued to form the columns between the high portion of the building and the two-story wings. The arches and columns are poured monolithic, thus forming reinforced concrete bents. The arches have a clear span of 62 ft. 8 ins., and a rise of 15 ft. 11 ins. The length of the supporting legs, or columns, from spring line to bottom of footings, is 37 ft. 7 ins. At the crown, the arches have a width of 1 ft. 6 ins. and a depth, including the roof slab, of 3 ft. 0 in.; at the spring line, and continuing to the roof of the two-story wings, the width is increased to 1 ft. 11 ins. and the depth to 3 ft. 5½ ins.; below the roof of the two-story wings the columns are 1 ft. 11 ins. x 3 ft. 0 in.

Figure 1 is a cross section of the building through the main gymnasium. This drawing illustrates the type of construction used, and gives details of the arches and columns.

In designing the arches, they were considered to be fixed at the gymnasium floor level, elevation 24 ft. 4 ins. (see Fig. 1), the legs of each arch being tied together with four 1-in. round rods placed in the floor slab at this level. The design was first based on formulas for this type of construction given in Mensch's "Reinforced Concrete Pocket Book." These formulas are based on a constant moment of inertia, which did not obtain in this arch and its supports. It will be noted that the arch legs above the roof of the two-story portion, elevation 34 ft. 4 ins. (see Fig. 1), are larger than below this level, for architectural effect. The accompanying table gives the values of the moments at various points and of the thrust of the arch (both expressed in terms of pl^2) for the two conditions: (1) that the moment of inertia is constant; and (2) that it varies according to the shape of arch ring and legs, as shown in Fig. 1:

Constant moment of inertia.	Variable moment of inertia.
$M_a = 0.05\ pl^2$	$M_a =$ [illegible] pl^2
$M_b = 0.048\ pl^2$	$M_b =$ [illegible] pl^2
$M_c = 0.028\ pl^2$	$M_c =$ [illegible] pl^2
$T = 0.10\ \frac{pl^2}{h}$	$T =$ [illegible] $\frac{pl^2}{h}$

The arches were computed for a roof load, p, of 2,200 lbs. per linear foot. The stresses due to wind were taken into account, but they were not sufficiently large to affect the design. On account of the high stresses occurring in the arch legs a 1:1:2 concrete was used for their construction; for the arch proper a 1:2:4 concrete was used. The effect of the brackets, which support the running track, was to decrease rather than increase the stresses in the arches.

Column and Wall Footings.—Figure 2 is a footing plan of the columns and walls. These footings rest on clay, and were computed for an allowable pressure of 3,500 lbs. per square foot. In general, the reinforced concrete footings of those columns which support the arches are 8 ft. 6 ins. square, although a few of them are 7 ft. 6 ins. square. Each 8-ft. 6-in. footing is reinforced with rods running in each direction, a total of 40 ⅝-in. round rods, 8 ft. 3 ins. long being used. For the 7 ft. 6 in. footings the reinforcement consists of 24 ⅝-in. round rods, 7 ft. 3 ins. long. Stubs rods, bent into the footings, are used to connect the footings to the columns.

The details of the wall footings are shown in Fig. 2.

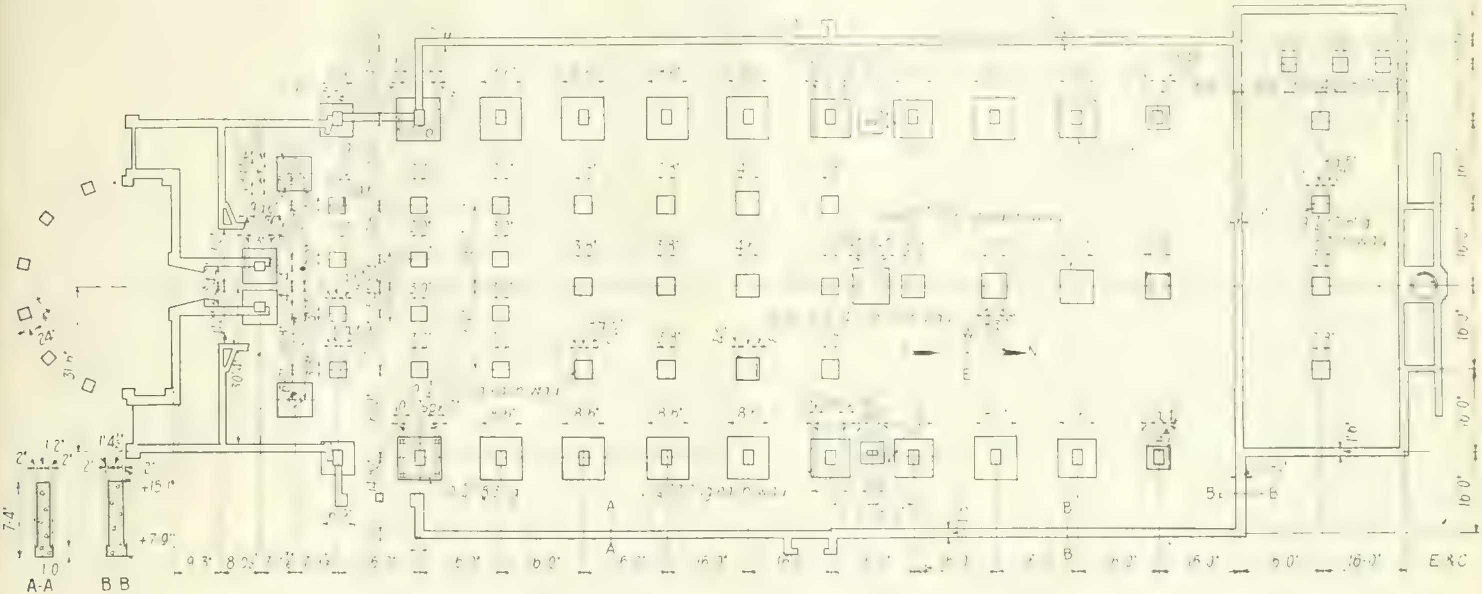


Fig. 2—Footing Plan of Chicago Hebrew Institute.

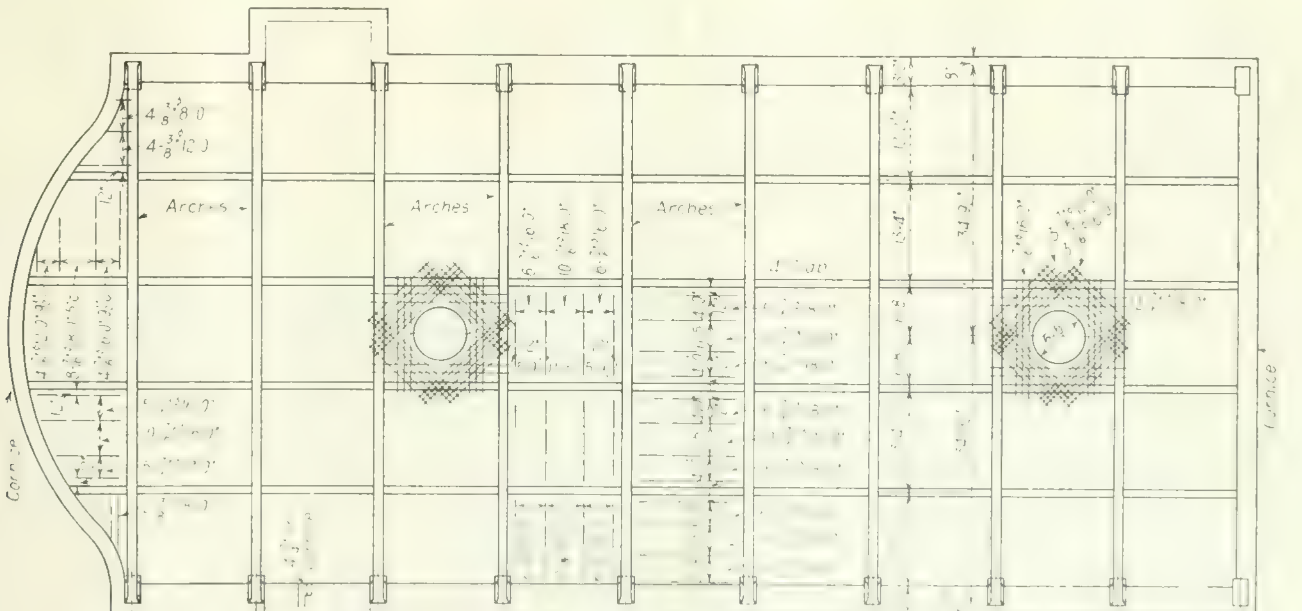


Fig. 3—Plan of Curved Roof Over High Portion of Chicago Hebrew Institute.

Roof Girders and Slab.—The curved roof over the main portion of the building is of the girder-and-slab type of construction. Figure 3 is a roof plan of this part of the structure. The roof slab has a thickness of 4 ins., and is reinforced in both directions with 7/16-in. round rods, spaced as shown in Fig. 3. The girders have a width of 11½ ins. and a depth, including the 4-in. roof slab, of 12¾ ins. Each girder is reinforced with two ¾-in. square rods and two ⅝-in. square rods, and with 15 stirrups composed of ¼-in. round bars. The front cornice girder shown at the left of Fig. 3 is curved both in a vertical and in a horizontal plane.

The roof over the two-story portion of the building is also of the girder-and-slab type of construction, the thickness of the reinforced concrete slab being 6 ins. Figure 4 is the third floor and roof framing plan; elevation 34 ft. 4 ins., the roof of the two-story wings and that of the second floor being at the same level. The elevation of the running track, shown in this drawing, is indicated in Fig. 1.

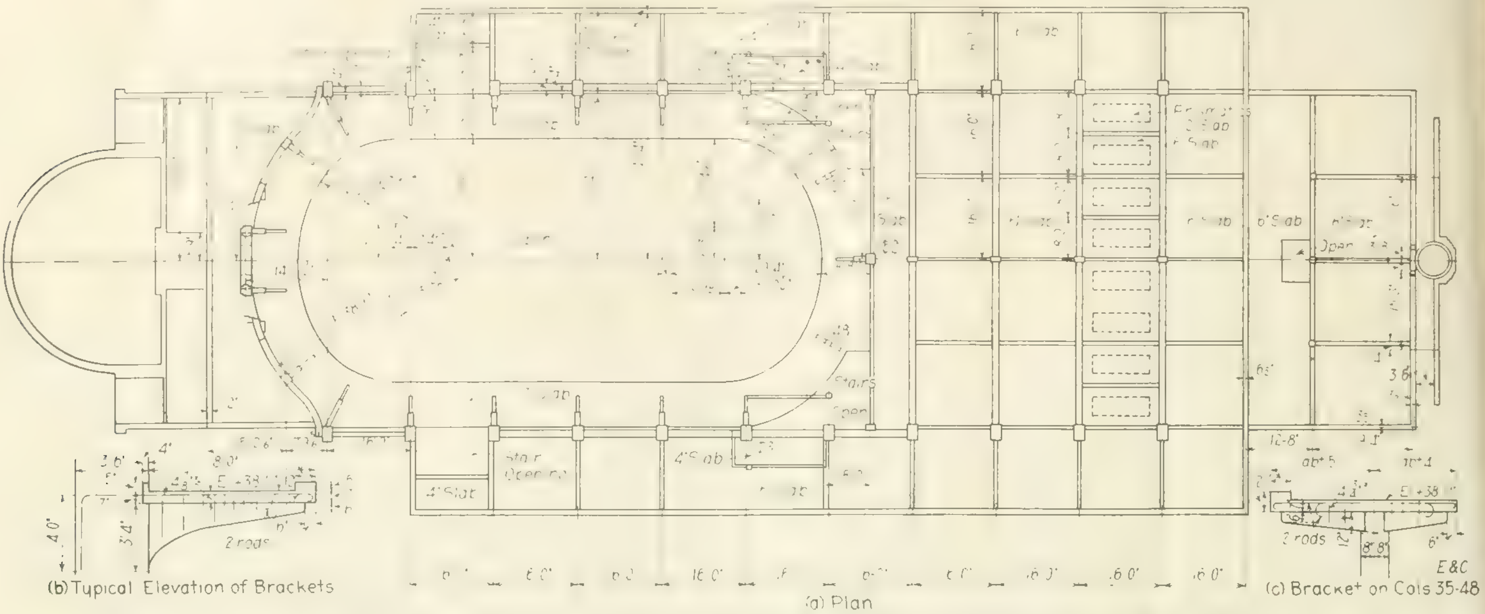


Fig. 4—Ceiling of Second Story, Roof of Two-Story Portion and Details of Brackets Supporting Running Tracks.

Running Track.—In general, the running track is supported on reinforced concrete cantilever brackets attached to the columns. At the north end of the track, however, some unusual design features are employed. By referring to Fig. 4, it will be noted that the cantilever brackets attached to column Nos. 6 and 23 each carries (at its end) one end of a girder, the other end of which rests on a column; this girder, in turn supports a part of the track. Columns Nos. 35 and 48 do not extend above the running track. A double cantilever bracket at the top of each of these columns supports the track at these points. Column No. 52 also extends *only* to the running track level; it carries at its top a cantilever bracket, which in turn supports a large section of the running track.

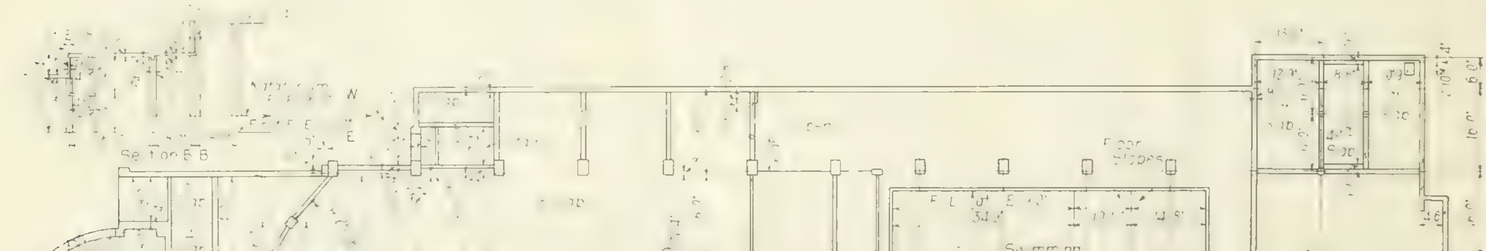


Fig. 5—Ceilings of First Story and Natatorium Floors of Chicago Hebrew Institute.

Figure 4 (b) is an elevation of a typical cantilever bracket, the width of this bracket being 14 ins. Figure 4 (c) is an elevation of the double cantilever brackets used at columns Nos. 35 and 48.

First Floor Framing.—Figure 5 shows the framing at the second floor and natatorium floor levels. By referring to this drawing it will be noted that both flat slab and beam-and-girder constructions are used at this level. By referring to section B-B, Fig. 5, it will be noted that, due to changes in the floor level, thin, deep girders are used at these changes in grade. At the line in which column No. 34 is located the girders have a length, center to center of columns, of 16 ft., a depth of 4 ft. 8 ins., and a width of 6 ins.; while at the line in which column No. 57 is located the girders are 32 ft. long, 6 ft. 8½ ins. deep, and 9 ins. wide.

Swimming Pools.—At the north end of the building there are two swimming pools (for location see Fig. 5), each pool having a width, between concrete walls, of 25 ft. 4 ins. and a length of 60 ft. 4 ins. Figure 6 is a plan and side elevation of one of these pools. These drawings, together with sections 1-1, 2-2 and 3-3, illustrate the construction features and the manner of reinforcing the sides and bottom of the pools.

CONSTRUCTION FEATURES.

Forms.—On account of the careful designing of the framework and staging, the quantity of lumber used for this work was exceptionally small. Even though the crown of the curved roof of the main gymnasium is about 42 ft. above the ground floor, the quantity of lumber used in stagings for the arches and roof slabs was only 4¼ ft. B. M. per square foot of horizontal projection.

The staging under each arch consisted of four towers, each tower being composed of four 4x6-in. timbers, in the form of a 6-ft. square, laced with 1x4-in. members to form 7-ft. panels. A 6-ft. space was left between each of the four towers. The various towers were then braced together to form a rigid system of falsework.

The arch forms were constructed on a 40x40-ft. platform, built on the ground at one side of the building. Each form was built in four parts, and hoisted into place. When in place it rested, by means of wedges, on 2x6-in. timbers rough nailed to both sides of the 4x6-in. tower posts. Great care was used in constructing the arch forms to insure that they conform closely to the lines of the arches. For the central slightly-curved portions of these forms the bottoms were formed of two layers of 1-in. boards; while for the sharply-curved end portions four layers of ½-in. boards were used. By using thin boards it was possible to construct these forms both rapidly and economically. The sides of the arch forms were constructed of 1x8-in. boards, placed horizontally, and braced with 2x4-in. vertical pieces spaced about 2 ft. on centers. Figure 7 is a view of the structure showing a part of the staging and forms for the arches and roof.

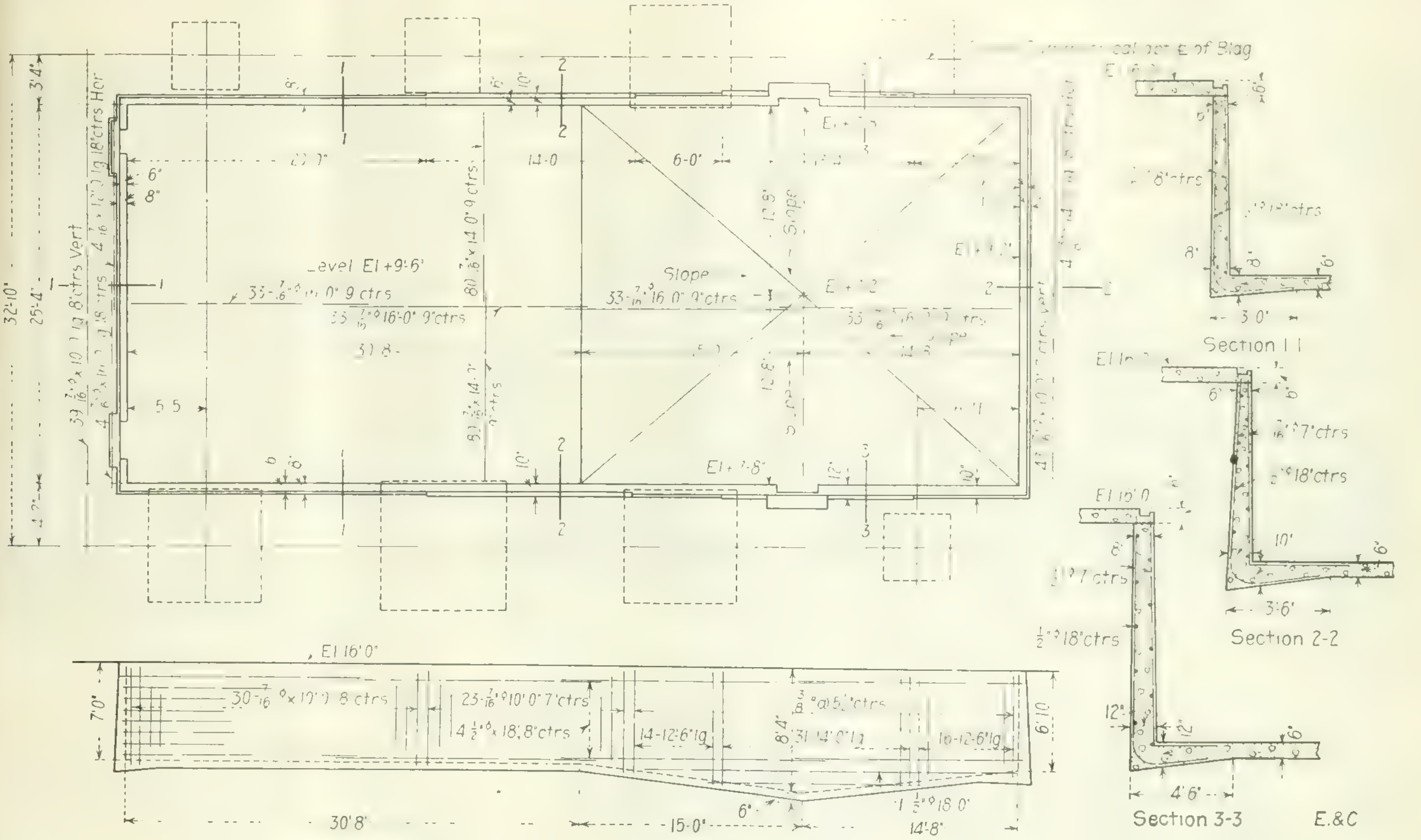


Fig. 6—Plan, Longitudinal Elevation and Partial Sections of Swimming Pool in Chicago Hebrew Institute.

The forms for the 4-in. roof slab between arches were supported on joists cut from 2x10-in. rough tamarack timber. These joists were placed perpendicular to the arches and were spaced about 2 ft. on centers. They rested on 2x10-in. ledges nailed to the tops of the 4x6-in. posts, these ledges thus having a span of 6 ft. At the junction of the arch ribs and roof slab a 5x5-in. fillet was formed, using sheet metal forms for this purpose.

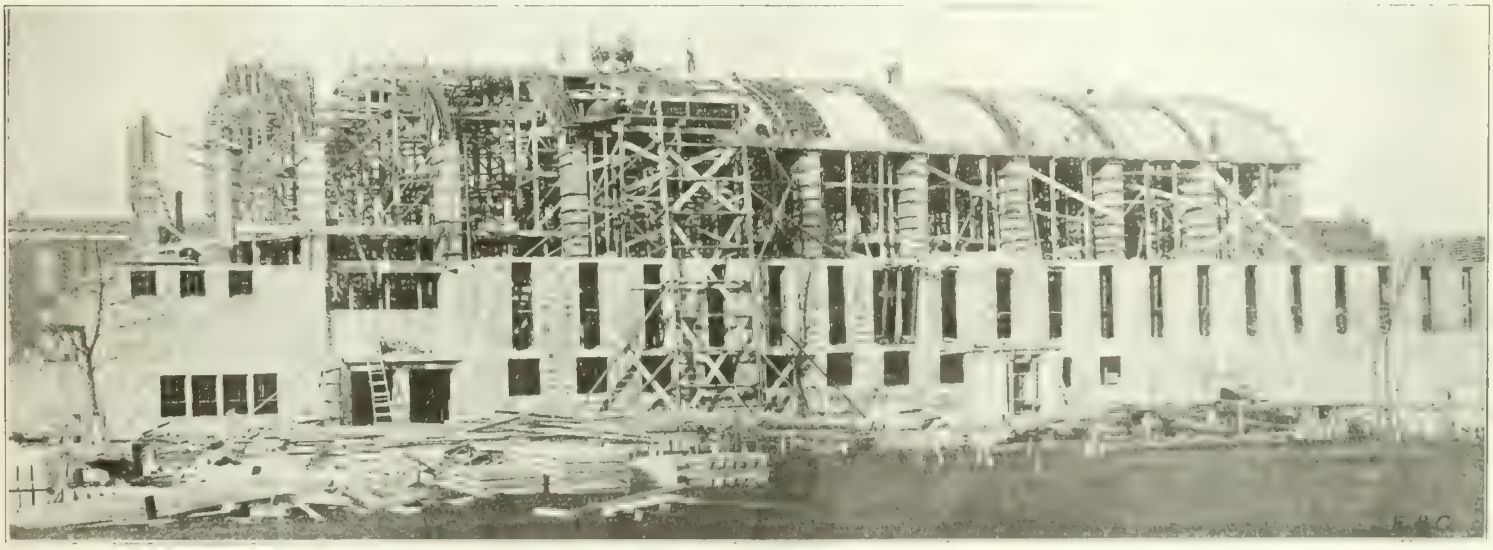


Fig. 7—East Elevation of Chicago Hebrew Institute Showing Arch and Roof-slab Forms and Staging—View Also Shows Material Carriage Hoist.

It was necessary to tie together the column forms at each arch to prevent their being forced out of line by the lateral pressure of the wet concrete on the steep slopes of the arch ribs. It was also necessary to provide against the tendency of the wet concrete to flow in the sloping cornice forms. These forms were braced with long 4x6-in. timbers, set with their bases at the 34-ft. level. To lessen the pressure caused by the tendency of the wet concrete to flow toward the ends of the arch ribs, each arch was concreted in three sections, on three consecutive days. To insure a firm bond between these sections a high percentage of reinforcement was used at the junctions between sections. The lower portion of each arch, for a length of 18 ft., was so steep that an upper form was necessary to hold the wet concrete in place. This part of the arch form was built in 6x8-ft. panels, held in place by spreaders, and wired to the joists.

For architecural effect, the front (Taylor St.) wall of the gymnasium follows the line of the running track. At the intersection of this wall with the curved roof (as has been noted) an ornamental concrete cornice is provided, which follows the compound curve of the intersection of wall and roof. The construction of the forms for this cornice required very careful computations, but by using thin boards which could be readily sprung, it was possible to construct these forms with little difficulty. The forms were built on the 40x40-ft. platform at the ground level and then hoisted into place and braced.

In constructing the forms for the brackets supporting the running track, sheet metal was used for their bottoms, to insure a smooth, even surface.

In building the forms for columns and girders 1-in. quarter rounds were used at the corners to give a finished appearance.

Bending and Placing Reinforcement.—The main reinforcing bars for the arches were bent on an ordinary bending bench, by means of gas-pipes, to templets made of ½-in round bars. These were placed in the forms singly, and the ⅜-in. round ties then fastened to the bars by a man working inside of the forms while another man stood at the top of the form and held the bars in the correct position. The position and size of the arch reinforcement are shown in Fig. 1.

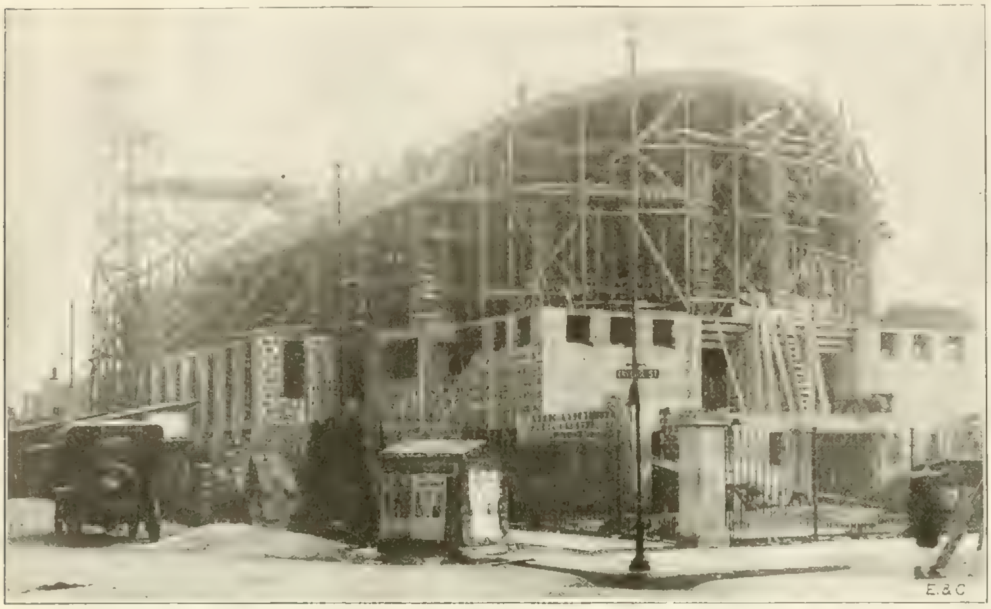


Fig. 8—Front and West Elevations of Chicago Hebrew Institute, Showing Concrete Plant and Forms in Place.

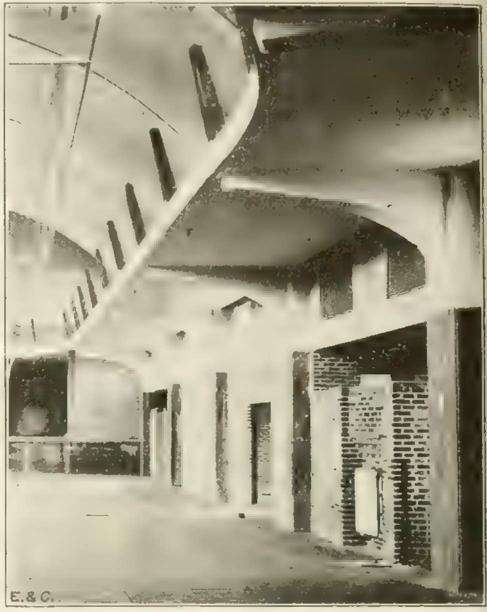


Fig. 9—Interior View of Portion of Main Gymnasium of Chicago Hebrew Institute.

Hoist for Elevating Materials.—The lumber and reinforcing steel for the arches and roof were elevated in the special carriage hoist shown in Fig. 7. This hoist had a width of 10 ft. and a capacity of one ton. It moved along two parallel tracks, and automatically dumped its load of lumber or steel on a platform at the roof level. The hoist was raised or lowered by means of a cable, operated from the concrete hoisting engine located on the opposite side of the building.

Concreting Plant and Procedure.—The concreting plant consisted of a ¾-cu. yd. batch mixer, equipped with a side loader, discharging into a 20-cu. ft. hoisting bucket, which in turn emptied into a 1½-cu. yd. hopper suspended from the hoisting tower.

In concreting the main arches, a staging was built adjacent to the hoisting tower, and extended from the 34-ft. level to the 66-ft. level, the latter being about 1 ft. above the crown of the arches. This staging supported a runway, about 12 ft. wide (see Fig. 8). The concrete for the arches and roof slab was dumped from the hopper into 4-cu. ft. wheelbarrows, and wheeled to the highest point of the roof and along the comparatively level crown portion. From this position, it was spouted to the lower parts by means of small chutes laid directly on the roof. For all other parts of the structure, the concrete was hauled in carts having a capacity of 6 cu. ft.

The concreting of the arches was done during the period Nov. 2-Nov. 6, 1914. Although the temperature was around 50° F., a number of salamanders were supported at a distance of about 6 ft. below the roof surfacing and kept in operation both day and night to hasten the setting of the concrete. The arch forms were removed about the middle of December.

Testing of Arch.—In February, 1915, one arch was tested, by order of the city building department, by loading the half span with twice the live load used in its design. This loading test was quickly and economically conducted by suspending, at three points along the half span (7 ft. 8 ins. apart), a cradle on which was piled the required load, consisting of 2 x 10-in. x 14-ft. planks. This cradle was swung from the arch a few feet above the ground floor by means of a ⅝-in. cable about 300 ft. long, the cable being passed successively around the timbers of the cradle and the loading points of the arch, through holes cut in the roof slab. "Crosby" clips were used at connection points, to prevent an unequal distribution of the applied load.

The test was made while the staging was still in place so that measurements to determine possible deflections could be made quite accurately. Although careful measurements were made, there was no appreciable deformation of the arch or change in the distance between columns at the springing lines. The difference in temperature between that existing in the morning and afternoon caused a rise and fall of the crown of about 1/16 in.

Removal of Forms and Finishing.—The settlement of the crown when the arch forms were removed was between ⅛ and 3/16 in. The staging was left in place until the 3-in. pipes for the gymnasium apparatus and electric light fixtures were installed and until after the ceiling was painted.

The painting of the ceiling consisted of applying three coats of white cement paint. All floors have a granitoid finish, the surface of which was covered with sand and kept wet for a week after being laid. Figure 9 is an interior view showing the surface finish of the concrete, and the interior brick finish of the tile walls. The view also shows a portion of the arches and running track. Figure 10 shows an exterior view of the finished building.

Swimming Pools.—The two swimming pools (for details see Fig. 6) were built in four working days, each pool being completely concreted in one day. They were constructed of 1:1½:3 concrete, heavily reinforced, and were waterproofed with three coats of "Ironite." The pools were lined with white mosaic tile, and gutters were constructed of cement.

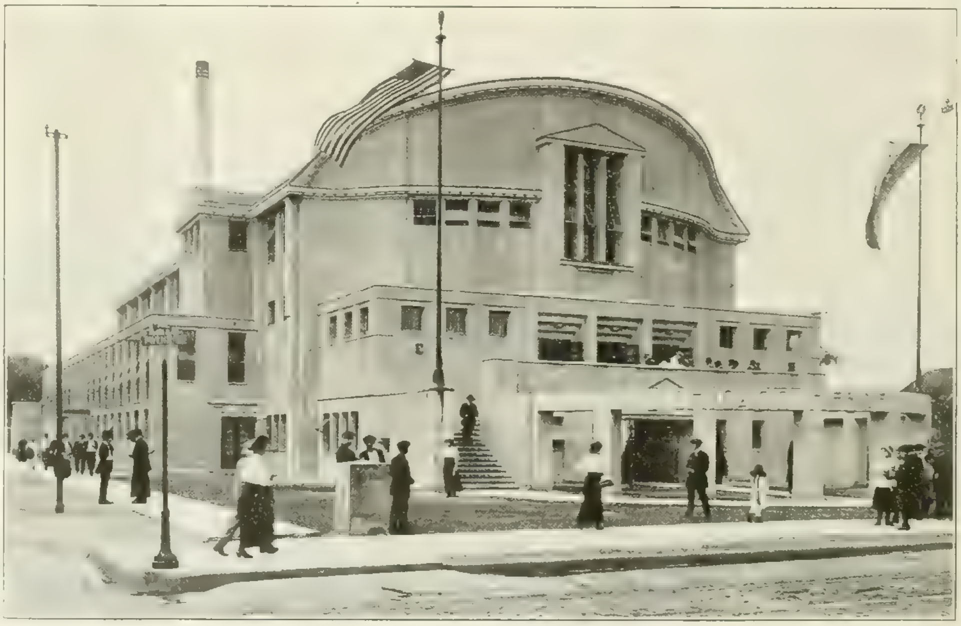


Fig. 10—View of Taylor Street Front of Chicago Hebrew Institute, Showing Architectural Treatment of Exterior.

Stairs.—The reinforced concrete stairs were constructed after the building was enclosed, and finished immediately after being concreted. Some of the stairs, which have 4-in. brick walls for railings, were built by first concreting the inclined slabs, then constructing the 4-in. walls, and finally placing the ready-made steps in position. The remaining stairs were built in the usual manner.

Railing Posts for Running Track.—The railing posts along the outer edge of the running track were cast in advance of the construction of the 7-in. track slab. The reinforcing bars in these posts were extended beyond the bases and bent into the plane of the slab. The posts were then set in place and the running track slab concreted.

PERSONNEL.

L. J. Mensch, of Chicago, was engineer and contractor for this building. The architectural design was executed by Ottenheimer, Stern & Reichert, also of Chicago. We are indebted to Mr. Mensch for the data upon which this article is based.

The Need for Treating Timber Used in Factory Construction With Suggestions as to Methods of Treatment.

(Staff Abstract.)

It is becoming difficult to get timber for mill construction of uniform quality with sufficient natural resistance to withstand fungus unaided in the moist atmposhere of textile and paper mills. Longleaf pine of high natural resistance can be obtained, but by present selling and grading methods there frequently is mixed with it enough light porous material to destroy the reliablity of the lot for important uses. Figure 1 illustrates the wide range of densities which is now being sold as good longleaf pine. As a result of the poor quality of timber practically obtainable and the higher factory humidities in common use antiseptic treatment of mill timber and planking is becoming a necessity.

Little experience is available to guide the pioneer in the preservation of mill timber. That which has been treated in the past has been used for basement floors, bridges, and other construction near or in contact with the earth, where the conditions are somewhat similar to those which have been successfully met in treating railroad ties. The problem of mill frames and floors is different in several respects. Leaching is of little importance. Fire hazard with enclosed rooms containing large values demands the most careful consideration. The strength of the frame supporting a high building filled with processes involving wide variations in temperature and dryness, and subject to the constant shock and vibration of moving machinery must be safe-guarded against deterioration over long periods of time.

CAUSES OF DECAY.

Fewer botanical varieties of timber are practically available for mill construction than for railroad ties. This simplifies the problem as each variety of tree has its own fungus destroyers. Moreover the varieties of fungi which attack a given variety of wood are further limited by moisture and temperature requirements, in which most of them are very exacting. It is, therefore, to be expected that only a few varieties of fungi will be found in mill buildings.

The railroad tie in contact with the earth is subject to continuous attack by *mycelium,* as well as by *spores* from *fungi* which flourish on nearby decaying vegetation. Such sources of infection exist to a much less degree in a building with smoothly painted ceilings and clean floors. As a result, timbers of moderate natural resistance, such as good quality longleaf pine, heart-wood, without antiseptic treatment, have proved entirely satisfactory for mill construction in the past. It is, therefore, to be expected that much less elaborate preservative treatments from those in use for railroad ties will satisfy the requirements of mill timber.

Members of the *polyporous* family cause much damage to mill roofs and basement floors where excessive moisture is prevalent. A reduction of the moisture will generally arrest them, but this is not often possible, owing to the necessities of manufacturies processes.

Dry rot fungi are able to carry on their work of destruction where little moisture is present. They have a treacherous resting state and are frequently brought into a building with the lumber. Their rapid growth, and the rapidity with which they destroy both new and old buildings, make them particularly dangerous.

Merulius lachrymans has not been considered common in this country, but from the many widely separated places in which it has been found it cannot be disregarded as a destroyer of structural timber. It is probable that the chief reason for its infrequent mention in the past is that the timber then in use had a high natural resistance to it. Plants of the *merulius lachrymans* and *coniophora cerebella* have been found associated with some of the most serious cases of rot investigated.

Merulius lachrymans must have the wood prepared for it by *coniophora cerebella* or some other acid producing fungus, is the conclusion of Dr. Falck. A regular sequence of fungi on a rotting stump is frequently observed. The study of wood treating processes should be further simplified by this peculiarity as it may be necessary to stop only the primary invaders to arrest their followers.

INFECTION OF TIMBER.

The present methods of handling loblolly and shortleaf pine timber are disastrous, not only to the purchasers but also to the lumber industry. The timber is generally of reasonable strength, and would make excellent material for many purposes if kept sound, but the high susceptibility of its broad sap wood to fungus attack makes it an ideal cultivating ground to destructive fungi, with the result that it is not only rapidly destroyed itself, but frequently carries dangerous wood destroyers into buildings previously sound. In one case a mill 25 years old, with oak posts and white pine beams, was found in a dangerous condition from dry rot, brought in apparently in boards used for making a temporary floor in the basement. Such timber should be given a suitable antiseptic treatment as soon as possible after it leaves the saw.

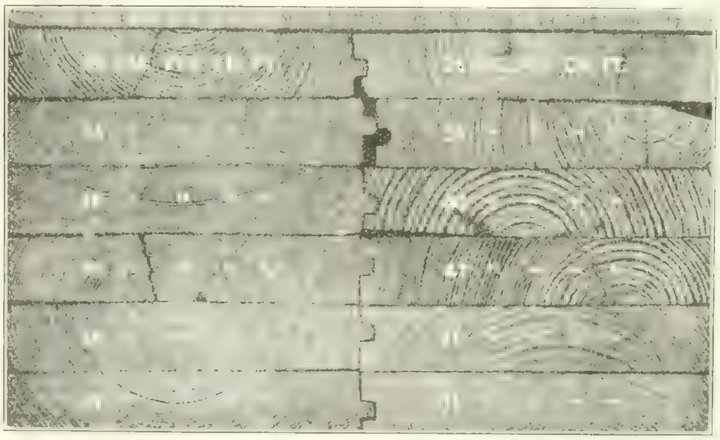


Fig. 1. Specimens Showing Variation in Density of Timber Sold as Good Longleaf Pine.

The facility with which new lumber can pick up infection, even when handled with unusual care, is almost incredible. The writer recently received from a Southern lumber manufacturer four samples of shortleaf and loblolly pine which were sawed from the logs in the woods and placed directly on the cars, not associated with other lumber. They were received within a week after they were shipped, and were bright, with no signs whatever of any form of fungus growth. They were placed in a cellar at an average humidity of about 90 per cent. In the course of a few weeks a fungus growth appeared on the sapwood. This continued to increase during the summer months, the samples having been received in the late spring. In the early autumn fruiting plants appeared. The increasing dryness of the atmosphere arrested them, so that it was not possible to determine the variety with certainty. If logs can be infected under such conditions, there is little hope for sapwood, which, after being sawed fresh from the forest, is closely piled on cars or in the holds of vessels for a voyage of several weeks, later being placed in lumber yards where destructive fungi are almost always present. In one very serious case investigated, there is little doubt but that the disease spread from timber to timber while piled in the mill yard awaiting erection. This would undoubtedly have been prevented by a suitable superficial antiseptic treatment of this material at the saw mill.

The combustibility of heavy timber construction with automatic sprinkler protection has not been found to be a serious objection in buildings in which this form of construction has advantages from cheapness, convenience in hanging shafting or comfort of employees. A useful property of importance in paper mills and weaving mills, where there is high atmospheric humidity, is the heat insulating power of heavy plank roofs. It would undoubtedly be advisable in many cases to make the roof an inch or two thicker than strength alone requires, with this object in view, as sweating roofs damage goods and are otherwise troublesome. With thick roofs it is absolutely necessary to have lumber which is immune to fungus under the conditions which prevail. If material of sufficient natural resistance cannot be obtained at a reasonable price, antiseptic treatment is imperative.

METHODS OF TREATMENT.

Coal tar compounds, which are extensively and successfully being used for railroad ties and other timber in exposed situations, are not generally adapted to factory construction, owing to the black, greasy surface which they leave, their somewhat disagreeable odor, and chiefly to the increased fire hazard.

Railroad ties and telegraph poles that have been creosoted are rather less combustible than those which have not. A part at least of this apparent fire resistance can be accounted for by the fact that the sound wood of the preserved material is considerably less combustible than the punky wood of that which has been attacked by fungus. The rapid escape of the heated gases from the immediate neighborhood of the burning material is also a factor with fires in the open air. Conditions in mill buildings are quite different. The closed rooms can retain the heat generated by the burning oil, rapidly raising the temperature to the ignition point of the wood, extending the fire, and increasing the water and smoke damage to the contents.

Chloride of zinc, which is extensively used on railroad ties, has, so far as the writer is aware, been used in mills only to a very limited extent and practically no data are available as to its value. The suspicion that it may gradually decrease the strength of the timber over long periods of service, or when subjected to high temperatures, would cause it to be regarded with disfavor until further proof of its harmlessness is forthcoming.

Corrosive sublimate has been used somewhat in the past with good results. Little experience is available as to its serviceableness when applied to mill timbers, although basement floor planks, fence posts, parts of bridges, etc., are in use about the Lowell mills which have been treated with it at various times within the past 60 years and which are reported to have given satisfactory service. One authority states that wood treated with corrosive sublimate is in extensive and successful use in Germany and Austria. Another authority regards corrosive sublimate as an effective wood preservative when applied in an open tank with comparatively little penetration, owing to its high toxic power and to the fact that it forms an insoluble compound in the wood cells, which make them permanent.

For treatment of mill timber an inexpensive process which can be applied on the job after the timber is cut to final shape has many advantages. In several cases where timber has recently been so treated with corrosive sublimate the cost and convenience have been very satisfactory.

From the limited information thus far available the corrosive sublimate process appears to be best adapted to the general requirements of mill timber. Fluorine compounds have shown good results in laboratory experiments, but no practical experience with them is available. The cheapness of chloride of zinc or sodium fluoride would not give them a great advantage over corrosive sublimate, as the cost of the chemicals is a comparatively small item in either case, when used in open tanks, and the cost would be easily compensated for by the greater toxic power of the mercury salt.

In conclusion, there is no doubt that the value of the mill timbers which rot each year is a sufficiently large sum to make preservative treatments well worth while. When the problem is narrowed down to the conditions of moderate exposure in the mills, the few woods available for mill construction, and the few fungi that commonly destroy them, it is probable that a reasonably cheap and convenient process such as corrosive sublimate in an open tank will satisfy all requirements if applied soon enough. Probably a light treatment at the saw mill and another after being cut to final shape and ready to be put in place in the mill frame will be found most serviceable.

ACKNOWLEDGMENT.

The foregoing data were taken from a paper by F. J. Hoxie, presented before the annual meeting of the American Wood Preservers' Association.

Concerning the Relative Cost of Using Steel and Wood Forms.

(Staff Article.)

According to data furnished by the Aberthaw Construction Co., of Boston, steel forms, when leased and returned, cost 30 cts. per square foot. The average cost of wood forms, when used four times, is about 3 cts. per superficial foot of contact. It is thus necessary to use steel forms ten times to bring the average material cost down to that of wood. Wood forms, however, are so shaken and damaged that, after being used three or four times, they are practically worn out and must be replaced.

The Aberthaw Company has used steel forms an average of 13 times on one job, with the result that the forms are still in good condition. This company has never used steel forms to destruction, although it has sometimes used them 30 times. Probably 45 usages is a conservative estimate of the life of steel forms. During the life of such forms probably 3 cts. per square foot will have been spent for upkeep, but when they are worn out the metal is worth about that amount as junk.

If the steel forms are bought at 45 cts. per square foot, instead of being leased at 30 cts. per square foot, the ultimate cost for each time used would be 1 ct. per square foot, to which should be added 0.5 ct. per square foot for wedges and keys. This makes their ultimate cost about one-half that of wood forms.

SEWERAGE AND SANITATION

Results of An Efficiency Test of a Shone Ejector Plant.

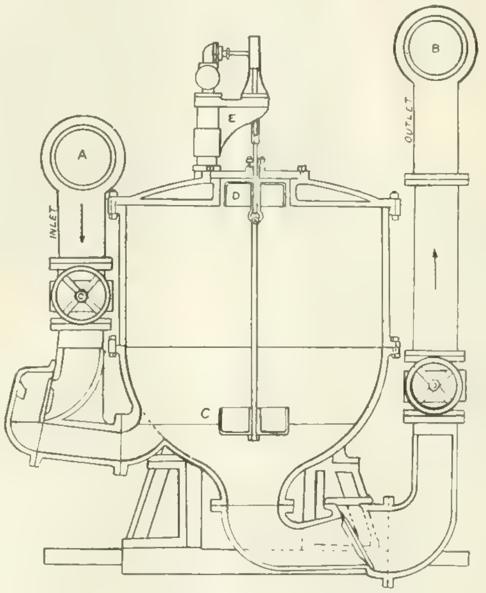
(Staff Abstract.)

The Shone sewage ejector, actuated from a central station by compressed air power, may be used in any of the following cases:

(1) Where there is no natural outlet. (2) Where the natural surface is so level as to render impracticable the construction of self-cleansing sewers at grades above the natural outlet. (3) Where sewers, proportional to the normal flows through them, and laid at self-cleansing grades would be so deep as to be prohibitive in point of cost. (4) In undulating districts containing several natural drainage areas, where natural gravitation would necessitate deep and expensive cuttings or tunnels. (5) In low-lying basins on flat districts from which it is not practicable to convey the sewage to the main gravitation system employed. (6) In large buildings from which liquid wastes cannot be discharged by gravitation. (7) For discharging sewage sludge.

THE EJECTOR.

A Shone ejector is shown in sectional view herewith. The sewage is admitted through the inlet pipe, *A*, gradually rising in the ejector till it reaches the under side of the bell, *D*, thus enclosing the air therein at atmospheric pressure. As the sewage continues to rise above the edges of the bell this air is compressed sufficiently to raise the bell with its attached spindle, thus opening the compressed air admission valve, *E*. The compressed air thus admitted presses on the top of the sewage, the check valve in the inlet pipe, *A*, closes, that in the outlet pipe, *B*, opens, and the sewage is forced out of the bell-mouthed bottom opening through the outlet valve and the raising main up to the outlet pipe, *B*, which communicates directly with the gravitating sewer. As the sewage passes out, its level falls till the cup, *C*, is left full of water, unsupported by the liquid pressure, whose weight causes the cup to descend, pulling down the bell and spindle and thereby reversing the compressed air admission valve, which first cuts off the supply of compressed air, and then opens the exhaust valve through which the air in the ejector exhausts down to atmospheric pressure. The outlet valve falls on its seat, the inlet valve opens, and the sewage fills the ejector again, driving the air out through the air exhaust valve as it rises. The positions of the bell and cup are so adjusted that the compressed air is not admitted till the ejector is filled with sewage, and is not allowed to exhaust till the sewage has fallen to the discharge level. The spindle is attached at the top to a lever provided with an adjustable counterweight, which, acting as a balance to the weight of the cup, *C*, permits a range of adjustment of the discharge level from a level where the falling sewage first leaves an appreciable weight in the cup, to a level which clears the cup entirely. The ejectors are made in sizes of the following capacities, 50, 100, 150, 200, 250, 300, 400 and 500 gals.



Sectional Elevation of the Shone Ejector.

THE TEST.

The plant tested is a portion of the sewerage system of Ithaca, N. Y., whose population is about 14,000. The separate system is used and the collection is according to the Fan system. The sewage of the city is collected by four mains, two of which flow directly to the pumping station, and the other two are brought to the ejector station, where the sewage is lifted 8 ft. to the gravitating main, which carries it to the pumping station. Two 500-gal. Shone ejectors are placed in a circular chamber 13.3 ft. in diameter, the floor of which is 22 ft. below the street. The south ejector was used for the test.

Compressed air is supplied through a main 4,018 ft. long, of 6-in. cast iron pipe, from an air compressing plant at the pumping station. The air plant consists of two Rand Drill Co.'s Class B steam air compressors. A receiving tank is used on which the pressure is kept between 13 and 15 lbs.

To be complete, the test required: (1) An efficiency test of the compressor; (2) an efficiency test of the air main; (3) an efficiency test of the ejector.

Compressor.—Since the ejector plant had to be kept in operation more or less continuously a number of half hour runs for the compressor test with 15-minute intervals was adopted, and seven such runs were made with the compressor pumping through the nozzle. Steam and air cards were taken from each side of the compressor every five minutes, as were also readings of the continuous counter, air-tank and air-nozzle gages, with corresponding temperatures, weight, and initial and final temperatures, weight and initial and final temperatures of jacket water, and temperatures of the room and of the outside air. Seven runs were made and the average efficiency of the air cylinder was found to be 77.87 per cent.

Air Main.—For the efficiency test of the air main, the same method was adopted and the same readings taken, except that the air nozzle with its gage and thermometer was removed from the receiving tank and attached to the end of the air main in the ejector chamber, where the atmospheric temperature was noted. Five runs were made and the results were as follows: Averages of mechanical efficiency both runs, 83.05 per cent, run number two, 48.94 per cent efficiency for air delivered. Efficiency from steam cylinder to nozzle on ejector = 83.05 × .4894 = 40.64 per cent. Efficiency of transmission = .4894 ÷ 77.87 = 62.85 per cent.

Ejector.—For the efficiency test of the ejector, a three-hour continuous run was made with the ejectors performing their regular duty, the southern ejector discharging at intervals of 3½ minutes and the northern at intervals of 45 minutes. Steam cards and readings of the continuous counter and of the tank gage were taken at the compressor at intervals of ten minutes, while at the ejector were taken the number of ejections and time of discharge and gage readings just before, at the minimum pressure during, and just after discharge. Barometer readings were obtained. The results of the 19 runs were as follows: Average efficiency of actual lift 16.39 per cent; of effective lift 7.39 per cent; and of the pump lift, 14.01 per cent. Actual lift, 17.96 ft.; effective lift, 8.17 ft.; pump lift, 15.37 ft.

The average, for Runs I and II, of the ratios between the respective totals, gave for the mechanical efficiency of the compressor 83.05 per cent.

The number of cubic feet of air pumped per minute, from the nozzle during Run No. 1 was found from the nozzle calibration curve and the energy stored therein was computed. The average percentage of these results to the I. H. P. of the air cylinders is 77.87 per cent, which represents the efficiency of the air cylinder, taking into account the loss due to heating and compressing the air.

For Run No. II, the same method of finding the horsepower of the air delivered was adopted, the efficiency referred to the air cylinder being found as 48.94 per cent, where the efficiency of transmission through the air main becomes 48.94 ÷ 77.87 = 62.85 per cent. From the data of the Run No. III were computed the efficiencies of the entire plant from the I. H. P. of the steam cylinder and the horsepower of the ejector computed on the basis of 4,810 lbs. of water lifted per each ejection through:

(1) An efficiency lift of 8.17 ft. from the inflow pipe to the end of the discharge pipe one block distant.

(2) A pump lift of 15.37 ft., being the above lift plus the friction head due to forcing the sewage through 451 ft. of 12-in. iron outlet pipe, which flows full during the time of the ejector discharge (about 14 seconds). This corresponds to a velocity of 7 ft. per second, for which the friction head is 7.2 ft.

(3) The actual lift of 17.96 ft. being the pump lift plus the lift due to the fall of the sewage from the entering main to the top of the ejector dome (0.59 ft.) plus the additional lift due to the center of gravity of the ejector contents being about mid-depth of the mass (2 ft.) below the top of the dome.

From these efficiencies and the efficiency between the steam cylinder and the nozzle in the Run No. II (i. e., 48.94 per cent of 83.05 per cent = 40.64 per cent) the corresponding efficiencies of the ejector proper were determined, as follows:

Efficiency of ejector = efficiency of total plant ÷ efficiency from steam cylinder to nozzle in Run II.

The efficiency of the ejector for the actual lift (40.33 per cent) may be considered very satisfactory. The efficiency of the total plant is low on account of the low efficiency of transmission, as well as on account of the efficiency of the ejector.

ACKNOWLEDGMENT.

The foregoing data are abstracted from a thesis by C. S. Moore from an abstract published in The Cornell Civil Engineer for June, 1915.

Method and Results of Making Sewage Gagings at Berkeley, Calif.

(Staff Abstract.)

Where possible the correct method of obtaining the data necessary for the design of a comprehensive system of sewers, intercepting sewers or sewage treatment works is to measure the flow of sewage in a district already sewered and of known population and characteristics. Thus the city of Berkeley, Calif., in the fall of 1911 approved the plan of its city engineer, Mr. J. J. Jessup, to install a weir at one of the sewer outfalls to obtain data on local sewage flow for use in designing the new system of sewers installed in 1914. The sewage flow was found to differ widely from the water consumption, a significant fact since the sewage flow is commonly assumed to equal the total consumption of water in designing new sewer systems.

A 16-in. sewer outfall was chosen as the best site for the weir. The district tributary to this outfall is residential, the character of the population varying from factory workers in the western part to those in better circumstances in the eastern part, the latter including some of the finest residences in the city.

The measuring device consisted of a box 4 by 5 ft. by 8 ft. 6 ins. built of 2-in. redwood and placed perpendicular to the sewer outfall. At the south end of the box was a 2-ft. suppressed weir with a sharp steel crest 3 ft. above the bottom of the channel of approach, which was 3 ft. long and 2 ft. wide. The sewer entered the box at the north end, the center of the pipe being 13 ins. from the end and 28 ins. above the bottom. The sewage passed through three baffles to reach the weir, two horizontal and one vertical. The float chamber, 2 ft. square, and the still box were on the east side of the channel of approach. A flush gate at the north end opposite the sewer inlet was used two or three times a week to flush the sludge out of the box. The 16-in. sewer along Folger avenue was constructed on a 1 per cent grade, which gives a maximum discharge of 8.5 cu. ft. per second, so the weir was built for a capacity of 9 cu. ft. per second.

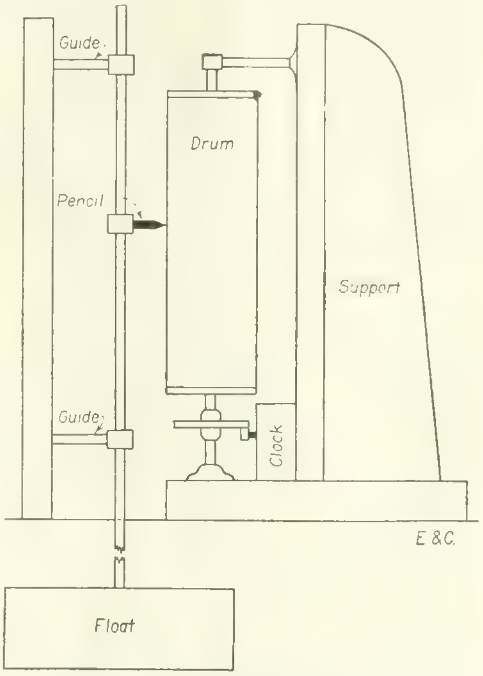


Diagram of Recording Device Used in Measuring Flow of Sewage at Berkeley, Calif.

The automatic recording device used is shown herewith. The vertical drum is 24 ins. in length and 22 ins. in circumference, and is so geared to the clock that it revolves at a rate of ⅛ in. per hour. The complete revolution was made in about seven days, the record sheet being changed every week. The pencil carried by the float rod is held against the drum by a spring, so that a curve is drawn upon the record sheet. By reference to a datum line drawn on the sheet when it is placed on the drum the curve gives the head on the weir at any time. This datum line is drawn by revolving the drum with the pencil bearing on the paper and the clock mechanism disconnected. The height of the datum line above the weir crest is determined by a hook gage.

The records obtained cover the period extending from March, 1912 (the date of completion of the weir), to March, 1913. During this time all conditions of flow were experienced, from the extreme dry weather flow to the high rate during and immediately following rainstorms, at which times the sewer was taxed to its capacity.

The rags and paper in the sewage caused considerable annoyance by clogging the baffles. It was thought that this clogging could be prevented by placing a screen in front of the baffles. A vertical bar screen was constructed and placed in the box, but was removed in a short time, since it was seen that the clogging of the screen caused more trouble than had before been experienced with the clogging of the baffles. Frequent cleaning of the baffles with a rake was the only method of doing away with this annoyance. The sludge which collected in the box was removed by pushing it out through the flush gate with a squeegee. The clock mechanism used to revolve the drum bearing the record sheet was a constant source of trouble. The exposure to the salt air caused the works, and especially the steel springs, to corrode, and it was necessary to clean the works often and to keep them well oiled. A duplicate clock was provided to avoid interruptions of the record.

In computing the discharge over rectangular weirs it has been found that for heads varying from 0.07 to 0.50 ft. the formula of Fteley and Stearns gives the most accurate results, while for heads above 0.50 ft. the Francis formula should be applied. For the case in hand these two formulas were applied in the computations for discharge. It was necessary to correct for velocity of approach. Although the weir crest was 3 ft. above the floor of the box, the channel of approach was taken as 2 ft. deep, to allow for sludge to a depth of 1 ft. under the crest.

The sewers of this district were designed to carry house sewage alone, and no rain water was supposed to enter them except through manholes or by seepage. Nevertheless, every rain immediately increased the discharge of the sewer, showing that rain water found its way to the sewer by a more direct route than either of the above. This was accounted for by the connections of roof drains to the sewer which had been made in many places contrary to the city ordinance prohibiting such connections.

The similarity of the record diagrams was very noticeable. For days with flow uninterrupted by rainfall the fluctuation of flow during the twenty-four hours follows the same cycle each day. The flow is a minimum early in the morning—about 4 a. m. to 6 a. m. There comes then a sudden increase to the maximum for the day, which occurs between 8 a. m. and 10 a. m. The flow then decreases slowly until about 5 p. m., when it begins to increase again, reaching a maximum at 8 p. m., after which it decreases to the early morning minimum. An examination of the records for various days shows a maximum flow on Sunday with very constant daily flow for other days of the week.

By taking off the maximum ordinate and minimum ordinate from each day's record diagram the maximum and minimum flows for that particular day were determined by means of a head discharge diagram. From the area under the curve the average ordinate was computed, and from this the average flow for the day was determined. The following results were obtained by omitting all rainy day records, of which there were 47. The following figures were found:

		Gals. per 24 hours.
Average flow for year		639,000
Maximum flow		912,000
Minimum flow		472,000
Percentage of max. over average	42.8	
Percentage of min. under average	26.6	

	Cubic feet per second.
Maximum rate for any day	2.1
Minimum rate for any day	0.2
Average rate for all days	0.99
Percentage of max. over average	112
Percentage of min. under average	80

The population of the district was determined by a thorough canvass, in which all dwellings, stores, schools, industrial establishments, etc., were counted. The "persons per dwelling" factor for Berkeley was taken from the 13th U. S. census and the population was found to be 19,000. From this and the above results we have:

	Gals. per 24 hours.
Average flow per capita	33.7
Maximum flow per capita	48.0
Minimum flow per capita	24.8

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The total number of connections in the district was found to be 4,844.

	Gals. per 24 hours.
Average flow per connection	132.0
Maximum flow per connection	188.5
Minimum flow per connection	97.5

The average consumption of water for the city of Berkeley as determined by the Peoples Water Company was 50 gals. per capita per day. Average sewage flow per capita equaled 67.5 per cent water consumption.

The following tabulation gives the lengths of the various sized sewers as scaled from the Berkeley sewer map:

	Miles.
6-in. sewer	22.2
8-in. sewer	13.6
10-in. sewer	2.5
12-in. sewer	0.8
14-in. sewer	1.2
16-in. sewer	0.7
Total	41.0

Average flow per mile of sewer equaled 15,600 gals. per 24 hours.

Since there is little water used about 4 a. m., the minimum daily flow, which occurred at this time, was accounted for by water reaching the sewer from leaky fixtures and seepage through joints in the sewer pipe. During the dry season the amount reaching the sewer by the latter means is so small that it can be neglected, and the minimum flow can be considered to be all leakage. So the amount of seepage can approximately be determined by taking the difference between the minimum wet weather flow and the minimum dry weather flow:

Minimum wet weather flow, cu. ft. per second	0.8
Minimum dry weather flow, cu. ft. per second	0.2
Ground water seepage, cu. ft. per second	0.6
Ground water seepage, gals. per 24 hours	388,000
Ground water seepage, gals. per mile per 24 hours	9,500

Samples of sewage were taken at different times from which the total solids, suspended solids, character and amount of sludge were determined:

Total solids, parts per million	1,160
Total solids, grams per capita per day	120
Suspended solids, parts per million	272
Suspended solids, grams per capita per day	35
Amount of sludge, cubic centimetres per litre	8.8

The sludge was composed of fecal matter, rags, pieces of paper, sticks, fruit, vegetables, peelings, foul entrails, matches, worms, pieces of rubber, coffee grounds and dead rats.

ACKNOWLEDGMENT.

The foregoing data are taken from an article by Mr. T. A. Bither of Berkeley, Calif., in Western Engineering for May, 1915. The weir was designed and constructed under the direction of E. A. Ingham, who took the records for the first month. Mr. Bither took the balance of the records. The work was carried on under the direction of Prof. Charles Gilman Hyde of the University of California.

Some Costs of the Fitchburg Sewage Treatment Works—Early Operation Results.

(Staff Abstract.)

A bonus of $5,000 was paid the contractor on the completion of the construction of the Fitchburg, Mass., sewage treatment works before the specified time of completion. The contract was awarded on May 15, 1913, to the R. H. Newell Company and N. S. Brock. The payment of the bonus was conditioned on finishing the work before Oct. 31, 1914. Some cost figures relating to this construction are here given.

An article describing and illustrating the features of the design was published in this journal for June 25, 1913. Briefly, the works consist of a Venturi meter in a concrete chamber, five rectangular Imhoff tanks each 30x90 ft. in plan and about 27 ft. deep, a dosing tank 48x74 ft. in plan, a sprinkling filter covering an area of 223x405 ft., four secondary settling tanks each 30 ft. in diameter and 25 ft. deep, and a sludge drying bed about 0.4 acre in area. There is also a two-story brick laboratory building 34x44 ft. in plan.

The total amount of excavation was 75,500 cu. yds. and the prices ranged from 29 cts. to 85 cts. per cu. yd. About two-thirds of the excavation was at 29 cts. The amount of reinforced concrete was 3,488 cu. yds., and the unit price for nearly all was $11.00 and $11.50 per cu. yd. The number of square yards of cement plaster partition walls was 5,900 and the price was $1.76 in the Imhoff tanks and $1.80 in the sprinkling filter. The amount of bars and structural steel used for reinforcing was 387,000 lbs. and the price in place was 4 and 4½ cts. per lb. The amount of broken stone in the filter was 34,052 cu. yds., and the contract price was $1.95 per cu. yd Cast-iron pipe, gates, valves, special and other material were furnished by the city and placed by the contractor. The total amount of work done by the contractor by the final estimate was $233,511, which includes considerable additional work not contemplated when the contract was awarded.

COSTS.

To any engineer designing a disposal works along similar lines and desiring to make an estimate of costs a brief statement of costs of this plant may be of interest. As the matter of excavation depends upon the location and condition, and would vary widely, all such costs in these figures are eliminated. The cost of the Imhoff tanks was $52,224, which, based on a population of 55,000, would be about 96 cts. per capita. The cost of the sprinkling filter was $122,990, or $58,847 per acre. Based on a population of 40,000 the cost was $2.94 per capita. The cost of the sludge drying beds when completed will be about 5 cts. per capita. The cost of the secondary tanks was $8,426, or about 15 cts. per capita for a population of 55,000. The cost of the dosing tank was $9,436, or 17 cts. per capita. When completed the disposal works will cost about $320,000, including cost of land, buildings, roadways and incidental work, but not including engineering and inspection. The cost of engineering and inspection for all the Fitchburg work has been 8½ per cent, which would add $27,200 to the cost, making the total $347,200, or $6.31 per capita for a population of 55,000.

OPERATION OF WORKS.

While the intercepting sewer will not be completed and all connections of present outlets made therewith until July or August, 1915, the works have been in continuous operation since Oct. 15, 1914, with such a flow of sewage as came from connections thus far made. The average daily flow from Oct. 15 to Dec. 31, 1914, was 1,742,000 gals.; during the month of January it was 3,761,000 gals. Of this average for January about 2,865,000 gals. passed through the filter. The detention period in the Imhoff tanks has been longer than desirable, being 5.8 hours to 12.6 hours ever since beginning operation, and practically all the matter in the sewage which is capable of being settled has been settled.

The average purification during January as indicated by nitrogen as total albuminoid ammonia was 62.75 per cent, and as indicated by total suspended solids was 87.12 per cent. The per cent of suspended solids removed by the Imhoff tanks during January was 68.6. Of the daily 24-hour samples of final effluent taken for January, 60 per cent were stable for 14 days. The nitrates in the final effluent for January averaged 3.85 p. p. m.

The effect of climatic conditions on the efficiency of disposal works of this nature has led some to consider it inadvisable to construct them in a locality having at times so low a temperature as central and northern New England. During the past winter there has not been the usual amount of cold weather so nothing positive can be stated relative to temperature effects. The temperature on the mornings of Dec. 26 and 27, 1914, was about 8° below zero, which is fairly cold for Fitchburg, the coldest for the last 20 years being 17° below zero. On Dec. 28 there was considerable ice on the sprinkling filter, covering perhaps nearly one-half of the surface of the bed, and the secondary settling tanks were frozen over thick enough to sustain a man's weight. A few days afterward nearly all trace of the ice had disappeared. During this cold period there was a marked decrease in the degree of purification obtained.

ACKNOWLEDGMENT.

The foregoing information is abstracted from a paper on The Sewage Disposal Works at Fitchburg, Mass., by David A. Hartwell, chief engineer, in the Journal of the Boston Society of Civil Engineers for June, 1915.

American Society of Mechanical Engineers.—The Spring meeting of the society will be held at Buffalo, N. Y., June 22-25, with headquarters at Hotel Statler. The program includes a trip to Niagara Falls, visits to various manufacturing plants in Buffalo, a reception and dance, business meetings and professional sessions at which the following papers will be discussed:

"The Engineer as a Citizen," Dr. F. H. Newell of Illinois University, formerly chief of the United States Reclamation Service.

"Rational Design and Analysis of Heat Transfer Apparatus," E. E. Wilson.

"Influence of Disk Friction on Turbine Pump Design," F. zur Nedden.

"Surface Condensers," C. F. Braun.

"Some Mechanical Features of the Hydration of Portland Cement and the Making of Concrete as Revealed by Microscopic Study," Nathan C. Johnson.

"Design of Rectangular Concrete Beams," Howard Harding.

"Model Experiments and the Forms of Empirical Equators," Edgar Buckingham.

"The Effect of Relative Humidity on an Oak Tanned Leather Belt," W. W. Bird and F. W. Roys.

CURRENT NEWS

The Doings of the Week.

Business in general continued to gain during the past week. Steel mills are now operating at about 90 per cent capacity; copper metal production is now around eighty-four per cent; lumber and cotton are now about 75 per cent of normal. War orders continued large and it is expected that these expenditures for the current year will reach $1,500,000,000. Bank clearings for the week ending June 17 showed a small increase over the previous week and a substantial gain over the corresponding period in 1914. In the construction field there are plenty of small undertakings ready for bids. The larger jobs, however, are not as abundant as could be wished. Difficulty in financing the big projects is holding back many large improvements. Eastern municipalities are beginning to offer many construction opportunities and prospects are good that a considerable amount of work in the East will be placed under contract soon. State and county highway work and bridge building made a good showing during the past week. A considerable number of street paving jobs also reached the call for bids stage. In the other municipal fields, such as sewerage and waterworks, with a few exceptions, no particularly large jobs came up for advertising. The Governor of Illinois has signed the 8-ft. waterway bill, and this $5,000,000 project probably will be started this summer. Several other big jobs also are likely to be ready for bids in a few days. In the steel market there were betterments both in sentiment and orders. Perhaps the most encouraging feature of the week was the heavy buying of railroad equipment for export. Russia placed orders for 450 locomotives, and France and Servia for 64 and 20 locomotives. France also placed contracts for 50,000 tons of rails and 3,745 cars. Domestic orders included 40,000 tons of rails, 12 locomotives and 4,000 cars. The steel mills have made a further advance of $1 per ton on bars, plates and shapes. *The Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending June 16 were as follows:

Finished Iron and Steel.	June 16.	June 9.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill....	1.25	1.25
Iron bars, Philadelphia.......	1.17½	1.17½
Iron bars, Pittsburgh.........	1.25	1.25
Iron bars, Chicago............	1.20	1.20
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York.........	1.369	1.369
Tank plates, Pittsburgh......	1.15	1.15
Tank plates, New York......	1.319	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York.......	1.369	1.369
Skelp, grooved steel, P'gh....	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh......	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh..	1.75	1.75
Galv. sheets, No. 28, P'gh....	5.00	4.50
Wire nails, Pittsburgh.......	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh........	1.35	1.35
Barb wire, galv., P'gh........	2.40	2.40

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—One encouraging feature of the past week in the railway situation has been the appearance of numerous newspaper reports of prospective construction undertakings. It has been some months since promoters and railway officials would even talk of what they intended to do. There is a report that the Lake Huron & Northern Ontaria R. R. has awarded a contract to the National Engineering Co., Marshall Bldg., Cleveland, O., for a 300-mile line in Canada. Contract for the Tucson, Cornelia & Gila Bend R. R., bids on which were opened a few days ago, has not been closed at this writing. The U. S. War department failed to approve of the plans for the river changes at St. Paul for the new Union Depot and the contract for the work was not let last week.

Roads and Streets.—Several State Highway Commissions are advertising work. New York is taking bids on 33 repair contracts; Ohio opens proposals June 29 on 10 contracts estimated to cost $200,000; Massachusetts, California, Washington and several other states also are taking bids on state aid road work. A considerable amount of work for counties and road districts is being advertised. In Indiana alone 35 county road jobs are ready for bids. Most of these, however, are small. In Mississippi, Madison County and Capiah County are asking bids on two good sized gravel road improvements. Street paving advertised includes a $118,000 job for Philadelphia, Pa.; 30,000 sq. yds. bituminous concrete for Trenton, N. J.; 24,700 sq. yds. paving at Lebanon, Pa.; and 25,500 sq. yds. for Stamford, Conn. Lake County, Florida, awarded contract for 112,000 sq. yds. modified asphalt. Allegheny County, Pennsylvania, let road contracts amounting to $110,000; New Boston, O., awarded a $93,000 paving job; Elma, Wash., let a $49,000 asphalt paving contract; Wallace, Manitoba, awarded contract for grading 71 miles of road; Pipestone, Minn., let contract for 40,000 sq. yds. concrete pavement, and Marshalltown, Ia., awarded contract for 25 blocks of concrete pavement.

Bridges.—Bids are now being asked on two large bridge undertakings for the city of Seattle, Wash. Both structures will be erected over the Lake Washington Canal. They are estimated to cost $880,000. A considerable number of smaller bridge projects reached the call for bids stage during the past week. The Tibbitts Pacific Co. was low bidder at $71,490 for a bridge for Contra Costa County, California; Hunter Construction Co., Youngstown, O., was awarded contract at $32,675 for steel bridge over Mahoning River at Youngstown; C. W. Requarth Co., Charlotte, N. C., has been awarded contract for $88,000 bridge dam at Appalachin, Ga.
near Bryson City, and for $120,000 concrete

Drainage and Irrigation.—No particularly large contracts in either the drainage or irrigation fields came up for bids during the past week. The U. S. Reclamation Service is asking proposals on 50,000 cu. yds. of canal excavation, 950 cu. yds. of reinforced concrete and 525,000 sq. ft. of canal lining. Two good sized drainage projects will be advertised in the near future. One of these provides for about $260,000 worth of work for the Burt-Washington County Drainage District in Nebraska; the other calls for a 24-mile ditch in Case and Bates Counties, Missouri.

Waterworks.—A fair amount of waterworks construction is ready for bids. Cheyenne, Wyo., is asking proposals on developments to cost $70,000; Media, Pa., is calling for bids on 2,000,000-gal. settling basin; Pratt, Kan., opens bids June 30, for waterworks improvements; Covington, Va., is asking proposals on a 2,000,000-gal. concrete lined reservoir; Baltimore, Md., opens bids June 30 for furnishing a 20,000,000-gal. centrifugal pump and electric power equipment. The Great Lakes Dredge & Dock Co., Chicago, Ill., at $157,000 was low bidder for new intake for Kenosha.

Sewerage.—Columbus, O., is asking bids on two storm sewers, one estimated to cost $250,000, the other $100,000. Peoria, Ill., will ask bids in a few days on the east section of the South End sewer. Michael Pontarelli, 2349 Greenleaf Ave., Chicago, and Henry J. McNichols, 209 South La Salle St., Chicago, were low bidders on the $700,000 Argyle St. sewer at Chicago.

Buildings and Rivers and Harbors.—One of the largest public building undertakings in the country will soon be ready for bids. Plans have been approved for the new $10,000,000 court house at New York City, and it is stated that the work will be advertised about July 27, the bids to be opened Aug. 9. The George A. Fuller Co. has been awarded the contract for the $2,500,000 Frick Arcade building at Pittsburgh, Pa. The Great Lakes Dredge & Dock Co., Chicago, was the only bidder for excavating for the tail race of the U. S. Power Plant at Sault Ste. Marie, Mich. The bid was on five plans and ranged from $129,700 to $182,255.

New Laws in Illinois.

Considerable construction work is provided for in the laws enacted by the 49th general assembly of Illinois, which ended its session last week. Much legislation of direct interest to engineers and contractors was passed. The workmen's compensation act was extended to include additional employments, the minimum compensation for death and of weekly indemnity was raised, the powers of the arbitrators were broadened and the circuit court authorized to review arbitrators' findings. Another law of interest to contractors makes bondsmen liable for labor as well as material furnished under state contracts. The structural engineers bill was enacted into a law. This provides for the creation of a state board of examiners for the licensing of structural engineers. The principal construction undertaking authorized was the 8-ft. waterway from the power plant of the Sanitary District near Lockport to the Illinois River near Utica. Another law appropriates $250,000 for the payment of interest on the bonds to be issued by the state for building this waterway. This is a $5,000,000 project. It will be carried out under the direction of a board of five commissioners named by the Governor. The new laws regarding highways included the following: $1,000,000 appropriation a year for the next two years, from the road fund for the building and maintenance of state aid roads; appropriation of the unexpended balance of the funds provided by the previous assembly for road building; appropriated $500,000 for the use of the State Highway Commission in building state aid roads; provided for the oil treatment of state aid roads; gives county boards a right by majority vote to specify the type of state aid road to be constructed in the county. Other legislative acts affecting highway construction include laws, allowing counties to accept voluntary contributions for building state aid roads; enabling counties to vote bonds for road building; authorizing the use of one-half the poll tax collected in towns and villages for road purposes; provides for laying out, widening and vacating of roads upon petition of not less than 12 interested landowners. A law that will facilitate the carrying out of drainage projects was enacted. This permits the construction of drains, ditches and levees across the land of another for agricultural, sanitary or mining purposes. Cities wishing to change from the commission form of government were given the right to do so. A law also was passed authorizing the construction of municipally operated utilities. The Lincoln Park Commissioners and West Park Commissioners of Chicago are authorized to issue bonds not exceeding $1,000,000 each for enlarging and improving their respective parks. Another bill enacted into a law enables Park Commissioners to issue bonds for the completion, improvement and maintenance of parks, boulevards and pleasureways. Legislation was passed requiring the erection of bridges over the Chicago drainage canal at Crawford, Cicero and 72nd Aves., Chicago. Appropriations provided for, other than those noted above, included the following: $50,000 for a site and armory at Monmouth, and a like sum for an armory at Peoria; $25,000 to the Rivers and Lakes Commission for levee work at Cairo; $10,000 for similar work at Mound City and $10,000 for levee work at Shawneetown; $140,000 for equipment for state heat, light and power plant at Springfield; $125,000 for sites for additional state buildings at Springfield; $95,000 for new buildings at Macomb normal school; $135,000 for normal school at Carbondale; $95,000 for school at Normal; $10,000 for school at De Kalb, and $15,000 for the Charleston school.

The Lighter Side of Engineering and Contracting

TO THE EDITORS:

The following clipping, taken from a recent issue of the Boston Transcript, may be of interest as suggesting the latest method of digging post holes.

Very truly yours,
METCALF & EDDY,
14 Beacon St., Boston, Mass.

June 4, 1915.

Hiram Johnson, a well-known farmer living near Waterville, south of Rome, N. Y., like all tillers of the soil, has been greatly annoyed by the promiscuous digging activities of woodchucks. This little pest attains its greatest happiness in puncturing for its abode holes in the farmers' best meadows, in which horses are in danger of breaking their legs in haying time.

Mr. Johnson, however, says he has learned to utilize the digging propensities of the little ground animals. He captured three alive last fall and has trained them to dig straight post holes any depth and size required.

He asserts that by attaching a strong cord to one of the animal's hind legs he merely has to indicate where the hole is to be dug, and when it is sufficiently deep he pulls the cord and the 'chuck scrambles up for its reward of a small bunch of dried alfalfa, after which it is ready to begin work on the next fence post hole.

A FEW week ago Andy Koenig and several friends went on a fishing trip. They brought back a tremendous cat fish and a still larger tale regarding its capture. It seems that one of the party, history is silent as to his name, had fished and fished and never got a bite. Much disgusted, he had, at last, started to still fish, using a heavy line and a strong hook. He got a bite at once, and started to land his catch; nothing doing; he could not stir it. At first he thought he was trying to pull up the bottom of the river, but the tugging at his line showed him that he had something on the hook. He shouted for help and the rest of the party rushed to the rescue. Three men took hold of the tackle and after a desperate struggle succeeded in bringing to the bank—an old whisky barrel, securely hooked through the bung hole. The fisherman tried to extricate his hook and finally in anger smashed open the barrel. Inside with the hook fast in its mouth was a 75-pound cat fish. After due deliberation the natural historian of the party reached the conclusion that the fish when quite small had swam through the hole in the top of the barrel and then had outgrown the entrance. It had lived there ever since, safe from molestation and growing fat on food washed in through the bung hole. When the hook dropped down through the hole it grabbed the bait and thus formed the basis of an excellent fish chowder and a still more excellent fish story.

An Ex-Contractor's Lament in 1915.

Backward, turn backward, O Time in your flight,
Make me a Contractor just for tonight;
Let me a letting, pretend "I've things cinched!"
My hunger would be appeased and my thirst would be quenched.

For then Scraper salesmen, and Powder men, too,
The Grocers and Feed man, would be "in a stew",
To give me a good time, 'twould be kind, to be sure,
As they did back in the nineties, my trade to secure.

Can imagine myself at the Southern, if in St. Louis I should be,
Or the Auditorium, if in Chicago, it's no difference to me.
Often I've been there, and "full plenty" I've had,
At the expense of the boys, who, when I left, were real glad.

How we'd walk up to the bar, order good old rye;
Or in the cafe 'twould be "Mumm's Extra Dry";
Get behind a sweet scented Stachelberg cigar,
Forget I'm a Contractor, and think I'm a Czar.

We'd take dinner at the Planters; at the Standard get a box,
Watch the ballet girls dance in abbreviated frocks;
We'd have supper at Faust's in Mephistopheles style,
Say "good-night" (?) at the Southern, with an inebriate smile.

And then the next day—but why carry it on?
I've asked for one night, for no more do I long.
The results of the "time," we can all plainly see,
But I long just the same for a grand letting spree.

A LITTLE Irishman, from the East, foot-sore and weary, drifted into a Western construction camp late at night. He applied to the foreman for a job. The latter asked him if he was a teamster. The Irishman promptly replied that he was. He had driven a one-horse cart in the street cleaning department of Boston, Mass. The foreman hired him. In the morning Pat went out to the stable tent and watched the boys wrestle with the horses. When they had a six-horse team harnessed up, the foreman told the new man to take it and drive to town for supplies. The Irishman took one look at the tangle of reins and shouted: "I resign; how many hands do ye think I've got? I ain't no octopus."

AT THE recent meeting of the Indiana Engineering Society, "an old surveyor" gave some pertinent advice for the benefit of the "young surveyor." Some of the suggestions were as follows:

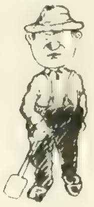
Be sure to have a flagman 50 pounds heavier than yourself. If the ice bears him, you can safely venture.

If in summer you find a swamp beyond your depth, face about and wade back. That would be prudence, and not cowardice.

If you mire in quicksand, or any other treacherous substance, and find it utterly impossible to extricate yourself, call for help. Almost any patriotic citizen is willing, under such circumstances, to assist the profession by giving science a boost.

When you are given great credit for accidentally striking a corner, pocket it (the credit, not the corner), for you will surely get censure for missing one when you are not in the least to blame.

AT A recent banquet of one of the engineering societies a prominent engineer was called upon to respond to a toast. It was his first attempt at after-dinner speaking and he was very much embarrassed. After an interval of several hours he found his voice and began: "Mr. Toastmaster and Mr. Gentlemen. I knew I would be called upon tonight and so I prepared a speech. It was a fine speech. It contained oratory that would have made Bob Ingersoll jealous and wit that would have made Bill Nye green with envy. It was an effort, a great effort. Only God Almighty and myself knew that speech—and now, God alone knows what I was going to say." Then he sat down.



Skinner Mulvey says:

Bob Connors ordered three eggs boiled four minutes; cook didn't have but one, so he boiled it 12 minutes. Pat Rooney says damn water. When he wants it, it is never there; when he don't want it, there it is.

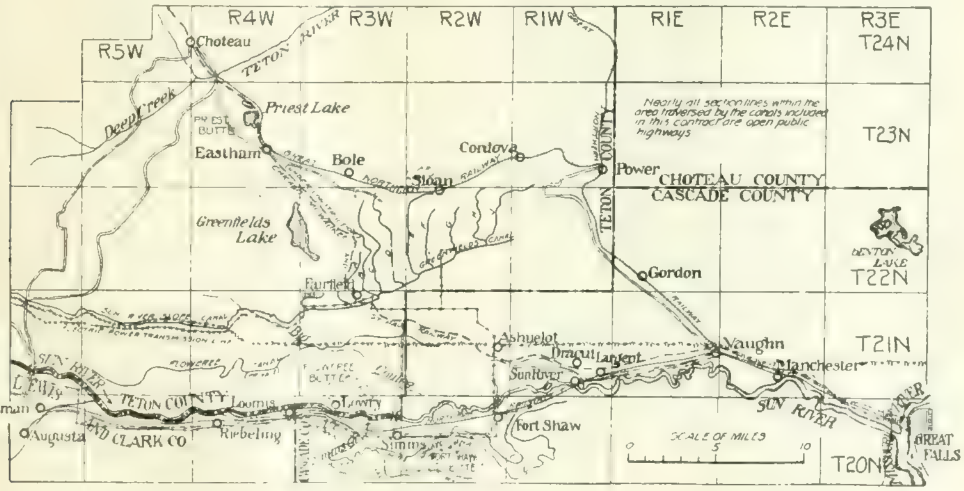
EARTHWORK AND STRUCTURES, SUN RIVER PROJECT.

Bids Asked by U. S. Reclamation Service on Laterals.

455,000 Cu. Yds. Excavation; 4,290 Cu. Yds. Reinforced Concrete.

A fair sized excavation and concrete job is being advertised for bids by the U. S. Reclamation Service. The work calls for the construction of canals and structures on the Sun River Project, Montana, and is situated about 25 miles northwest of Great Falls, Mont., and about 3 miles south of the towns of Bole, Sloan and Cordova, Mont., stations on the Choteau Branch of the Great Northern Ry. The location is shown on the accompanying map. The work involves about 455,000 cu. yds. of excavation, about 4,290 cu. yds. of reinforced concrete, the manufacture and laying of about 4,560 lin. ft. of concrete pipe, and the placing in wooden structures of about 265,000 ft. B. M. of lumber. The earthwork and structures are to be constructed for the first unit of laterals on the Greenfields distribution system of the Sun River Project.

The improvement is divided into 10 schedules, Schedules 1 to 5 inclusive covering the earthwork, Schedules 6 to 9 inclusive the structures except bridges, and Schedule 10 the bridges. The approximate quantities in the earthwork schedules are as follows:



Location of First Unit of Laterals of Greenfields Distribution System.

	Excavation		
	Class 1, cu. yds.	Class 2, cu. yds.	Class 3, cu. yds.
Schedule 1	84,000	900	50
Schedule 2	99,000	1,000	50
Schedule 3	93,000	900	50
Schedule 4	78,500	800	40
Schedule 5	57,500	1,000	60

The approximate main quantities in Schedules 6 to 9 inclusive are as follows:

	Excav., Class 1, cu yds.	Concrete, cu. yds.	Placing reinforcing steel, lbs.
Schedule 6	11,400	1,570	107,000
Schedule 7	5,500	720	52,000
Schedule 8	7,000	800	56,000
Schedule 9	6,500	810	57,000

The work under Schedule 10 calls for the construction of highway bridges. This requires 5,000 cu. yds. of excavation, 325 cu. yds. concrete and erection of 205M ft. B. M. of lumber.

The sections range from 22 ft. bottom width for the canal to a 5-ft. bottom width for the laterals. The banks, in general, will have a 4-ft. top width. The water depth ranges from 0.5 ft. to 2.3 ft. There also will be an earth dike with top width of 8 ft. and sire slopes of 2½ to 1 on the water side and 2 to 1 on the other side. The structures include inclined drops, controlling works, turn-outs, stilling basins, intakes and chutes, and wasteways. There also will be concrete pipe cross drainage culverts, combined drop and corrugated metal road crossings, metal flume inclined wasteway drops and measuring weirs.

Bids for the earthwork and structures of the first unit of laterals on Greenfields distribution system will be received at the office of the U. S. Reclamation Service, Fort Shaw, Mont., until 2 p. m., July 1.

WANAQUE RIVER WATER SUPPLY PROJECT.

Plan for Supplying Municipalities in Northern New Jersey.

Involves Storage Reservoir and Long Pipe Line.

A water supply development involving an expenditure of several million dollars is proposed for the cities of Northern New Jersey by the State Water Supply Commission. The plans provide for the development of a supply from the Wanaque River. The cities of Newark, Passaic and Montclair already have signified their intention of participating in the undertaking. The other municipalities which are expected to benefit by the supply include Paterson, East Orange, Glen Ridge, Elizabeth, Totowa and Nutley.

Two plans for developing the Wanaque water level have been proposed by Morris R. Sherrerd, Newark, N. J., consulting engineer to the State Water Supply Commission. These plans can be worked out either concurrently or independently as best suits the needs of the communities which finally decide to join in the state conservation project.

One plan is the construction of a reservoir on the Wanaque River near Midvale, having an elevation of flow line of 275 ft. above sea level, and a capacity of approximately 11,000,000,000 gals. This reservoir, together with Greenwood Lake, would make available practically the entire yield of the Wanaque River, being about 75,000,000 to 80,000,000 gals. per day. The proposed pipe lines to be constructed at first, however, are only calculated for a delivery of 65,000,000 gals. per day. From this reservoir would extend a pipe line, starting at the size of 72 in., continuing with that diameter to Paterson, then reducing to 60 in. until Newark is reached, where a further reduction to 48 in. is made for a final delivery to Elizabeth. This pipe line has been designed for a delivery of 50,000,000 gals. per day as far as Paterson and 30,000,000 gals. per day to Newark, East Orange and Bloomfield, and 15,000,000 gals. per day to Elizabeth.

The other plan contemplates a high level supply from a point just below the outlet of Greenwood Lake, where a small intake reservoir would be constructed far enough below the lake to obtain the advantage of the aeration of the water which might be drawn from the lake. By a 48-in. pipe line from this reservoir a supply of 15,000,000 gals. per day could be made available for a height of delivery at Little Falls, or 510 ft. above sea level. This height of delivery would enable the distribution of water within the limit of the capacity of the pipe line to nearly all the towns in the Passaic Valley at as high an elevation as they are now obtaining their water supplies without pumping.

The estimated cost of the water supply from Wanaque River with dam at Midvale is as follows:

Reservoir—Main dam	$404,000
2 Wing dams	8,500
Pipe line to main road	70,000
Railroad changes	160,000
Removing cemeteries	2,500
Land, clearing, road changes, etc.	200,000
Land damages	150,000
Intercepting sewer and disposal plant	50,000
Total	$1,045,000
Engineering, etc., 10 per cent	104,500
Total for reservoir	$1,149,500
Diversion rights	1,000,000
Total with water rights	$2,149,500

The estimated cost of the pipe line from Midvale Reservoir on Wanaque River elevation for hydraulic grade 240 ft. is as follows:

For 50,000,000 gals. capacity as far as Paterson, 90,000 ft. 72-in. steel pipe at $20	$1,800,000
For 30,000,000 gals. capacity as far as Newark, 75,000 ft. 60-in. steel pipe at $16	1,200,000
For 15,000,000 gals. capacity as far as Elizabeth, 20,000 ft. 48-in. steel pipe at $13	260,000
Right of way	40,000
Appurtenances, meters, etc.	75,000
Total	$3,375,000
Engineering, etc., 10 per cent	337,500
Total for pipe line	$3,712,500
Total for reservoir	2,149,500
Total for low level supply	$5,862,000

As previously mentioned the high level supply would be taken from an intake just below the outlet of Greenwood Lake at elevation of 572.5 ft. The quantity available would be 15,000,000 gals. daily. The rate of flow assumed for pipe line is 20,000,000 gals., and the loss of head ½ ft. per 1,000 ft. of pipe length. The lengths of pipe line and approximate heights to which deliveries could be made are as follows:

	Elevation, ft.
125,000 ft. to Little Falls, with branch to Paterson and Totowa	510
134,000 ft. to Cedar Grove	505.5
147,000 ft. to Montclair	499.5
162,000 ft. to Glen Ridge	491.5
165,000 ft. to Bloomfield and Nutley	490
170,000 ft. to East Orange	487.5

The estimated cost of the high level supply is as follows:

Intake dam	$ 50,000
Right of way	5,000
Land for intake	5,000
Change of railroad	2,500
170,000 ft. 48-in. steel pipe at $15	2,550,000
Appurtenances, meters, etc.	50,000
Total	$2,662,500
Engineering, etc., 10 per cent	266,500
Total	$2,928,750
Diversion rights	500,000
Total for high level supply	$3,428,750

If the two plans are combined the total estimated cost would be $9,290,750—$5,862,000 for the low level supply and $3,428,750 for the high level supply. Based on these figures it is estimated that water can be delivered at from $43 to $25 per 1,000,000 gals. The undertaking of the development by the State Water Supply Commission is dependent upon the municipalities interested entering into contracts for a water supply. As noted elsewhere in this article several of the larger cities already have joined the plan, so that it is possible that definite action towards carrying out the project may be undertaken soon.

New Vessel for U. S. Coast Survey.—The U. S. Coast and Geodetic Survey is to have a much needed new vessel for use in surveying and charting coasts. Plans and specifications for the new boat will be sent out about July 1. The new vessel will be named the "Surveyor" and its first use will be in the waters of Alaska. It will be a two-deck, single screw steamer with triple expansion engine and two Scotch boilers, using crude oil as fuel The sum of $220,000 is available for the complete construction and equipment of the "Surveyor."

Bids Asked on $200,000 Road Letting in Ohio.

The first state road letting in Ohio for the past two months is now being advertised. Bids will be received on 10 contracts covering an aggregate of about 25 miles and involving an estimated expenditure of approximately $200,000. Three contracts provide for new construction, while the remaining seven cover work for the Bureau of Maintenance and Repairs. This calls for reshaping the old roads and surfacing. Table I gives some details of the improvements. Bids will be received until 2 p. m., June 29, by Clinton Cowen, State Highway Commissioner, Columbus, O.

TABLE I.—DETAILS OF ROAD CONTRACTS TO BE LET JUNE 29 AT COLUMBUS, O.

County.	Road section.	Road.	Township.	Type.	Length, miles.	Width, pvt., ft.	Width surface, ft.	Estimated cost.
Licking	Sec. J	Summit Station Extension	Lima	W. B. mac.	0.5	12	22	$ 3,876
Muskingum	Sec. N	Zanesville-McConnellsville	Wayne	Brick	6	16	26	11,297
Sandusky	Sec. E	Sandusky-Clyde	Townsend	Concrete	1.24	16	26	17,279
Franklin	Sec. L	Columbus-Newark	Truro	Bit, mac.[1]	8.55	[2]20	[2]26	[3]66,448
Franklin	Sec. K	Columbus-Marysville	Perry	Bit. mac.	3.34	16	26	29,636
Lake	Sec. A	Painesville-Warren	Concord	Bit. mac	1.98	14	26	16,805
Licking	Sec. A	Columbus-Newark	Lima	W. B. mac.	1.09	16	26	7,484
Lucas	Sec. G	Toledo-Wauseon	Swanton	Bit mac	1.72	16	26	19,075
Medina	Sec. N	Cleveland-Wooster	Medina	W. B. mac.	1.85	14	26	13,369
Union	Sec. F	Marysville-Marion	Paris	Bit. mac.	1.36	16	26	12,186

[1] Bituminous macadam and waterbound macadam. [2] 26-ft., 20-ft., and 16-ft., roadway, 30 and 26-ft. [3] Alternate bids will be received for surfacing with bituminous macadam, waterbound macadam and macadam treated with lignin liquor; estimated cost, $69,661.

Pier Construction at Philadelphia.

The city of Philadelphia is about to commence construction on its port development in the southern section of the city, which will involve an ultimate expenditure of about $25,000,000. This probably will be the largest single concentrated expenditure ever undertaken by the city. The complete development calls for ten piers, and the establishment of car storage yards and other facilities.

The ordinance authorizing the acquisition of the necessary property at the foot of McKean street for the first pier was signed by the mayor on June 14. Bids were at once asked for dredging at the site of the pier preparatory to the construction of the substructure. This pier will be the largest so far built by the city and will cost approximately $1,500,000. The work will be in charge of the Department of Wharves, Docks and Ferries, of which John Meigs is the director.

State Road Construction Letting in New York.

Bids were opened June 16 by the New York State Highway Commission on 21 construction contracts covering about 76 miles of highway. There was a large number of bidders on each job, and the figuring was very close as is indicated by the fact that on most of the contracts there was a difference of only about 20 per cent between the high bid and the low bid. The following tabulation shows the high and low bids and the number of bidders on each contract.

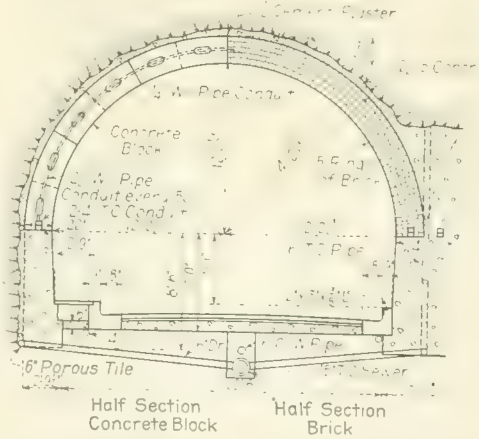
Road No.	Length, miles.	High bid.	Low bid.	No. bidders.
1239......	.68	$12,523	$10,739	12
1241......	2.32	26,273	20,750	11
1273......	2.50	26,330	23,650	5
5554......	4.58	49,462	42,030	12
1098......	4.22	52,093	38,258	15
1106......	1.54	48,042	43,720	6
5532B.....	6.86	82,229	72,552	15
1283......	4.54	37,503	33,561	16
1284......	6.05	42,316	35,274	17
5560......	1.32	32,849	29,719	7
5561......	4.42	59,993	53,855	12
5562......	2.38	53,592	41,121	10
5563......	5.07	79,876	74,706	6
5559......	8.89	79,803	67,990	13
1072......	2.06	63,928	53,321	13
1073......	7.23	101,225	85,389	25
1074......	1.91	47,958	40,978	18
582......	2.46	24,845	20,123	10
1893......	1.80	18,533	17,005	6
1120......	.34	16,908	15,055	11
1154......	.88	8,932	7,976	7

HIGHWAY TUNNEL FOR ALLEGHENY COUNTY, PA.

Bids to Be Opened July 12 on $2,000,000 Contract.

Total Length, Including Approaches, Is 5,800 Ft.

A $2,000,000 tunnel contract is being advertised for bids by the Commissioners of Allegheny County, Pennsylvania. The work calls for the construction of County Highway Tunnel No. 1, a twin tube bore, about 5,800 ft. in length, with approaches. It will extend from the southerly side of East Carson St., near Third St., Pittsburgh, in a southerly direction to a point on Warrington Ave., near Boggs Ave., Pittsburgh. The tunnel proper will be approximately 4,875 ft. long. The north approach will have a length of about 100 ft., and the southerly approach a length of about 825 ft. The main dimensions of one of the tubes are shown on the accompanying illustration.



Section of One of Twin Tunnels.

The approximate estimate of quantities includes the following:

Completed tunnel, lin. ft....................	4,875
Membrane waterproofing over monolithic concrete arch rings in tunnel, sq. ft.....	120,000
Excavation in north approach under Pennsylvania R. R., cu. yds.............	9,300
Concrete masonry in north approach, cu. yds.	3,400
Waterproofing over arch rings in north approach, sq. ft........................	8,600
Excavation in south approach, cu. yds...	19,600
Concrete masonry in south portal and in retaining walls in south approach, cu. yds.	5,300
Steel reinforcing bars, lbs..................	200,000
Brick paving in approaches, sq. yds......	3,600
Steel protected concrete curb in approaches, lin. ft..........................	1,750
Concrete sidewalks in approaches, sq. ft..	7,100
Rebuilding 6 ft. city sewer, lin. ft........	1,050
Terra cotta pipe sewers in approaches, 15-in., lin. ft..............................	1,000
Terra cotta pipe sewers in approaches, 9-in. and less, lin. ft.....................	200
Porous drain tile, 6-in. and less, in approaches, lin. ft.........................	2,600
Cast iron water pipe in approaches, 6-in., lin. ft.	1,000
Cast iron water pipe in approaches, 4-in., lin. ft.	100
Sewer manholes in approaches...........	6
Sewer inlets in approaches..............	5
Terra cotta pipe sewer connecting with 6-ft. city sewer, lin. ft....................	900
Special manholes on 6-ft. sewer..........	3
Standard manholes in 15-in. T. C. sewer.	3
Fences in southern approach, lin. ft......	1,600

Bids will be received on either brick, concrete or concrete block construction for the arch rings of the tunnel. The foundations and side walls below the springing line will be of monolithic concrete or concrete block masonry consisting of 1 part cement, 2 parts sand and 4 parts gravel or broken stone. A 1:2:4 gravel mix is specified for the monolithic concrete or concrete block masonry above the springing line. The concrete packing back of the arch ring and side walls will be a 1:2½:5 mix. It also is specified that wherever directed by the engineer the space back of the masonry arch rings and bench walls shall be filled with dry packing consisting of hard, durable stone, none to exceed 6 in. in size. This dry packing will be grouted after the masonry lining is in place.

If brick or concrete masonry is used in the arch rings a coating of mortar 1½ thick consisting of 1 part cement and 2 parts sand will be plastered over the back of the arch. If monolithic concrete masonry is used in the arch rings the contractor will place a water proofing membrane in each tube over the arch rings for a distance of about 600 ft. from the portal at each end of the tunnel. This membrane will consist of two plies of cotton duck or burlap saturated with pure bitumen or straight run American coal tar pitch and three plies of water proofing cement of pure bitumen or pitch.

The north approach passes under eight tracks of the Pennsylvania R. R. The bid on the construction for the approach will include the cost of carrying these tracks during construction. The concrete masonry in the north approach will be a 1:2½:5 mix, and similar proportions will be used in the work at the other portal. The south approach will require the construction of a considerable amount of concrete retaining wall. There also will be quite a bit of open cut excavation, fill and embankment.

The tunnels will have 20 ft. roadways, and, with the approaches, will be paved with brick on a 6-in. concrete base in the approaches and a 6 in. to 9 in. concrete base in the tunnel. The sidewalks, 2 ft. 9 in. in width, in each tunnel, with the steel protected concrete arch, will form a conduit for electric wires. The sidewalks in the tunnels will consist of concrete slabs 3 in. deep, with a 1 in. wearing surface, reinforced with expanded metal. In the tunnel there will be a 6-in. terra cotta drain placed every 300 ft. and manholes and inlets about every 600 ft.

Bids for the construction of County Highway Tunnel No. 1 will be received by Hyatt M. Cribbs, County Controller, Pittsburgh, Pa., until 1:30 p. m., July 12. A. D. Neeld, 237 Fourth Ave., Pittsburgh, Pa., is the consulting engineer.

Buildings for Naval Radio Station, San Diego, Cal.

The Bureau of Yards and Docks is calling for bids for the construction of buildings for the naval radio station near San Diego, Cal. This station is approximately 8 miles from San Diego and 2½ miles from Lemon Grove. The structures to be erected under the contract are a power house, one operating building, one storehouse, one pump house, one quarters for commanding officer, one double quarters for chief operators, and one quarters for operators.

The power house, operating building, and storehouse will be of brick construction, stuccoed, with concrete bases and foundations, steel and concrete roof construction, except where tile roof covering is indicated. All quarters and pump house will be of wood frame construction on concrete bases and foundations, stuccoed exteriors, and tile roof covering. All walls and ceilings will be plastered except walls and ceilings of storehouse and walls of power house. The general dimensions of the buildings are as follows, excluding porches: Power house, 40 ft. 2 ins. wide, 72 ft. 2 ins. long;

operating buildings, 26 ft. 2 ins. wide, 47 ft. 8 ins. long; storehoust, 22 ft. wide, 41 ft. 6 ins. long; pump house, 15 ft. 10 ins. wide, 16 ft. 10 ins. long; quarters for commanding officer, 51 ft. 10 ins. wide, 46 ft. 4 ins. long; quarters for chief operator, 27 ft. 4 ins. wide, 62 ft. 4 ins. long; quarters for operators, 18 ft. wide, 64 ft. long.

Bids on the above work will be received until 11 a. m., July 24, by the Bureau of Yards and Docks, Navy Department, Washington, D. C.

A $130,000 Road Letting in Allegheny County, Pa.

A $130,000 road letting will be held soon by the commissioners of Allegheny county, Pennsylvania. Authorization has been received for calling for bids for the improvement of the following roads:

Road.	Type of surfacing.	Est cost.
Wilmerding and Monroeville	Macadam	$30,348
Noblesville "O"	Brick	2,407
Newtown and Rodi	Brick	31,592
McCoy Extension	Macadam	19,271
Braddock and Ardmore	Macadam	6,254
Millers Run Extension	Macadam	31,119
Millers Run Extension	Brick	61,210

Bids will be received by Hyatt M. Cribbs, County Controller, Pittsburgh, Pa. John Gillespie is County Road Commissioner.

PERSONALS

Mr. Robert Leslie Pettigrew of Great Falls, Mont., who graduated this year from the civil engineering class of Montana State College, has received an appointment to the post of assistant engineer in the national forest products laboratory at Madison, Wis.

Mr. H. A. Keller has been appointed superintendent of city water works for Niagara Falls, N. Y. Mr. Keller held the same position from May, 1889, to June, 1891. He has been in various outside lines since that time and has received his present appointment upon passing the civil service examination for the place.

Mr. F. M. Lockwood has been appointed "manager of operation" for San Diego, Calif., and will have charge of all city departments except fire and police and purchasing. Mr. Lockwood is a civil engineer and was assistant superintendent of the sewer department in 1912 and assistant superintendent of the department of sewers, buildings and electricity since 1913.

Due to the reorganization in the Department of Agriculture, the Baltimore local office of Drainage Investigations, recently maintained at 319 Custom House, Baltimore, Md., with John R. Haswell, drainage engineer, in charge, has been discontinued, but the work will still be conducted by Mr. Haswell through the Office of Public Roads and Rural Engineering located in the Willard Building, 515 Fourteenth street N. W., Washington, D. C.

Mr. George Cromwell has been appointed city engineer of San Diego, Calif., succeeding Mr. W. M. Rumsey. Mr. Cromwell was superintendent of construction for the National Wood Pipe Company for a time, and later was resident engineer for the Stone & Webster Engineering Corporation on hydroelectric development at Verdi, Nev. He was also for a time field engineer for the Oro Development Corporation on Feather River water power development. Mr. Cromwell is an associate member of the American Society of Civil Engineers.

Mr. Wilbur F. Reed has been appointed superintendent of the Kalamazoo, Mich., water plant, succeeding Mr. Herman A. Watson, who resigned. The water department of Kalamazoo operates under civil service and Mr. Reed was selected from a list of six applicants who took the examination. He has already served about twenty years in this capacity, and was succeeded by Mr. Watson four years ago, at which time the water department was not under civil service regulations. Mr. George Houston is water commissioner of Kalamazoo.

Andrew Swickard, Hydraulic Engineer.

Mr. Andrew Swickard, author of the notable series of articles on "The Use, Design, Construction, Cost and Durability of Wooden Stave Pipe," which has been published at intervals in Engineering and Contracting during the past eight months, is in general practice as hydraulic engineer with offices at 216 Fulton street, Palo Alto, Cal. Mr. Swickard began his engineering career in 1890 on railroad, county and municipal surveying in Seattle and vicinity. From 1892 to 1898 he was engaged in general engineering work in various parts of California, including the design of a number of county road bridges, water works plants and sewer systems. From 1898 to 1900 Mr. Swickard was with the United States army engineers at Manila as chief draftsman in the chief engineer's office. The following year he spent in recovering his health which had been seriously impaired during his Philippine service. He then completed his course in civil engineering at Stanford University, leaving in 1903 to become assistant engineer with the Bay Cities Water Co., San Francisco. From 1904 to 1908 he was with the Excelsior Wood Pipe Co., of San Francisco, as engineer and assistant manager. During this time Mr. Swickard designed and directed construction of large wooden pipe in most of the Pacific coast and Rocky Mountain states, Alaska and Mexico. It was during this period that he gained most of the experience and collected the data which enabled him to put forth his valuable series of articles on wooden stave pipe.

Andrew Swickard

During 1908-1910 he was engaged in general practice in San Jose, Cal., and from 1910 to 1913 he was resident engineer in the South San Joaquin irrigation district which comprises 70,000 acres in the southern part of San Joaquin County, California. From 1913 to 1914 he was chief engineer on this project. While chief engineer Mr. Swickard was in charge of the design of all structures of the distribution system and also of the details of an earthen dam 60 ft. high. The total cost of this system was approximately $3,300,000. Since 1914 Mr. Swickard has been in general practice at Palo Alto, and has also carried on some experimental work at Stanford University which consumed a considerable amount of his time.

At the present time Mr. Swickard is engaged on an irrigation project which will eventually serve 16,000 acres of land in a fruit growing region where the natural rainfall is variable and seldom sufficient to secure maximum yields. Water will have to be stored, and because of occasional dry years, two years' supply must be stored. An earthen dam 140 ft. high is the main feature of this work, which is still in the preliminary stages. Mr. Swickard estimates the total cost at $1,200,000.

Mr. A. T. North, associate member of the American Society of Civil Engineers, is now associated with the Abraham Lund Company, general contractors, 1117-18 Association Building, Chicago, and will be in charge of the engineering and estimating departments.

Mr. Frederick E. Everett has been appointed acting state highway commissioner of the state of New Hampshire, to succeed the late S. P. Hooker. Mr. Everett was assistant engineer for the New Hampshire state highway department from 1906 to 1909, and division engineer from 1910 until receiving his present appointment. Prior to 1906 he was for a time assistant engineer for the park department, Cambridge, Mass.

Mr. Karl M. Mitchell, former village manager of River Forest, Ill., has been appointed city manager of Sherman, Texas. Mr. Mitchell occupied the position at River Forest for two years past. Prior to that he was manager of an electric fixture business, of which he was also part owner. He received his training in electrical engineering at Chicago and Northwestern Universities, and from 1896 to 1912 was in the employ of various public utility companies, for the last six years of that time as manager and efficiency expert.

Mr. Robert S. Brown, who recently opened an office at Asheville, N. C., for civil engineering practice, is a graduate of Trinity College, Durham, N. C., class of 1908. For one year after graduation he was on railroad location and construction in Montana and Idaho with the Gilmore & Pittsburgh Railroad, and later was for a time on location and construction work for the Chicago, Milwaukee & St. Paul in Montana. During the year 1911 he was engaged on reconstruction work or in the division engineer's office of the San Pedro, Los Angeles & Salt Lake in Nevada. The following year he was engaged on electric railroad location in Alabama and last year on general work in Georgia and North Carolina.

Mr. L. L. Robbins, who has been the assistant engineer for the Pennsylvania State Highway Department, in charge of the district comprising Beaver, Westmoreland and Allegheny counties, has been removed, and Mr. S. W. Jackson, who has been in charge of the district comprising Bradford, Cameron, Lycoming, Sullivan, Potter and Tioga counties, has been placed in charge. The vacancy thus created has been filled by the promotion of Mr. J. S. Ritchey, who has been county superintendent of Sullivan county. Mr. W. R. Mason has been appointed county superintendent. The district comprising Berks, Carbon, Schuylkill, Lehigh and Northampton counties is now in charge of Mr. John T. Gephart, Jr., who succeeds Mr. G. C. Langenheim.

Another important change in the Pennsylvania State Highway Department is the removal of Mr. Thomas C. Boyd of Pittsburgh from the post of registrar of the automobile division, and the appointment of Mr. George M. Bruester of Philadelphia to succeed him.

Mr. George W. Deaves of Delaware county, Pennsylvania, has been appointed superintendent of that county, to fill the vacancy caused by the resignation of Mr. A. A. Sellers. Mr. B. F. Dively has been named to succeed Mr. E. L. Coveney as superintendent of Bedford county. Mr. C. E. Myers succeeds Mr. Robert Black as superintendent of Westmoreland county. Mr. W. G. Dick is the new superintendent of Allegheny county, and Mr. W. A. Dilzer has been named as superintendent of Berks county.

Mr. Charles A. Kyle has been appointed bridge engineer for the state highway commission of Montana, a new office in that state. Hereafter all highway bridges in Montana must be built from standard plans of the commission and approved by it after erection before being paid for. Mr. Kyle is well qualified to take charge of the designing of standard plans and supervision of construction. He was with the Chicago Bridge & Iron Works about ten years as draftsman and chief draftsman, and was engaged principally on highway bridges. From 1900 to 1915 he was with the American Bridge Company, and during the past six months has had an office at Salt Lake City as structural engineer. While with the American Bridge Company Mr. Kyle was engineer and manager of the plant at Lafayette, Ind., for four years. For three years he was checker and squad boss in the drafting room at Chicago. For the last seven years he was structural engineer and designer on several large jobs, including the Steptoe Valley Smelting Company's plant at McGill, Nev.; steel structures for the International Smelting & Refining Company at Salt Lake City; concrete and steel viaduct at Des Moines, etc. He also worked on valuation of bridges for the Chicago Great Western, and was structural engineer on the great Tooele smelter in Utah.

CIVIL SERVICE NEWS

The United States Civil Service Commission announces an examination for the following position:

Associate chemist, qualified in chemistry of metals; Bureau of Standards. Salary $2,000 to $2,500 per annum. Graduation with bachelor's degree in chemistry from four years' course at college or university of recognized standing, and at least three years' subsequent research work in chemistry of metals and alloys are prerequisites.

OBITUARIES

John Dey, aged 55, for many years city engineer of Waukesha, Wis., died recently at his home in Pewaukee.

Thomas H. Verner, superintendent for years of the city water bureau at McKeesport, Pa., died suddenly at his home in that city June 13, aged 50.

NEW CATALOGUES

Railway Appliances.—Paper. Leaflets. Walter A. Zelnicker Supply Co., St. Louis.

Zelnicker Bulletins Nos. 171 and 174, listing bargains in tool steel, spike mauls, locomotives and cars, car parts, engines, steel piling and miscellaneous items now on hand.

Truck Trailers.—Paper, 5x7 ins.; 20 pp. The Troy Wagon Works Co., Troy, Ohio.

Book Two, describing Troy Truck Trailers and showing by illustration and figures the economy and added efficiency gained by using trailers with motor trucks. Shows the trailers in use and gives specifications.

Tunnel Waterproofing.—Paper, 3½x6¼ ins.; 4 pp. Cement-Gun Company, Inc., 30 Church St., New York City.

Bulletin 91, a reprint of an article on "Tunnel Waterproofing with Cement-and-Clay Mortar," fifty feet below sea level using a cement-gun. Illustrated.

Cement-Gun Process.—Paper, 6x9 ins.; 4 pp.; 1-p. insert. Cement-Gun Company, Inc., 30 Church St., New York City.

Bulletin No. 101, describing the Cement-Gun Process of permanently repairing coke ovens. Describes apparatus, with cut, and operation, and contains fac-simile letter from the company for which the work was done.

Tractors.—Paper, 12x9 ins.; 16 pp.; Knox Motors Company, Springfield, Mass.

The Knox Tractor is described with illustrations and specifications. The arguments in favor of tractor haulage are summarized and details of construction of Knox tractor are explained with special reference to the double spring suspension feature.

Venturi Meter.—Paper, 6x9 ins.; 36 pp. Builders' Iron Foundry, Providence, R. I.

Bulletin No. 84, consists of a brief history of the invention and introduction of the Venturi meter, descriptions of applications, special meters, recording devices, etc., instructions as to installing, and tables of standard meter tubes. Illustrated.

Water Drill.—Paper, 6x9 ins.; 4 pp.; Ingersoll-Rand Co., 11 Broadway, New York City.

Form 4034, descriptive of Type No. 26 Leyner-Ingersoll water drill. Resembles the larger No. 18 Leyner-Ingersoll drill, but is lighter in weight and intended for smaller diameter and shorter depth holes. Illustrated.

Water Filters and Coolers.—Paper, 6x9 ins.; Everson Filter Co., 70 West Lake St., Chicago.

Catalogue No. 6 describing Everson water filters and coolers. Shows various sizes and styles and typical installations of systems in office and factory buildings. Gives general specifications and describes methods of installing and cleaning.

CATALOGUE REVIEWS

Gas and Gasoline Engines.—6x9 ins. Chicago Pneumatic Tool Co., Fisher Building, Chicago, and 52 Vanderbilt St., New York City.

Bulletin 34-X, dated May, 1915, relating to Chicago Pneumatic Class A-G "Giant" Gas and Gasoline Engines. The bulletin illustrates these engines in six sizes, ranging in horsepower from 16 to 130. The engines are similar in general design to the well known Giant fuel oil driven engines manufactured by the same company with the exception that they are designed for operation with manufactured or natural gas. Their enclosed self-oiling features, extreme simplicity and perfect automatic regulation should recommend them in the field where manufactured or natural gas is available for power purposes.

Copies of this bulletin and further information relative to these engines may be obtained by applying to the Chicago Pneumatic Tool Company, at either of the offices above mentioned, or any of its branches in all principal cities.

Hy-Rib Handbook.—Paper, 5½x7½ ins.; 144 pp.; Trussed Concrete Steel Company.

The 13th edition of the handbook of Hy-Rib and metal lath products is a very comprehensive reference book on the subject of roof, floor, wall and ceiling construction, without forms. Hy-Rib is a steel sheathing, stiffened by rigid deep ribs, manufactured from a single plate of steel. It is a combined unit of forms, reinforcement, lath and channels for concrete, stucco and plaster.

All the various types of Hy-Rib are shown with their applications to all types of constructions. Specifications and reading matter have been completely revised and include the most recent developments and improvements. Many new details and discussions have been added. The photographs of installations are particularly comprehensive, including many new applications. Illustrations and information on Pressed Steel Studs and Kahn Pressed Steel Construction, as well as the floretyle construction, have been added.

INDUSTRIAL NOTES

The Panama-Pacific Exposition announces the award of two grand prizes, five medals of honor and two gold medals on farm machinery to the Holt Manufacturing Co., of Stockton, Cal. All these awards indicate scorings of 95 per cent or better.

The Ingersoll-Rand Co. on June 1 opened a branch office at 139 Townsend St., San Francisco. Arrangements have been made with Harron, Rickard & McCone, former agents, whereby they co-operate with the Ingersoll-Rand Co. in the sale of its machinery after the expiration of their agency contract on July 22 next. Mr. H. L. Terwilliger is district manager for the territory handled by the San Francisco and Los Angeles offices, with headquarters in San Francisco.

The Universal Portland Cement Co. makes the following announcements: R. F. Atkins, formerly assistant credit manager at Chicago, has been appointed Eastern credit manager at Pittsburgh, vice L. S. Fuqua, deceased. Ray S. Huey, formerly assistant general superintendent, Buffington Plant, Buffington, Ind., has been appointed superintendent of the Duluth Plant, Duluth, Minn. Fred Robinson has been appointed assistant superintendent of that plant. C. O. Soderquist, formerly superintendent of Mill No. 6 at Buffington Plant, has been appointed assistant general superintendent, Buffington Plant. J. H. Kempster, formerly chief chemist, Buffington Plant, is now superintendent of Mills 3 and 4 of the Buffington Plant. M. S. Humphreys, formerly chief draftsman, has been appointed superintendent of Mill No. 6 at Buffington, Ind.

FOREIGN TRADE NOTES

The following foreign trade opportunities are listed by the Bureau of Foreign and Domestic Commerce. Where addresses are omitted in the items they may be obtained from the office of the Bureau at Washington, D. C., or from the following branch offices: New York, Room 409 U. S. Customhouse; Boston, 752 Oliver Bldg.; Chicago, 629 Federal Bldg.; St. Louis, 402 Third National Bank bldg.; Atlanta, 521 Post Office Bldg.; New Orleans, 1020 Hibernia Bank Bldg.; San Francisco, 306-7 L. S. Customhouse; Seattle, 922 Alaska Bldg. In applying for addresses reference should be made to the file numbers.

Concrete Pipe Machinery.—Business man in Chile wishes to secure catalogues and prices of forms and machinery for making small concrete sewer pipe. No. 17275. [For address see first paragraph.]

Bridges—Siamese.—Royal Railway Department is asking bids for supply of 3 steel viaducts for the Northern Line. The tenders must reach the head office in Bangkok not later than Oct. 29, 1915. Specifications and drawings may be examined at the Bureau of Foreign and Domestic Commerce or its branch offices. The bids should be forwarded to L. Weiler, director general of the Siamese Royal Railway Department, Bangkok, Siam. Correspondence may be in English.

Grain Elevator.—Canadian company contemplates expending $100,000 for erection reinforced concrete grain elevator. No. 17,-205. [For address see first paragraph.]

Fire Alarms.—Tenders are asked by Secretary Rangoon Municipality, until Aug. 11, for a proposed installation of fire alarms for the town of Rangoon. A copy of the general specifications and schedule of prices may be obtained from Ogilvy Gillanders & Co., 67 Cornhill, London, E. C., England.

Pipe.—Bids will be received until July 14, by President Corporation of Madras, India, for supply and delivery of cast-iron pipes, special castings, sluice valves, hydrants, etc. The total weight of the pipes and special castings is about 4,700 tons, the diameters varying from 2½ in. to 42 in. Forms of tender may be obtained from James Mansergh & Sons, 5 Victoria St., Westminster, Madras.

Turbines.—Tenders will be received until July 12, by Metropolitan Board of Water Supply and Sewerage for the supply and delivery at the pumping station at Ryde, New South Wales, of two steam turbines, with condensers, air pumps, etc., and spares. Copies of the specifications and form of tender may be obtained from the offices of the Metropolitan Board of Water Supply and Sewerage, 341 Pitt St., Sydney, Australia.

Dredger.—Tenders will be received at the office of the South Australian Harbors Board, Adelaide, Australia, until Aug. 24, 1915, for supply and delivery of a steel self-propelling barge-loading bucket dredger. Further information may be had on application to the office of the South Australian Harbors Board, Victoria Square, Adelaide, Australia.

Structural Steel and Cement.—Contractor in Italy wishes to enter into business relations with American manufacturers of structural iron and steel. He also desires to receive quotations on Portland cement. No. 17262. [For address see first paragraph.]

Engineering and Contracting

**Devoted to the Economics of Civil Engineering Design
and to Methods and Cost of Construction**

EDITORS
H. P. Gillette C. S. Hill C. T. Murray S. C. Hadden C. W. Malcolm C. R. Thomas

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Tangled Theories of Railway Valuation.

A three-day hearing on valuation questions was recently held by Director Prouty of the Valuation Board of the Interstate Commerce Commission. Representatives of the railways and of the state railway commissions replied to a list of questions on disputed points involved in appraisals. It is significant that the railways and the commissions rarely agreed, the former adhering quite closely to the "competitive theory," and the latter adhering to the "agency theory."

It may be questioned whether the two disputants realized that there are two fundamentally different theories of valuation, for neither of the disputants was wholly consistent. In our issue of Dec. 11, 1912, we published an article entitled, "Two Conflicting Theories of Valuation," by Halbert P. Gillette, which was perhaps the first published analysis of the fundamental cause of the many diametrically opposed ideas as to appraisals. Briefly stated, Mr. Gillette holds that nearly all differences of opinion may be thrown into two general classes, based on two tacit, although not usually avowed, theories: (1) The Agency Theory, and (2) the Competitive Theory.

According to the agency theory a public utility company is conceived not only as being, but as having always been, a public agent in the full sense of the term agent. As such agent a utility company would be entitled to a fair return on its actual investment from beginning to date. The rate-making value of its property would be the actual cost of its physical plant plus any accumulated deficits in fair return on its investment. Hence in appraising its plant, the attempt would be to estimate what it had actually cost under the conditions that existed when it was built. If there were trees to be cleared and grubbed at the time of construction, then the cost of such clearing and grubbing would appear in an appraisal, even though not a single tree might now exist within a mile of the property. If construction were done piece-meal, then piece-meal prices would be applied. If prices of materials had varied, then weighted average prices over a period of years would be used.

The "agency theory" has never been followed to its logical limit, but it has been quite closely adhered to by some state railway commissions, notably that of Wisconsin, most of whose decisions on disputed points can be seen to fall under the "agency theory." Thus, the deficit method of calculating "going value," or the Wisconsin method as it is often called, clearly implied adherence to an "agency theory."

The "competitive theory" is the one that may be said to have been adopted by the U. S. Supreme Court, at least in large measure. According to this theory the appraiser is not concerned with past conditions or past costs. He must assume that his first task is to estimate the cost of reproducing the plant under present conditions, much as if he were called upon to estimate the cost of a proposed plant intended to render the same service as the existing plant. The "competitive theory" implies the possibility of building an *alternative* plant, and of setting up its cost as a criterion by which to judge the value of the existing plant.

According to the "competitive theory," present unit prices for wholesale construction are to be applied. If all the land adjacent to the right of way is now cleared, then no clearing is to be estimated in the appraisal. But if buildings and other improvements now exist on adjacent land available for right of way, then the cost of acquiring and removing those improvements must be included in the appraisal. Carried to its logical conclusion, the "competitive theory" involves estimating the cost of building up a business equal to that of the existing plant under *competition* with that plant. In short, the "competitive theory" involves estimating the cost of building an alternative plant and acquiring an alternative income equal to that of the existing plant.

The editors solicit short descriptions of novel and useful methods and devices employed in engineering construction. Articles not to exceed a column (about seven hundred words) are preferred. Photographs or sketches should be included if they add interest and aid explanation. Utility and not careful writing will be the chief factor in determining acceptability. Accepted articles will be paid for.

These are the two theories stated briefly. But, as not many appraisers, commissions or courts have realized that any definite theory, other than the vague theory of "justice," could be applied at all, there has been a woeful muddle of inconsistencies. The tendency of each extreme partisan has been to spring nimbly from one position to another in an effort always to gain as much as possible for his client. This tendency was not without some exemplification in the recent hearing before Director Prouty.

Probably there must be some measure of compromise between the "agency theory" and the "competitive theory," but let no one imagine that there can be any real logic in the compromise.

Certainly an appeal to facts will show that railways and other public utilities have not been regarded as agents, in the full sense, until very recently, and even now they are not *treated* as agents by the public. Railways, for example, are compelled to compete, and often with disasterous results. Surely this is not an application of any real agency theory of relationship.

Before there can be consistency in decisions on rate-making values, the commissions and courts must realize that two theories of rate control exist, and that the two theories are incompatible. The "competitive theory" has nothing in common with the "agency theory," yet somehow we must pass from a regime under the former to a regime under the latter. It will be unfair to attempt to make the "agency theory" retroactive, to any great extent, and the courts have thus far resisted the attempt. Doubtless the most just solution of the problem would be to start with a clean slate by appraising all public utilities at their fair market value, based on capitalized net earnings; and thereafter apply the "agency theory" as fully as possible. Whatever the ultimate rulings of the courts may be, this much is certain: Neither appraisers nor courts can approach the problem intelligently until it is recognized that there are two distinct theories that must be understood before attempt is made to pass upon the hundred and one questions of detail that arise in the course of an appraisal.

Some Comments and Queries on Water Works Superintendence.

The problems of the water works operator of a quarter century ago appear simple in comparison with the complex character of present day water works superintendence. Twenty-five years ago the water superintendent was chiefly concerned in the physical problem of keeping the system in passably good running order—in getting water to the consumers at all times under fairly adequate pressure. The operator of that period was but little troubled by such considerations as quality of supply and economy of operation.

Now the physical problems are either successfully disposed of or are solved with precision and properly, as fast as they arise. The great majority of towns of 1,000 and over have water systems installed and in running order. The operator finds little difficulty with physical problems, but in maintaining the purity of the supply and in increasing economy of operation he has engrossing problems. Then, too, the modern operator is largely concerned in such matters as water waste prevention, meterage, fuel consumption, valuation, rates and rate making, the proper selection of new machinery and supplies, the introduction of new and improved methods in field and office, the installation of reinforcing or feeder mains, the proper location of new distribution reservoirs, construction methods and costs, provision and charges for fire protection, the prevention or mitigation of electrolytic corrosion, etc. While attention to all these matters was as important then as now this importance was not as generally appreciated as it is today. The old time operator was excusable in overlooking these and other fine points which might be mentioned but equal charity cannot be extended to present day managers. More is known now about proper operation procedure and therefore more may fairly be expected from the water works operator of today.

We are well aware that the handling of many of the matters mentioned is frequently, perhaps generally, delegated to outside experts or to the specialists within the larger departments. However, the chief water works operator, whatever his title and whatever the extent of the works in his charge, should have a good grasp of all these subjects and should be the leader of thought in his community in all matters pertaining to water supply. If this assertion is true it follows that the chief operator who, in municipally owned systems, is usually called the superintendent of water works, should be chosen because of his knowledge of the duties and responsibilities of the office. How many superintendents of water works are chosen on this basis? How generally is the office used as a political plum? Does knowledge gained in office tend to prolong the tenure of office? What is the average tenure of this office? How much longer can the water works associations continue their present apathy as to the rise and fall of the individual superintendent? Are the associations morally obligated to safeguard the general public's interest in water supply matters? Are they faithfully discharging this obligation while failing to take official action calculated to discourage the appointment of incompetents or the removal of competents for considerations of political expediency?

WATER WORKS

Data and Discussion on Leakage from Cast Iron Water Mains.

Many published data show the large volume of leakage from the cast iron water mains in the larger and secondary cities, including New York, Chicago, Milwaukee, Minneapolis, etc., and it should be noted that the same condition exists in the smaller cities and towns. Thus the village of Westerville, Ohio, where this form of leakage amounts to 50 per cent of all the water pumped, is a good illustration. Perhaps the towns and villages suffer even more than the cities in this particular because small water systems are not infrequently poorly constructed by untrained and inexperienced workmen. The caulking is often carelessly done. It is unfortunate that so few of the smaller municipalities are in a position to make the proper tests for loss because such data would be of great value.

Water leakage and waste may properly be divided into the following classes: (1) House or inside leakage due to defective plumbing. (2) Over-consumption, especially in summer. (3) Water stolen from the mains, and waste due to flat rates. (4) Underground leakage from services and mains. The first three sources of waste can and should be regulated by the installation of meters. This leaves only the underground leakage from services and mains for special consideration and serious study. During recent years several large cities have made exhaustive studies of the whole subject of water waste. The data here given will be confined to those pertaining to underground losses.

At Baltimore 60 per cent of the leakage is charged to defective house connections, 20 per cent to broken supplies, services and private pipes and 20 per cent to mains, valves and water used in street construction. These figures pertain to the high sections of the city and it was thought very likely that leakage from the mains direct would be found much higher in the lower parts of town. In New York City, in Manhattan and the Bronx, the waste detected and stopped from the fall of 1910 to April, 1913, was approximately 40,000,000 gals. per day. The underground leakage detected and stopped was about 25 per cent of the total.

Very complete and thorough tests, extending over seven or eight years, have been made in the city of Washington. The data on underground leakage are so itemized as to show exactly the amount of loss from the different sources. During the seven years from July 1, 1907, to July 1, 1914, the underground leakage detected and prevented averaged 5,759,200 gals. per day. This was distributed as follows:

Sources of leakage.	Average daily leakage detected and prevented. Gallons.
1 Abandoned taps and services	140,843
2. Iron services	1,702,643
3. Lead services	611,600
4. Wiped joints	380,171
5. Couplings	825,871
6. Stopcocks	33,077
7. Street washers	8,371
8. Joints on mains	1,183,943
9. Broken mains	262,486
10. Valves	47,514
11. Blow-offs	142,986
12. Fire hydrants	51,100
13. Public hydrants	23,914
14. Unclassified	346,200
Totals	5,759,143

The foregoing tabulation shows the two principal sources of leakage to be from iron services and joints on mains. The former comprises approximately 29 per cent and the latter 21 per cent of the total loss, or in other words the two combined represent one-half of the entire leakage. The loss shown in the case of couplings (which is the next largest) practically all occur in one year (1908-1909). Hence it is hardly fair to give this much weight. The loss from such a source should never be excessive. In most cases it is almost negligible. The losses both from lead services and wiped joints, while varying to quite an extent for the different years, are seen to be sufficiently large to warrant serious consideration. The other losses are rather variable and are not of so much importance.

The cases of Baltimore, New York and Washington may be taken as typical. The results obtained indicate that the underground leakage represents anywhere from 25 per cent to 51 per cent of the total waste, but it must be borne in mind that the figures quoted represent only the amount of waste that was detected and stopped. Just what proportion of the waste was not detected or prevented we are not told, except in the case of New York. Mr. De Varona states that this represents only 15 per cent to 20 per cent of the total pumpage unaccounted for. Now in making such surveys as this it is much easier to detect leakages from services and house fixtures and waste occurring inside buildings than it is to detect leakages from the mains proper. As a matter of fact there is no reason why all inside loss could not be absolutely determined and this at a low cost. It would be a little more expensive to make such an investigation of the underground services, but this could also be done and the leakage from such a source determined. Then it is only reasonable to suppose—say in the case of New York for instance—where only 15 per cent to 20 per cent of the waste was actually accounted for, that a much larger percentage comparatively of the inside loss would be located and stopped than that of the leakage occuring underground, particularly from the mains themselves. As previously stated, if a water works system is properly metered, the inside waste ceases to enter into the problem. Where a consumer is paying so much per thousand gallons for the water he uses, he will see that the plumbing is in good shape and that over-consumption is stopped.

It is a very difficult matter and in many cases practically impossible to make a close examination of the mains underground. This would necessitate the tearing up of paving, as well as otherwise seriously disturbing street traffic. Such a condition would not be tolerated in a large city, and even if they were willing to suffer the inconvenience, the work itself would be too expensive. This leads the writer to conclude that in most cases the leakage from mains greatly exceeds the amounts which the surveys indicate. Where the soil is porous and the street well paved, particularly with certain substances like concrete or asphalt, a leak even of considerable size from the main would not be detected on the surface. The water could easily find its way to a sewer and would remain undiscovered indefinitely. There might be numberless leaky joints that would thus pass unnoticed. Even a careful examination of the system, unless the pipe were actually uncovered and examined, would fail to disclose the location of these, except in a general way. Hence it is almost impossible to determine the exact underground leakage from mains and the rather low percentage of loss from this source as shown in the report cited is probably accounted for in this way.

Recently Walnut Street, one of the principal thoroughfares of Kansas City, was repaved in the heart of the business section. There is a large supply main down this street and the writer observed that the city was going to the expense of uncovering the joints in this main and recaulking them. Unfortunately the writer has been unable to learn just the extent of leakage that was found and does not believe the city could furnish these data, but, since they went to considerable expense to repair the main, it is only natural to conclude that they felt the loss fully justified the cost of the work. The few joints that the writer examined showed that leakage did exist.

No matter how carefully joints are made, even by skilled workmen, a certain amount of leakage will always be found to exist. In a paper read before the New England Water Works Association Sept. 9, 1914, Mr. E. G. Bradbury presents some very interesting data on the subject "Allowable Leakage from Water Mains." From a series of tests made by Mr. Bradbury on a large quantity of pipe laid under his supervision at Akron, Ohio, and also at some other points, he proposes as a standard of allowable leakage in newly laid cast iron water pipe an average of 100 gals. daily per mile per inch of diameter of each complete contract or district with a maximum limit of 200 gals. daily per mile per inch of diameter. Mr. John H. Gregory specified at Columbus, Ohio, a permissible leakage equaling approximately 520 gals. daily per mile per inch of diameter, and justified this allowance with the statement that "the limits of allowable leakage specified were not guessed at, but were determined after careful study of the measured leakage in pipe lines with which the writer was familiar." The New York Aqueduct specifications allow a loss of 2 gals. per foot of lead joint, which is equivalent to approximately 240 gals. per mile per inch of diameter. Burns & McDonnell of Kansas City, who have supervised the construction of some three or four hundred water works systems throughout the Middle West, in their tests allow a leakage of 80 gals. per mile per inch of diameter.

Now if we make an average of the allowances as prescribed by the authorities cited above, we find this to be 235 gals. per mile per inch of diameter. This, it must be borne in mind, takes into consideration only the actual leakage from the joints of the mains themselves where these mains are freshly laid and, therefore, at their best. Pipe systems necessarily become less efficient with age and the natural tendency would be for this joint leakage to increase with age. Just what the amount of this increase would be, it is almost impossible to determine, for as already explained, main joint leakage is so distributed as to make examinations, tests and repairs practically out of the question. However, this does not lessen the serious losses that now occur.

Unless applied to some concrete example, figures such as the above do not mean a great deal. Hence for the sake of illustration the writer will apply these to a city of, say, 100,000 population. In such a town the average diameter of the pipe would probably be about 10 ins. The amount of mains, say, about 200 miles. The loss per day would be 470,000 gals. Figuring the production cost of the water at $50 per 1,000,000 gals., this would represent a loss of $23.50 per day, or $8,577.50 per year. Allowing 6 per cent for interest and sinking fund, this would capitalize at $142,958.

This, now, represents only the *minimum* loss from *joints* alone in a newly constructed system, which is supposed to be built in the best manner possible. With age, even in a properly constructed system, joint leakage undoubtedly increases. The writer believes that during the life of the ordinary system, it would be only fair to average the loss at double the minimum when first tested, or say place the total joint leakage at 500 gals. per inch mile per day. Apply this to the foregoing case, we find the yearly loss to be $18,250.00, or at 6 per cent, an investment of $304,166.66.

Now in addition to the joint leakage we must take into consideration the following sources of underground loss: 1. Hydants and valves. 2. Service connections. 3. Leaks, defective mains, dead ends, and "sweating."

In a paper read before the American Society of Civil Engineers, the late Emil Kuichling (Trans. Vol. 38), set the well known standard of one drop per second from each joint on a main; five drops from each hydrant or valve; and three drops from each service pipe, as a fair average in a properly constructed system Now whether or not we may differ with Mr. Kuichling as to the actual loss per second, the ratio assigned by him seems to be well taken and tests tend to verify this. Hence the writer feels justified in making use of it here.

Most pipe in use at the present time is made in 12-ft. lengths. In the case of the city previously cited with 200 miles of mains, this would mean 88,000 joints. Figuring a service connection every 65 ft. would give us a total of 16,240 connections. Estimating a hydrant or valve every 300 ft. gives us a total of 3520. By applying the ratio of leakage suggested by Kuichling, and reducing to the same unit, we have:

Pipe joints ....88,000 x 1 = 88,000 units
Service connections......16,240 x 3 = 48,620 units
Hydrants and valves.... 3,520 x 5 = 17,600 units

Or, letting 100 per cent represent the three sources of leakage, we find same to be divided approximately as follows:

Pipe joints..........................	56 per cent
Service connections..................	33 per cent
Hydrants and valves..................	11 per cent

Taking the value of 500 gals. previously determined in the case of pipe joints, we arrive at the following results:

	Gals. per inch mile per day.
Loss from joints on mains................	500
Loss from service connections............	300
Loss from hydrants and valves............	100

This brings us to the question of leaks by reason of defective or cracked mains, dead ends and "sweating"—a very hard thing to determine exactly in a general way because what is true in the case of one system might not be true of another—hence any loss that is assigned to such sources is much in the nature of an expression of opinion. There is little to substantiate or prove what might be said. However, as to defective mains, experience has shown that this need not be considered in the case of cast iron, once they are thoroughly tested and accepted for there does not seem to be any case on record where they have rusted out under ordinary conditions, even after a century or two of service. There is doubtless in many cases considerable leakage at times because of cracked or broken mains, but such losses are only temporary in most instances as they are easily discovered and repaired, therefore the loss is not serious. The writer can find no reason for believing that dead ends are a source of much waste, yet some authorities seem to think so—just why it is hard to understand, provided the system is properly inspected. The question of "sweating" seems to be a debatable one; certain tests made at Philadelphia several years ago on a 24-in. main under a pressure of 200 lbs. indicate that this is rather large. The writer has been unable to find any other tests to bear this out in the case of ordinary pressures. Under high pressures—say 1,500 to 2,000 lbs. to the square inch, there is quite a noticeable tendency for the water to be forced through the walls of the mains, even in the case of cast iron where the metal is an inch and a quarter or more in thickness.

Now, as previously stated, the loss from the causes enumerated and discussed in the foregoing paragraph is largely a matter of local conditions and, at best, only the expression of a personal opinion of what the loss should be. In the case of a well built system, properly kept up, the writer considers a loss of 100 gals. per inch mile per day as a liberal allowance from such sources. Assuming this, then, as being a fair estimate, we have losses from legitimate sources (no account is here taken of "steals" from mains, because it is a question that cannot be properly dealt with as applying generally) determined as follows:

	Gals. per inch mile per day.
Loss from joints on mains	500
Loss from service connections...........	300
Loss from hydrants and valves...........	100
Loss from other sources..................	100
Total	1,000

Applying the above results to the concrete example previously cited, i. e., to a city of 100,000 inhabitants with an estimated length of 200 miles of mains, average diameter 10 in., water cost of $50 per 1,000,000 gals. and money figured at 5 per cent for sinking fund and interest:

Source of loss.	Loss for yr. in gals.	Value at $50 per million gals.	Represent at 6% an investment of—
Joints on mains..	365,000,000	$18,250.00	$304,166.66
Service connections	219,000,000	10,950.00	182,500.00
Hydrants and valves	73,000,000	3,650.00	60,833.33
Other causes	73,000,000	3,650.00	60,833.33
Totals	730,000,000	$36,500.00	$608,333.32

In other words, the city would be justified in spending $608,333.32 to save the leakage from the mains, and a proportionate amount to reduce it. Of course it is almost a physical impossibility to make the mains "bottle tight," but it is possible to reduce the leakage materially.

The writer understands that several manufacturers are either making at the present time, or preparing to make, pipe in 16-ft. lengths. Under the circumstances it would not be amiss to call attention to the fact that the use of 16-ft. pipe would necessarily reduce the loss from joint leakage 25 per cent. The exercise of more care in caulking and alignment, and the testing in open trench where practical would also tend to reduce loss from this source. More stringent regulations regarding the making of service connections and proper care in doing the work and examination of frequent intervals thereafter would unquestionably eliminate much of the waste. The same thing, of course, applies to other causes of loss. The writer believes that fully two-thirds of the leakage as determined in this article is entirely unnecessary and might be prevented at a cost which would undoubtedly represent a saving to the city.

ACKNOWLEDGMENT

The data and discussion here given are from a paper before the recent annual meeting of the Southwestern Water Works Association by Mr. Joseph W. Ivy, manager of the Kansas City office of the American Cast Iron Pipe Co.

Suggestions Pertaining to the Improvement and Standardization of Procedure in Water Works Management.

(Staff Abstract.)

The following suggestions pertaining to the improvement and standardization of procedure in the operation and management of water works properties are quoted from the presidential address of George G. Earl, General Superintendent New Orleans Sewer and Water Board, at the recent annual meeting of the American Water Works' Association.

GOOD CONDITION OF PHYSICAL SIDE.

The progress which the physical side of water works problems has made, and is making, speaks loudly and truly of the unselfish co-operation which has always existed and still exists between the allied professions whose efforts are responsible for the advance which by its very momentum must continue.

CHAOTIC CONDITIONS AS TO BEST PRACTICE IN MANAGEMENT.

The end which lags and which should be given the best efforts of your best minds, however, has reference more to the matter of water rates and accounts and to the means and relations which exist in the matter of connections from the main to the property line, and in the matter of the maintenance of such connection and of the meter which should exist on each connection. The monumental work which the committee on the tabulation of water rates and allied comparative data submitted to the convention in 1914 reflects the greatest credit upon the persistence and industry of the chairman and those members of the committee who may have been able to co-operate with him in its preparation. It includes over 100 pages of comparative statistics, applying to over 300 cities, and has been prepared with the greatest care with a view of assembling together an intelligible and comparable resume of certain features of water works practice. The data include information as to water rates, distribution systems, electrolysis, metered services, source of supply, pumpage, treatment and consumption, public fire service, private fire service, and private service lines. While it represents information of the highest value, as a matter of reference as far as it goes, it tends mainly to emphasize the very wide divergence of practice and the almost chaotic condition as to what may be considered the best practice in many of these matters.

When we examine in detail the annual reports of water works plants all over the country we find even more strongly marked this divergence of practice, and we find ourselves absolutely unable by comparative study of accounts to formulate any satisfactory comparison in almost any matter pertaining to them. The divergence of conditions and interests, as between publicly and privately owned plants, is one cause of this trouble. The gradual growth of plants and the cumulative effect and inherent inertia of outgrown conditions, and of accumulated mistakes, are in part responsible. The persistent survival of flat rates for water and illogical conditions as to payment or non-payment for fire protection, based on every conceivable measure of probable use or relative influence, are the main obstacles to any approach to better conditions, and the inherent and obvious inadaptability of existing meter rate schemes to deal fairly, as between different classes of consumers, is the real stumbling block in the way of the universal introduction of meters and the general reconstruction of water and fire service rates.

The officials of many cities see the necessity of universal metering to save unnecessary expenditures in extensions and operation, but they do not see how they can curtail consumption and maintain the necessary revenue without resorting to some one of the numerous expedients which are variously used to create an unfair difference in favor of one or the other of their various classes of consumers, because in existing rates one or another class of consumer has been paying too little and will strenuously oppose an increase.

The committee's tabulation shows a range of meter rates of from 5 to 50 cts. per 1,000 gals. charged to small consumers, and from 2 to 20 cts. per 1,000 gals. charged to large consumers; and even at 50 cts. it is quite possible that some of the small consumers are getting more service than they are paying for, and certain that others are getting very much less. Meantime, every flagrant overcharge of one class of consumer in one place is breeding discontent, and every flagrant undercharge of the same class of consumer in another place is encouraging that discontent, and the water works interests are being ground between the mill stones of those discontents.

It is fully recognized that existing laws, contracts, customs and conditions complicate every consideration of a rapid revolutionary change in any given case, and not only that each class of consumer whose pocket never would be touched will constitute an obstacle but also that those who would be benefited will be suspicious and slow to recognize the benefit and to lend their co-operation. For this reason, great educational work will be necessary, and the approach to better conditions will be slow.

The greatest opportunity for co-operation today, which is before the various water works associations, lies in the commanding position which a short, clear, comprehensible dedication of the general principles which should govern a proper division of the necessary total water revenue, as between the taxpayer and the water rate payer, and as between the various rate payers, would hold. Such a dedication could not bring all rates suddenly to the recommended basis, but it would tend to bring the co-operation of general public sentiment into play, and thereby cause all movement to be toward the general system recommended. It would act as a buffer in the meantime for the company or city where some particular phase of its rate system is under fire, and really may be inequitable, to show exactly why such rate has to be charged, leaving the burden of defense of the too low charges which compose it and which may be enjoyed by the small consumer, or the large consumer, or the taxpayer as the case may be, to their beneficiary. There have been many papers and discussions before this Association that bear upon various phases of this question, and there is a well established practice as to the determination of what constitutes an efficient service, and as to how to arrive at a reasonable value. There is no great divergence of opinion as to what constitutes operation and maintenance expense, or fixed capital and depreciation charges, or a reasonable profit over and above these, and public service corporations nearly everywhere have to stand ready to show and defend their status in these respects, and are prepared with expert help to establish all of the things.

It is not, therefore, the question as to the total revenue which should be allowed, but rather the question as to how the payment of such revenue should be divided between the various classes of consumers, including the taxpayer, which needs to be illuminated, regarding which, so long as the total profit is not reduced, the business departments of the water works fraternity will be in the strongest position if they lean toward a fair deal for every interest in its adjustment, leaving the parties who have the bills to pay to do a large part of the worrying.

Some Examples of Stadia Surveying and Its Broader Uses With Special Reference to Preliminary Hydraulic Surveys.

(Staff Abstract.)

While it is a well known precept that the degree of accuracy of a survey should be consistent only with the purpose for which the survey is being made, experience indicates that, especially in reconnaissance and preliminary work, engineers are prone to lay too great stress on accuracy and thereby greatly reduce the amount of work which it is possible to do in a given time.

For a number of years the engineers of the United States Geological Survey and the Reclamation Service have been using the stadia method for practically all preliminary work, and it was in the latter service that the writer first learned the great economic advantages of this method.

GOVERNMENT IRRIGATION WORK.

The writer's first practical experience with the stadia was in making surveys of the irrigable areas on a reclamation project. The land on this project was of a rolling character, and there were many knobs and points of land contained within an irrigable area but too high to be reached by the water. To traverse these small pieces of land and tie them in as is ordinarily done by the transit and chain method would have entailed a great amount of work, but by the stadia method it proved to be easily accomplished in a very short time. As fractional acres were not considered in this survey, the stadia method gave as good results as were desired.

A short time later the writer was sent to make a preliminary survey of a proposed irrigation project. Funds for the purpose were rather limited and the project was fairly large, so it was necessary to do the work in as cheap a manner as possible. With this object in view two parties were put on the work, equipped for making surveys by the stadia and transit method. All the data required on the project to make up preliminary estimates of the cost were secured in four months. These data included tentative location for all necessary canals and laterals, plats of all the irrigable land, hydrographic surveys of water supply and storage sites and data from which to figure approximate cost on the whole works.

STUDY OF PRACTICAL USE OF STADIA METHOD.

This government work completed, the writer had a fair insight into the possibilities of the use of the stadia method and started to make a study to determine the extent of its practical use. My experience had taught me several things about the method, the first in importance being that the distances measured could be made accurate to about half of one per cent by using reasonable care, and that errors in distance, in a line of considerable length, were compensating; while errors in chained distances are usually cumulative. Second, the bearings taken were as accurate as by any method with reasonable care. Third, the elevations taken were compensating and when carried to distances of two or three miles very often checked to the nearest tenth of a foot and were seldom over three or four-tenths out. The conclusions I arrived at, and still maintain, were that the method is sufficiently accurate for practically all preliminary purposes where the preliminary survey is not actually to be used for construction purposes. It is of course, the only logical method of taking topography for the purposes of computing storage capacities of reservoirs and for figuring large volumes of earthwork.

FURTHER EXAMPLES OF STADIA SURVEYS.

The next piece of work I undertook to do by stadia was the survey of the Cannon Falls, Minn., dam-site. At the time this work came up I was busily engaged making property surveys and was requested to make the dam-site survey and get the data into the office as quickly as possible; I had, among my equipment, a plane table that was not in use and as the data required needed to be quite accurate, the procedure of taking stadia topography was varied by using an equipment consisting of this plane table combined with a level. The plane table was set up at an advantageous point and the rodmen were placed upon each contour with the level. The distances were measured from the plane table by means of the stadia wires in an alidade and the contour sketched on the plane table sheet. This gave very accurate topographical details of the site, fully as accurate as were required for the preliminary lay out of the dam structure. This topography was taken and plotted in one day's time by this method and gave results almost equal to a cross sectioning of the site.

A short time after this I received an assignment for a large amount of preliminary work in the Sierra Nevada Mountains in California. This work consisted of making studies and a report on the storage possibilities and feasible power sites above a hydroelectric plant that was then owned and operated by the company on the American River. On investigation, I found that surveys to determine the facts which were required would be long and tedious, so I again put the stadia method into use with other variations than those I had used before.

The topography of the country in the Sierras is exceedingly rough, difficult of access in some parts, and required fairly accurate work to determine, as the company wished, the probable cost of any developments which might be made. The work to be done was the preliminary locating of about 75 miles of canal and flume lines and the survey of six or eight reservoir sites to determine storage capacity and feasibility of construction. I put five stadia parties on this work. On the canal location, I made my instrument stations a traverse located on a grade contour which followed the approximate grade the flume or canal would require to carry the desired amount of water. From this traverse I took topography above and below the lines for a distance sufficient to vary the location of the canal or flume by 100 ft. above or below as the case might require. In traversing these lines, in addition to the topography, slope angles of the hillsides were turned with the instrument at each station and notes were made of the character of material through which the canal or flume would have to be constructed. Bench levels were run over the lines to check elevations at approximately each mile. Section ties were made on each intersecting section line by stadia method and azimuth of the line was checked at least once a day by direct observation on the sun. As a result of this plan of surveying, I obtained: 1st, a good preliminary location of my canal and flume line; 2nd, that by being checked with a level, the elevations were sufficiently accurate to be relied upon for any future work; 3rd, the line was tied to the section corners in a manner that showed exactly what property had been traversed, and, 4th, the slope angles of the hills had been obtained to determine the feasibility of the construction of either canal or flume section and the material had been noted to an extent that gave data from which to make a fairly accurate estimate of the cost.

In making surveys of the reservoirs on this work, practically the same scheme was used, except that a flat contour was used instead of a grade contour. This contour was run entirely around the reservoir and used as a base line from which to take topography above and below. Then such additional base lines were run through the reservoir as were necessary to cover the entire area. On these surveys notes were made of the character of the standing timber and the course of the stream was definitely mapped. Section ties were made in the same manner as those made in the canal line.

Dam site topography was taken over the area of the dam site with the transit and stadia method. This topography was taken very carefully with points located very close together so as to show a great deal of detail of the sites.

The unit cost of making these surveys were as follows: Canal location, $36.40 per mile; levels, $10.42 per mile; topography, 42 cts. per acre. It must be remembered that this survey was made through a very difficult country where the timber was heavy and the underbrush very thick and requiring much cutting.

DETAIL OF PROCEDURE.

At this point it may be well to state the method which had now been worked up. To begin with, I have found the best instrument for this work to be a Berger transit with a 6-in. plate and equipped with a full vertical circle and level bubble on the telescope. Graduations on both the horizontal and vertical scales should read to one minute. (A finer division of the scales than this makes the verniers more difficult to read and gives an accuracy beyond that which is required). Rods of any good stadia marking may be used and I use one rod for backrod equipped with two targets. One target sites, that is the ordinary 13 ft. Philadelphia is set and clamped at 5 ft., the second target is clamped at the top of the rod. This rod is used for checking roughly the distance between stations on the traverse, by setting each target on a stadia hair and reading the interval on the back of the rod. This check is mainly for catching 100-ft. errors in reading. The most successful transitman is a two-eyed, two-handed man who can sight with either eye and work both hands on his instrument at once.

The party consists of one transitman, one recorder, one head rodman, two or more side rodmen, one back rodman and as many axmen as the work may require. I have always found it very convenient to figure my azimuth from the north point and to read my verniers clockwise through 360°. In starting work on a line, the elevation of an initial point must be known and the azimuth of a line from that point to some other point must have been previously determined. The instrument is set up on this point and the height of the instrument measured from the point to the axis of the telescope by means of a rod or a tape. This gives the actual elevation of the axis of the instrument. The transit telescope is then sighted along the line of known azimuth with the vernier set to that azimuth. The lower motion of the instrument is then clamped and the upper motion set free turned to any desired azimuth for the next sight. The required number of side shots are then taken after which the next point on the traverse line is set and the upper motion of the instrument clamped on the azimuth to the next traverse point, at the same time an elevation reading is taken to this point preferably making it a level sight with the telescope leveled. As these various operations are carried out, the instrument man calls his readings to the recorder. When this proceeding is all completed, the instrument is ready to move. It is then set up on the next traverse station, a level shot taken to the station just vacated, measurement taken from the present station to the axis of the instrument, the instrument transited and a back sight taken on the previous station and set by the lower motion with the telescope reversed. This process carries the true azimuth of this line ahead on the instrument and if the instrument does not slip, it is, when back sighted, ready to go ahead on the true azimuth for the next side shots and traverse stations. This makes a mechanical check on the recorder's notes and produces little error if much care is taken in the adjustment of the instrument's line of sight.

The elevations carried, as may be seen, are equal to two independent lines of peg levels, as the instrument is set on every station and shots taken forward and back. A check is made at each station between the two lines by measuring the height of the axis of the instrument above the point set upon. Where vertical angles are read on the traverse stations, considerable care must be used, and both foresight and back-sight angles read for check. The notes that are taken must be complete and therefore are taken under the following headings ruled out in the notebook. These headings are: Station from, Station to, Distance, Azimuth, Magnetic Bearing, Back Sight Rod, Fore Sight Rod, Height of Instrument Above Station, Vertical Angle, Elevation, and Remarks. In the "remark" column is noted any feature of the topography such as fence corner, road intersection, edge of timber, top of hill, water edge, etc. I have found that for this work, a loose leaf note book is quite advantageous as the notes may be removed from the book and turned over to the draftsman for plotting and later filed in consecutive order along the line being surveyed. I have also found it advantageous to have the draftsman merely plot the points and to have the instrument man sketch in the contours as his memory of the country traversed is quite advantageous in filling in details.

STADIA ON RAILWAY SURVEY.

Following this work in California, I was called upon to make surveys for a short railway line that ran through a broken pot-hole country where the best location was rather difficult to determine by the ordinary methods. The country was open so that long sights could be taken. I ran a stadia traverse through the country on what would ordinarily be a preliminary location line and took topography for a distance of about a quarter of a mile on each side of the line, giving me a strip of topography a half mile wide. This work went very rapidly, the party of six men averaging almost five miles a day. I ran in all cases two of these preliminary lines and in some of the most difficult places, three lines, paralleling one another so that the plotted topography would overlap. This gave me accurate topography over a strip of country a mile or a mile and a half wide from which the best location was laid out on paper and later run in the field in the usual manner.

RESERVOIR SITE SURVEY.

My next experience with stadia topography was that of making surveys of a reservoir site in the Cumberland mountains in Tennessee, and on this survey I think the method reached the highest degree of perfection that it has yet reached in my hands. The reservoir was a large one and was to be contained within a stream valley and four large tributaries that spread out very much in the shape of a hand. The total length of the flowage line of this reservoir was about 275 miles running up the stream and its branches a distance of some 40 miles from the dam site. Together with the topographic survey, it was necessary to make property surveys from which could be taken the description of property that had to be acquired. The work was so large that I did not wish to traverse the ground with my survey parties more than once, so I endeavored, and succeeded, in devising a scheme by which the work could be done at one operation. My method was as follows: Level parties were sent over the ground to establish bench marks about every half-mile along the line, which bench marks were set on the elevation of the flowage line traverse. I then started a survey party on each side of the stream, working opposite one another. Instead of using a level rod with targets for taking back sight distances on my traverse line, I had my rear rodmen and one of the side rodmen check this distance with a chain thereby getting absolute distances between traverse points. The rest of the procedure was the same as I had before used, taking the topography above and below the traverse line by means of side shots and my fore sight distsances by stadia as usual, but in plotting the traverses, the chain distances were used and these distances were also used in writing descriptions. About every half a mile, the two parties working opposite one another on the stream would check with one another across the stream, making the closure by distances and angles, thereby checking azimuth as well as distances on the traverse. By this procedure, I succeeded in one operation in getting the necessary topography of this large reservoir site so that storage quantities could be computed and all details of the reservoir mapped. In addition, I obtained in a legal manner, the description of all property that it was necessary to purchase. The results of this work were satisfactory and the work was done in a comparatively short time considering the magnitude of it.

The character of the country was very precipitous and mostly covered with underbrush and timber with perhaps as much as 25 per cent in open fields. Rock bluffs were encountered which required the field parties to leave the reservoir contour and go, in some cases, as much as 60 ft. above the required elevation and this caused some delay in making the surveys. Outside of the reservoir proper were a number of pot-holes some of which were below the flowage line of the reservoir and consequently required surveys to show the part of them that would be flooded when the water was raised.

Two axmen were required on each party. The work was done from Nov. 15, 1911, to March 15, 1912, being the worst portion of the year in that section to do field work. The work was done in 378 working party days. A total of 275 miles of flowage line contour was run, costing $26.70 per mile; 5,423 acres of topography were taken at a cost of 22 cts. per acre; 9,464 stations were set and 36,828 side shots were taken. The average run of a party for each day was 0.84 mile and 17 acres of topography. The organization on the work proved very satisfactory as by the arrangement used, two parties were working opposite one another on the streams and a consequent rivalry arose between them as to which would accomplish the most work, each party trying to get ahead of the other one. This situation, no doubt, increased the speed of the parties to a very large extent.

The region was inaccessible and each party had to carry a full camping outfit. Each party also had a team and a teamster for hauling supplies, taking the parties to and from work where possible and doing other things that the occasion required. The first of each week each party would send their team to headquarters with orders for supplies and at the same time would send in the notes of the work that had been done the previous week. In the headquarter's office, two draftsmen did all the plotting for six full parties and made tracings of the maps as they were completed, keeping the work up to date in every way, including the figuring of reservoir capacities and the writing of land descriptions. When the field work was finally finished, there remained only one week's work to be done in the office.

HIGHWAY, TRANSMISSION LINE AND DRAINAGE SURVEYS.

These instances are given to demonstrate some of the uses this method may be put to and I have since used the same methods for other purposes such as location of roads, transmission lines and drainage ditches. It is apparent that in the drainage work this method should prove very practical as it is the easiest method by which the best location for farm laterals and ditches can be determined. A comprehensive drainage scheme must drain as much land as possible with the least possible length of ditches. To arrive at this result, a study of the whole must be made at one time rather than a study of the separate parts. The ordinary case is that some data must be acquired from which the land may be roughly plotted and the ditches first laid out on paper to show the most feasible location. This certainly can be done more quickly and with fully as good results, by taking the preliminary notes by the stadia method and later running a paper location in on the ground in the usual manner. For road work, the stadia is fitted only for preliminary survey. By this method a base line may be run along the approximate center line of the road and the side shots taken in the ditches on either side at culverts and road crossings and any other features that it is desirable to show, such as pole lines, fences, cuts and fills. This work may be done very rapidly as there is practically no hindrance to it along the road and data may be secured from which a rough profile may be plotted of the crown of the road and the bottom of the ditches on both sides.

From this may be laid out the road profile and the best method of draining, thereby working out a comprehensive scheme of the whole rather than of the separate parts. It has been my experience that in almost any engineering work, a study in a general way of the whole work will usually give entirely different results than if the work is taken piece-meal, and the results are usually a great deal more satisfactory than by the other plan.

In my experience a great many instances have occurred where data of an approximate nature were required to determine only in a general way certain features of a project. For instance in 1914 I was making a reconnaisance for a railway in the South. One terminal of this railway was located on the edge of the Mississippi delta and it was to extend a number of miles back through the hill country and away from the delta. I was requested to keep my gradient down, if possible, to a half of one per cent and I found that some difficulty would be experienced in maintaining this grade in the first line of hills through which it would be necessary to construct. There were four or five locations where this might possibly be done, but it was difficult to determine which of these locations would prove to be the better. With the aid of two rodmen and about three days' work, by the stadia method, I was able to run lines over these various locations and secure data enough to determine the distance and elevation on each one and from those data it did not take long to determine which was the most advantageous route. By the ordinary methods, considerable time would have been lost with a full survey crew in reaching a conclusion at this particular point. Of course, it was necessary to follow the chosen line up with preliminary lines and location lines, but this was only necessary for the most feasible route.

The result of all this stadia work is to convince me that it is the best and cheapest method for most preliminary work. A great deal of time has been saved by me and a large amount of money has been saved for my employers by the use of this method, and I therefore commend it as being worthy of a thorough consideration when preliminary surveys are contemplated or general data are required.

ACKNOWLEDGMENT.

The foregoing discussion is the major por-

[illegible] a paper by W. B. Saunders, Mem. Am. Soc. C. E., Plymouth Bldg., Minneapolis, before the Minnesota Surveyors' and Engineers' Society.

Prevention of Weed Growth in Water Supply Reservoir by "Coppering."

(Staff Abstract.)

Weeds which formerly created an offensive odor and which imparted an objectionable color to the water supply of Gloucester, England, have been combated successfully by means of copper sulphate. The weed growths occurred in the city's reservoirs of potable water.

At one time it was necessary to reduce the growth of the weeds by the use of rakes. This involved a considerable annual expense. After experiments it was found that the use of copper sulphate in quantities of 1 to 1,000,000 was sufficient to destroy the lower forms of plant life without injuring fish life and without rendering the water toxic to man.

One of the methods employed in applying the copper sulphate was to place the crystals in a canvas bag which was then trailed over the surface of the water from the stern of a rowboat. Another method was to scatter the fine crystals over the surface of the water as in sowing seed. By this method the crystals fall rapidly to the bottom of the reservoir before dissolving. This method has an advantage over the other one mentioned in which the solution is much diluted before reaching the bottom.

The three reservoirs of the Gloucester corporation have a total capacity of 120,000,000 gals., and the quantity of sulphate used is 400 lbs. on each yearly application, or 1 to 3,000,000, which is found to be adequate to keep down the weeds. Each reservoir so treated is allowed to stand at least three days, and where possible a week, after the application, at the end of which period it is fit for domestic use and no trace of sulphur can be found in the water. The treatment, it has been found, is best carried out in the month of February.

ACKNOWLEDGMENT.

The experiments leading up to this work were performed by George Embrey, chemist for the Gloucester county council. The data here given are from the Canadian Engineer.

Household Water Sterilization With Hypochlorite of Lime.

(Staff Abstract.)

For the household sterilization of water in small quantities, by means of hypochlorite of lime, the following formula will prove useful and easy of application:

To make stock solution of chloride of lime take ½ lb. of chloride of lime and mix it thoroughly with 1 gal. of water. The bottle used should have a closely fitting glass stopper. Shake thoroughly for some time. Allow this stock solution to stand for about eight hours, or preferably over night, in order to allow the undissolved portion to settle.

From the clear solution at the top of the bottle take two drops and place in each gallon of water to be sterilized, thoroughly mixing same by agitating the mixture with a clean paddle or stick for about three minutes. This shaking or mixing is absolutely necessary to insure complete sterilization. If the water is muddy or has been condemned, use a greater quantity, not to exceed three drops to a gallon. If the water has a taste or odor from the solution, the quantity may be reduced until such taste or odor disappears.

Do not buy a can that has stood on the shelf of the store for some time. The chloride should be in a powder and if found caked in the can it is worthless as a sterilizer. Be sure the can contains a loose powder, and insist upon having what is known as "35% Commercial Chloride." If only a portion of the can is used, the can must be closed and made air-tight by replacing the top as it was when purchased. As soon as the powder cakes or solidifies it should be thrown away, as it is no longer of any value as a sterilizer.

In keeping and storing chloride of lime the factors to be guarded against are carbonic acid, moisture, heat and light. Therefore, it should be kept in closed vessels in a dry, cool place.

ACKNOWLEDGMENT.

The suggestions above given are taken from Florida Health Notes, the official bulletin of the State Board of Health of Florida, Vol. IX, No. 10.

GENERAL

Some Important Considerations in Right of Way Valuation.

By Halbert P. Gillette.

I.

Ever since the decision in the "Minnesota rate case" there has been worry among railway officials and appraisers over the apparent exclusion of "right of way multiples." For the purpose of this discussion we may define a "right of way multiple" as being the factor by which the ordinary selling price per acre of land must be multipled to get the acreage price paid for it when taken for public use under the exercise of the right of eminent domain. The use of a "right of way multiple," therefore, is a convenient method of estimating severance damages, special value for railway purposes, etc., and it may even be taken to include overhead costs involved in securing the right of way.

The testimony in favor of "right of way multiples" failed to convince Justice Hughes, and I believe it failed for two reasons: First, because a "right of way multiple" was treated, and even spoken of, as a "hold up factor"—a sort of piratical tax which, as Justice Hughes said, should not be recognized in a court even though it may exist as a fact. Second, because the whole theory of reproduction cost of right of way was based on an untenable hypothesis, involving the absurdity of assuming the existing railway to be non-existent in order to conceive the cost of buying the existing right of way.

My object in this paper is briefly to outline a tenable theory of right of way valuation that can not be criticised adversely without abandoning all existing theories of commercial valuation. To do this I will first discuss the fundamental theory of land values. Then I will show how the general theory can be simplified for ordinary application to railway right of way valuation. Finally I will outline the elements of value that go to make a "right of way multiple."

The value of land is the capitalized prospective ground rental derivable from it. Ground rental is measured by the economic advantage in position and in mineral and other marketable content of the given land, contrasted with land that barely pays operating expenses. Since the days of Ricardo there has been no serious dispute on this economic generalization. All land and all land entitles, such as coal, natural gas, water, etc., can be valued in no other way than by capitalizing the excess of their income over that obtainable from land that yields nothing in excess of actual operating expense plus fixed charges on the buildings and plant. Once this fact is clearly grasped, the proper methods of determining the value of land and land entitles become evident.

It may be said that the best test of land value is the price at which it sells in an open market. This is ordinarily true where there are frequent sales in a market and where the land is sold for the use under consideration. But even in such a case the sales are based on capitalized prospective rental, so that, in the final analysis, we come back to land income as the basis of land value.

In a very interesting pamphlet entitled, "The Valuation of Railroad Right of Way," Mr. Frank W. Stevens, special counsel for the New York Central Railway, offers some suggestive thoughts as to the special value that attaches to right of way. He also cites many court decisions showing that land taken by condemnation must be valued upon its most advantageous prospective use. Two facts seem to be legally established: (1) That land may have a *special value* for particular purposes (such as reservoir sites, rights of way, etc.) and that this special value is recoverable by the owner where condemnation occurs. (2) That consequential damages to the owner are also recoverable.

Let me first indicate how the value of land for special purposes is ascertainable. The following rules are perfectly general, and apply equally to a reservoir site, a railway right of way, a farm, or a city lot:

(1) For a given use the value of a given piece of land, *A*, exceeds that of the next available piece of land, *B*, by the capitalized difference in their respective *net earnings* after deducting therefrom the interest, depreciation and taxes on the buildings and plant used in production, as applied to that use.

Expressed algebraically this rule is:

$$V - v = \frac{(G - E) - (g - e) - (F + f)}{r}$$

In which V and v = values of the two land parcels.

G and g = gross earnings of same.

E and e = operating expense.

F and f = fixed charges (interest, depreciation and taxes) on buildings.

r = interest rate suitable to express normal return.

(2) If the gross earnings of the two pieces of land, *A* and *B*, are identical, then the value of *A* exceeds *B* by the capitalized difference in their respective *operating expenses* after deducting therefrom the interest, depreciation and taxes on the buildings and plant used in production; or

$$V - v = \frac{e - E - (F + f)}{r}$$

(3) If the gross earnings and investment in buildings and plants are identical for *A* and *B*, then the value of *A* exceeds *B* by the capitalized difference in their respective operating expenses; or

$$V - v = \frac{e - E}{r}$$

(4) If the gross earnings, the investment in buildings and plants, and the operating expenses for *A* and *B* are identical, then the value of *A* equals the value of *B*, or the *value* of an owned piece of land, *A*, is ascertainable by determining the *cost* of securing an alternative piece of land, *B*; or $V = v$.

As I conceive it, this last rule (4) is the one that a railway should ordinarily seek to apply in measuring the value of the right of way that it owns. Yet no such rule was presented to the Supreme Court in the "Minnesota rate cases." Instead, the court was asked to conceive the existing railway plant as non-existent, and then to conceive what it would cost to *reproduce the existing* right of way. Confronted with such an impossible hypothesis Justice Hughes said:

> Moreover, it is manifest that an attempt to estimate what would be the actual cost of acquiring the right of way, if the railroad were not there, is to indulge in mere speculation. * * * The values of property along its line largely depend on its existence. It is an integral part of the communal life. The assumption of its non-existence, and at the same time that the values that rest upon it remain unchanged, is impossible and cannot be entertained.

Here we have an admirable illustration of the losing of an important point in a case almost entirely as a result of an incorrect theory of valuation. Suppose, instead of presenting to the court the hypothesis of non-existence of the railway, the court had been asked to consider the probable cost of securing right of way for a railway parallel to the existing railway, could the court have rejected such a proposition as "mere speculation" or "impossible"? The facts are that many a right of way has been purchased under just such conditions, hence the assumption is not speculative or impossible. Moreover the test of *value* of *A* that is had by ascertaining the *cost* of securing an alternative, *B*, is a test that every man is accustomed to apply. The man who is intending to buy a city house and lot applies such a test repeatedly. Our rule (4) above given, is precisely such a test of value, as, in fact, are also the more general rules (1), (2) and (3).

If we approach the question of right of way value from this logical point of view, we can show at once that not only must there be paid the farm acreage price for farm land contiguous to the existing railway but a considerable sum in addition to cover consequential damages. Also it can be then shown that land purchased at "retail," in small parcels such as are bought for right of way, costs more per acre than land purchased "wholesale," as in buying an entire farm. Picturing, then, the process of buying a right of way approximately parallel to the existing right of way, we see at once that the following elements affect the purchase price:

(1) Severance damages resulting from the severance of associated parcels of land that can be more economically operated as a whole than in segments.

(2) Incidental damages resulting from noise, smoke, shutting off of view, etc., as a result of building a railway near places of habitation and business.

(3) Loss of income to the land owner during the period required for him to move to a new site and to establish a business equal to that lost as a result of being compelled to move.

After the purchase of the right of way is effected there comes not only the cost of removing existing buildings but the loss of value of those buildings which were paid for by the railway. Where right of way is purchased through urban and suburban property, it is not merely the value of bare land that is involved but also that of buildings and improvements. Although this is quite evident the moment we adopt the theory of testing the value of an existing right of way, *A*, by estimating the probable cost of a parallel right of way, *B*, it is not evident when the theory of wiping out the existing railway is adopted.

To sum up, a proper "right of way multiple" must provide not only for all consequential damages to the owner of the property but must also provide for the value of buildings and improvements and the cost of removing them from the right of way.

I agree with Mr. Stevens that a railway right of way possesses value because of its superior economic location. There really can be no question on this point. Wellington's entire book on the economics of railway location is an exposition of the value of a given location as determined by capitalizing the profits securable from it. Part of the differences in value between different locations is attributable to the skill of the locating engineer, but the largest part is inherent in the topography and the productive character of the country. The question for the courts to decide is this: To whom belongs the right of way value due to its superior economic location? Is it the property of the public or the property of the railway? The value of the right of way is deducible by the rules above given.

Right of way values are analogous to water right values, particularly in that both depend largely upon topography. In deciding adversely to the contention that water rights possessed value for ratemaking, it was held by the lower courts in California that capitalizing profits to ascertain value of water rights constituted circular reasoning, and water right values thus ascertained were therefore rejected. But the United States Supreme Court has recently reversed this decision, holding that water rights must be valued and included in the total value used as a rate making base. I see no cardinal difference between such a decision and one that would affirm that a railway is entitled to all the special value that inheres in its right of way by virtue of its economic location. Water rights possess value because of their economic location, and if this value is to be considered as part of a rate making value, wherein does it differ in principle from allowing a similar value due to the economic location of a railway right of way? If there is a difference, and if an economic railway location of right of way has no special value to be allowed in ratemaking, what becomes of the logic of the decisions relating to special value cited by Justice Hughes in his Minnesota decision? In fact what real meaning is there in his own language when he says:

> If, in the case of any such owner, his property had a peculiar value or special adaptation for railroad purposes, that would be an element to be considered.

There can be no "peculiar value or special adaptation for railroad purposes" except a value based on the capitalized excess net income securable with the given right of way as compared with some alternative right of way. Therefore, if we properly interpret the decisions of the Supreme Court itself, we find ample justification for applying rules (1) to (4) above given.

When railway and public service commissions assert that it is always untenable to establish any sort of value for ratemaking by capitalizing any sort of income, they go directly counter not only to court decisions but to their own decisions in every case where *land* value is involved. What, indeed, is the acreage value of a farm if it is not capitalized income? Yet the same commission that unhesitatingly allows a right of way value based on farm acreage price, will contend that it never capitalizes any income in establishing a ratemaking value, because that would involve circular reasoning!

Mr. Brooks Adams, in the "Spokane Rate Case," unsuccessfully attempted to prove that every railway company has been a trustee or agent, and, as such, should be held accountable for all past transactions. Not only has the Interstate Commerce Commission rejected this theory of *past* agency relationship, but so has the Supreme Court. Justice Hughes was particularly emphatic on the point when he said:

> As the company may not be protected in its actual investment, if the value of its property be plainly less, so the making of a just return for the use of the property involves recognition of its fair value if it be more than its cost. The [railroad] property is held in private ownership and it is that property, and not the original cost of it, of which the owner may not be deprived without due process of law.

Had the agency theory been sustained, the actual cost of right of way and not its present value would have been prescribed. The instant the agency theory as to past relations is thrown out, there remains no other way to appraise right of way than as private property owned by the railway. This would inevitably result in giving to a railway the full special value inherent in its lands as essential parts of an economic transportation plant.

Cost of Hydraulic Sand and Gravel Mining.

Contributed by R. J. Borheck, Tacoma, Wash.

Costs of hydraulic sand and gravel mining are extremely variable. The geological and physical characteristics of the deposit, source of water supply and output determine the ultimate cost.

A glacial deposit well balanced in sand and gravel, free from clay or cementing materials; bank of sufficient height; little overburden; low lift for water, and proper inclination of flumes will assure a low cost of handling. Should the deposit contain an excess of oversize, much foreign matter and a restricted height of bank, then the cost of production will naturally be higher. This may be reduced by proper methods of handling oversize and economic method of washing and screenings. Should the bank be too low for economic sluicing, this difficulty may be overcome by stepping down, provided the material is of such character to be reclaimed. This will mean an additional cost of 3 cts. to 5 cts. per cubic yard.

The amount of water to be used is dependent upon the character of the material, size and cleanliness, and the inclination of the flumes, which may vary from 6 per cent to 15 per cent for economic reclamation.

For any given quantity of water, grade of flume and material of similar character and disposition, the maximum output of any bank is dependent upon the proper mixture admitted to the flumes. Flume transportation of sand and gravel are vastly dissimilar in character and must be treated as such. In the one case, for a given inclination of flume it would require six volumes of water to one of sand, against five volumes of water to one of gravel. Sand and gravel mixed in the proper proportion would require four volumes of water to one of solids, and in some instances, even less water for economic reclamation of the bank material.

For economic operation the proper mixture should be admitted to the flumes and sufficient working faces and sufficient laterals and pipe outlets should at all times be available.

Source and cost of power for pumping are all factors in the ultimate cost and can only be fixed dependent upon local conditions. Washing and screening costs are fixed for any given material and vary only according to the disposition of the means at hand and character of the material.

Deposits containing from 20 to 25 per cent waste material have been handled at a cost of 15 cts. per cubic yard, where the conditions were favorable for the disposal of the waste and crushing of oversize was not warranted.

An instance is recorded where 150 ft. of clay had to be penetrated by a tunnel before the gravel and sand could be reached; the material was handled at a cost of 12 cts. per cubic yard, with an output of 700 cu. yds. per day. Another instance of flume transportation of one-quarter mile, where the output, screened and washed in bunkers cost 13 cts. per cubic yard.

Probably nowhere in the country has the sand and gravel industry been more widely studied or a diversity of means employed or such strides made in the economic reclamation of sand and gravel, correct washing, sizing and grading than on the Pacific coast. There are used hydraulic and mechanically operated plants, steam, electric, gas driven piston pumps, centrifugal and power pumps, steam shovels, drag line, cableway, power scraper, and scraper buckets operated with and without tower, belt and bucket conveyors, steam and electric hoists, mechanical and hydraulic screening and washing plants, crushers and crushing rolls, sand separators, washers and dryers; almost every conceivable means of reclaiming the material dependent upon the supply and economy of operation.

Hydraulic plants having capacities ranging from 300 to 2,500 cu. yds. per day are operated at costs of 15 cts. down to 8 cts. per cubic yard, including all labor, material, power, renewals, depreciation, interest, taxes and fixed charges of every kind incidental to placing the material in bunkers washed and sized ready for marketing.

The economy of this method is at once apparent when we take into consideration the little machinery employed and the decreased wear and tear on plant. Plants having an output of:

500 cu. yds. per day can be built, averaging $6,000.
800 cu. yds. per day can be built, averaging $10,000 to $12,000.
2,000 cu. yds. per day can be built, averaging $15,000 to $20,000.

with more than corresponding economies in operation. Should there be an available supply of gravity water, the operating cost may be reduced several cents a yard. Mechanically operated methods of reclaiming the materials, either by steam shovel, drag line, bucket, cable-way or drag scraper, etc., have to take into consideration besides first cost, the upkeep, which, for the wearing parts, is generally very high, when based on considerable output. Transportation charges, cable renewals, pumps, motors engines, fuel, oil, track, elevators, screens and auxiliary appliances all contribute to the cost of output.

Dredging and dredging methods are economic in reclaiming, but the limited storage and necessity of scows and extra unloading cost at storage end all contribute a proportionate share of cost. The costs of a mechanically operated plant having capacity 500 to 2,000 cu. yds. per day will rarely fall below 25 cts. in first instance and 15 cts. for larger output. The washing and screening would alone contribute one-third to one-half of this cost.

Washing and separating into respective sizes, for the Pacific coast plants is generally made by a novel means: by "Acme" washing and separating device, which has the added advantage of screening, washing and separating the material in respective grades in one operation.

The cost of the above process is astonishingly low. For a 300-cu. yd. output the cost covering a two-year period for one plant was 1.5 cts. per cubic yard, including installation, labor, power, repairs and renewals. Here the separation was adapted to a bucket cableway; total output 136,000 cu. yds. For a 600-cu. yd. capacity plant the cost of washing, screening and separating was 1.1 cts. per cubic yard for one-year period. For a 1,000-cu. yd. capacity plant, hydraulically operated, the cost for a two-year period, in which the total output was 410,000 cubic yards, the cost was 8/10 cts. per cubic yard. The itemized cost of operation of this plant, the material, sand and gravel, in almost equal proportions, was as follows:

	Per cu. yd.
Sluicing, labor, renewals and repairs	$0.042
Screening, washing and separating	0.008
Loading scows	0.010
Power (steam)	0.018
Plant depreciation, interest, overhead	0.023

In the operation of the above plant a close check was made in the performance of the separator and washer. The gravel was graded in three sizes: 2½ in. to ¼ in., 1½ in. to ¼ in., ¾ in. to ¼ in.; sand into coarse for concrete and fine for building purposes. Samples of graded material were checked for voidage from time to time, covering two years' operation. Samples thoroughly dried:

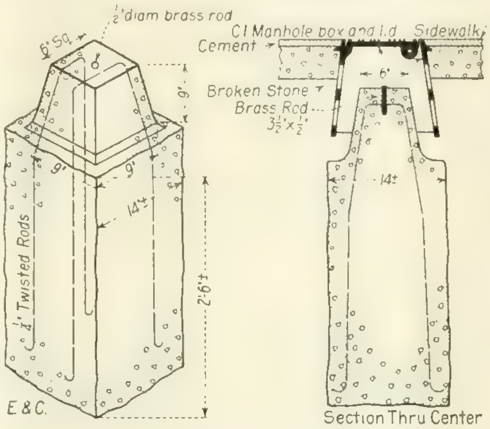
	Silt
2½-in or heavy grade ran 30, 31 and 32 per cent	0.0
1½-in. medium grade ran 33 and 34 per cent	0.0
¾-in. fine grade ran 35, 36 and 37 per cent	0.0
Coarse sand, more variable, 29 to 33 per cent	0.0
Fine sand, 36 to 40 per cent	0.0

The efficiency and economy of the separator were well demonstrated, as it requires but one man in attendance to operate to a capacity of 1,000 cu. yds. per day, and it can be erected at most any where for $2,000, with an annual upkeep of $300 to $600, dependent upon the amount of material handled.

New Street Line Monuments at Pittsburgh, Pa.

(Staff Abstract.)

Permanent concrete monuments, of the type here illustrated, are used in marking the street lines as relocated by the Bureau of Surveys of the city of Pittsburgh. A 1-ton Lippert Stewart automobile truck is used in distributing the materials used for the monuments and cover boxes. In cases where the old stone monuments were found buried, sometimes to a depth of 7 or 8 ft., they were built up to the present grade with concrete and centered. The placing of new cover boxes over the old stones buried slightly beneath the sidewalks is another important part of the work of the Bureau. Under the old conditions the sidewalks were constantly being torn up, by the city's engineers and by those engaged in private practice, to get at the monuments. Sometimes these walks would be replaced in a fair condition, but often were left unsightly and dangerous to pedestrians. The new arrangement provides a uniform, smooth sidewalk and at the same time enables the engineer having occasion to use the monuments to open the cover on the boxes, thereby exposing the monument for purposes for which they were intended.



Details of New Form of Standard Street Line Monuments Used in Pittsburgh, Pa.

The new concrete monuments are all centered with a bronze plug projecting above the top of the concrete about ¼ in. These plugs are also used for recentering the old stone monuments where the original center has become obliterated. These plugs not only furnish an accurate center for transit work, but they are probably the best type of bench marks for city use. The bench mark tablets placed in belt courses, etc., of permanent buildings are perfectly satisfactory for the purpose intended, so long as they are left undisturbed, but experience has shown that owners are constantly remodeling the buildings, which necessitates the removing of the tablets and the resulting loss of the established elevation. While many of the street line monuments become destroyed the case is not as general as with the tablets placed in the buildings, and as it is possible to establish elevations on the monuments much closer together than on the other type of tablets the resulting loss of one monument in a section is not felt so keenly as when tablets were used exclusively.

The form of the monument boxes now in use appears to meet the conditions satisfactorily. The cut shows the boxes as now constructed. The concrete monuments as now built are about 2½ ft. deep, set so that the top is approximately 6 ins. below the finished surface of the pavement. The base of these monuments is from 2 to 2½ ft. square, with a finished top about 9 ins. deep. This top portion is molded in a sheet-iron form built for this purpose and under usual conditions is the only portion of the monument requiring a form of any kind for its construction.

A record is made showing the location of all monuments set, date of setting and engineer in charge, with references to the field note books, the elevation of the bench marks etc.

ACKNOWLEDGMENT.

This information is taken from the 1913 annual report of the Bureau of Surveys of the city of Pittsburgh.

Results of Some Tests to Determine the Effect of Various Elements in Steel on Its Resistance to Corrosion.

(Staff Abstract.)

In an effort to combat the tendency of iron and steel to corrode when exposed to the action of air and water there has been much serious thought given to this problem by metallurgists and others. It is generally agreed that the best solution is so to protect the surface of ferrous materials as to exclude all corrosive elements. As film coatings do not offer permanent protection, however, much study has been given to the possibility of producing steel or iron which in itself possesses corrosion-resisting properties.

REASONS FOR DIFFERENCE OF OPINION.

After years of research, investigation and practical experience, there is unfortunately at the present time not a complete unanimity of opinion on this subject. This difference of opinion is the result of several causes, some of which are avoidable. These may be grouped as:

(a) An undue adherence to theory without practical demonstration of the value of the theory.

(b) An undue and reprehensible adherence to a particular class of product in which the investigator may be interested financially or otherwise.

(c) Placing too much confidence in accelerated tests.

(d) Losing sight of the fact that under the best practices heats below the average are manufactured in all classes of products, and the consequent drawing of conclusions from comparing a good heat of one type with a poor heat of another type.

(e) Drawing general conclusion from results obtained under peculiar conditions, which may or may not be in any way representative.

The adherents of the different schools are divided into four main classes as follows:

(1) Those who believe in genuine iron, the product of the puddling furnace.

(2) Those who believe in normal mild steels, the product of the open-hearth and Bessemer furnaces.

(3) Those who believe in so-called pure irons, the product of the open-hearth furnace, in which the carbon and manganese are reduced to a minimum, and to which copper may or may not be added.

(4) Those who believe in normal open-hearth and Bessemer steels with which have been alloyed a small amount of pure copper. Attempts have also been made to use nickel as the alloying element.

After many years of careful study and investigation, the writer is one of the firm believers in the fourth class mentioned—copper alloy steels. Our investigations have dealt principally with the exposure and observation of full-sized sheets, unprotected in any way, under service conditions. Many different heats have been used, thus eliminating the chance of accidental results. The majority of our tests have been made under atmospheric influences. We realize that it is impracticable to make tests under all of the many varying conditions, and we believe that atmospheric corrosion is the most important, especially when considering structural material in general and sheets and plates in particular.

RESULTS OF TESTS.

About five years ago, in testing the corrosion resistance properties of sheets made from electric furnace steel, it was noticed that one heat of steel which contained about 0.07 per cent of copper was markedly superior to the others in its resistance to corrosion. Some further work indicated that the results obtained were not accidental, and that the copper was probably the controlling factor. To remove the last element of doubt several heats of both Bessemer and open-hearth steel were used and copper added in varying amounts to some of the ingots as they were poured, while to other ingots of the same heat no additions were made. Careful surveys of both the bars and sheets rolled from these ingots proved that the diffusion of the copper under these conditions was practically perfect. These ingots were rolled into 16-gage and 27-gage sheets and exposed to the atmosphere in the Pennsylvania coke regions, at Atlantic City, N. J., and along the Allegheny River above Kittanning, Pa., thus obtaining widely varying conditions of atmosphere.

TABLE I.—COMPOSITION AND RELATIVE LOSSES OF 2X4-IN. TEST PIECES EXPOSED IN COKE REGIONS.

Grade.	Ref. No.	Gage.	Analysis. Carbon.	Manganese.	Sulphur.	Phosphorus.	Copper.	Relative losses, 100 equals greatest corrosion.
Bessemer	1	27	0.05	0.44	0.082	0.101	0.23	39.09
Bessemer	2	27	0.05	0.44	0.075	0.099	0.34	39.61
Bessemer	3	16	0.07	0.46	0.069	0.095	0.33	41.57
Open hearth	4	27	0.10	0.46	0.035	0.043	0.17	42.09
Open hearth	5	27	0.07	0.47	0.038	0.043	0.25	42.22
Open hearth	6	27	0.06	0.33	0.035	0.018	0.25	43.27
Open hearth	7	27	0.06	0.35	0.036	0.018	0.16	43.92
Bessemer	8	16	0.08	0.45	0.070	0.094	0.21	44.05
Open hearth	9	16	0.14	0.46	0.038	0.043	0.27	46.67
Open hearth	10	16	0.13	0.44	0.035	0.042	0.18	46.67
Open hearth	11	16	0.10	0.35	0.033	0.019	0.23	47.32
Open hearth	12	16	0.10	0.34	0.035	0.020	0.16	48.36
Low carbon and low manganese material	13	27	0.02	0.03	0.036	0.003	0.07	50.19
Low carbon and low manganese material	14	16	0.03	0.03	0.034	0.003	0.06	53.20
Open hearth	15	16	0.13	0.45	0.035	0.042	0.00	74.64
Open hearth	16	27	0.09	0.47	0.037	0.043	0.00	78.16
Bessemer	17	16	0.08	0.46	0.070	0.098	0.00	91.64
Bessemer	18	27	0.05	0.45	0.076	0.100	0.00	96.86
Open hearth	19	16	0.10	0.34	0.034	0.019	0.00	98.82
Open hearth	20	27	0.06	0.35	0.033	0.018	0.00	100.00

After about one year's exposure, the steel without copper had entirely corroded away, while the copper-bearing sheets from the same heats were in excellent condition. After a little more than three years' exposure, two of the 16-gage sheets of plain steels have absolutely failed, while the third, which is re-prosphorized basic open-hearth, is in poor condition. The copper-bearing panels are, after three years' exposure, nearly as good as when first installed, and, so far as we are able to determine by observation, have not changed in any way in the past two years. Similar results were obtained at the other two test stations.

Table I gives the results of exposure tests in the coke regions. The tabular data show the composition and relative losses of the 2x4-in. pieces, these pieces being exposed Nov. 21, 1911, and taken down Aug. 14, 1912. Each loss value is the average of six pieces. The mill scale was removed from all test pieces before exposure, and all pieces were cleaned with ammonium citrate solution before final weighing.

On March 4, 1913, a second series of sheets was exposed in the Pennsylvania coke regions, which shows the remarkable inhibitive power of the copper content. Table II gives the analysis of the sheets used in this series of tests. Panels D, E, V, Z, and ZZ are copper-bearing steels; panels Y and YY are plain open-hearth steels, without copper additions; panel F is reworked muck iron; and panel I is a genuine charcoal iron. The test pieces were of 27-gage sheet steel, 2x4 ins. in size. They were exposed to the weather for eight months at Scottdale, Pa. The results are the average of eight tests of each grade. The mill scale was removed before the samples were exposed, and all pieces were cleaned with ammonium citrate solution before final weighing.

By referring to Table II it will be noted that the copper alloy steels have given better service than the genuine iron sheets.

The writer, collaborating with J. O. Handy, is at present conducting a corrosion test in two different localities. In this test are included 700 full-sized sheets of 44 different characters of steel. This test should be completed in approximately six months from the present date, and it will no doubt give us some additional valuable information which will be made the basis of a subsequent paper. In this series we have included copper additions in amounts from approximately 0.04 to 2 per cent, and we have also made additions of sulphur, phosphorus, aluminum, silicon, mill scale and steel turnings. Although the sheets have been exposed only about ten months, and we have not yet completed our observations, we are already able to draw some interesting conclusions.

After nine months' exposure the sheets of plain steel containing a high percentage of sulphur have corroded much faster than those containing a normal percentage of sulphur. Up to the present time the sheets with high copper content, up to 2 per cent, are not showing any better resistance to corrosion than those containing only 0.25 per cent of copper. From present indications the beneficial effect of the copper content is quite marked down to as low as 0.04 per cent. A sheet of steel to which silicon had been added is failing badly, as are also sheets to which aluminum and sulphur have been added separately.

TABLE II.—COMPOSITION AND RELATIVE LOSSES OF 27-GAGE, 2X4-IN. SHEETS EXPOSED FOR EIGHT MONTHS AT SCOTTSDALE, PA.

Panel.	Grade.	Analysis. Carbon.	Manganese.	Sulphur.	Phosphorus.	Silicon.	Copper.	Loss in ozs. per sq. ft.	Rank.	Relative losses, 100 equals greatest corrosion.	Condition of test pieces after exposure.
V	Bessemer	0.04	0.39	.078	0.114	....	0.31	3.15	1	42.63	No holes
E	Open-hearth	.04	.30	.043	.065	....	.31	3.24	2	43.84	No holes
ZZ	Open-hearth, unannealed	.11	.45	.049	.099	.011	.25	3.32	3	44.93	No holes
Z	Open-hearth, annealed. Same heat as ZZ	.04	.43	.049	.099	.011	.25	3.33	4	45.06	No holes
H	....	.042	.16	.024	.003	....	.21	3.39	5	45.87	No holes
D	Open-hearth	.06	.50	.037	.016	....	.26	3.50	6	47.36	No holes
C	Open-hearth	.06	.33	.035	.018	....	.25	3.51	7	47.50	No holes
O	....	.027	.07	.033	.007	...	.09	3.69	8	49.93	No holes
W	....	.049	.05	.043	.005	...	.10	3.88	9	52.50	Holes in 2 pieces
I	Charcoal iron	.03	.06	.013	.052	.039	.07	4.04	10	54.67	Holes in 3 pieces
J	....	.022	.03	.031	.006	...	.034	4.12	11	55.75	Holes in 1 piece
F	Reworked muck bar	.04	.07	.023	.134	.162	*	4.66	12	63.06	Few holes in all
YY	Open-hearth, unannealed	.11	.45	.048	.090	.007	*	5.11	13	69.15	Many holes in all
Y	Open-hearth, annealed. Same heats as Z and ZZ	.04	.45	.046	.099	.006	*	7.39	14	100.00	Only lace work left

*Trace.

GENERAL CONCLUSIONS.

From our work to date we are prepared to draw the following conclusions as to the influence of the various metalloids in steel sheets when exposed to the atmosphere

Carbon.—Although there has been no attempt to determine directly the influence of carbon it seems that in the low ranges present 0.02 to 0.14 per cent in mild open-hearth and Bessemer steels carbon has little influence.

Manganese.—Although the writer is aware that some metallurgists advance the theory that manganese is detrimental to steel in its resistance to corrosion we neither agree with the theories advanced nor have we observed the slightest evidence or proof that such claims are justified.

Much the greater part of the manganese present in steel exists alloyed with the iron, in which form we would not expect it to influence corrosion as far as the electrolytic theory is concerned, since two materials differing chemically or mechanically are required to start electrolysis, and these conditions are not obtained by simple alloying. Some of the manganese unites with sulphur, forming manganese sulphide, which exists in isolated patches and which is at best only a feeble conductor of electricity, and as such should stimulate corrosion to only a slight extent, if at all. It is possible that these patches of manganese sulphide, when they occur at the surface of the steel, or as they become exposed by the wasting of the steel, become oxidized to sulphates, in which form the efficiency of the moisture as an electrolyte would be increased. This action, however, is due to the presence of sulphur and not to the presence of manganese. Sulphur in steel must exist in combination, and if there is not sufficient manganese present it will unite with the iron, forming iron sulphide, in which form it will be at least as harmful as in the form of manganese sulphide. Tests made by Burgess and Aston indicate that manganese alone in steel lessens rather than hastens corrosion.

Sulphur.—We are convinced that, of all the metalloids commonly present in steel, sulphur, especially when present in abnormal amounts, is the most harmful from a corrosion standpoint. Our experiments show that in non-copper steels as the sulphur increases up to 0.18 per cent corrosion is hastened.

Phosphorus.—Although it is undoubtedly true that by increasing the phosphorus content of steel the resistance to sulphuric acid is lowered, yet our work indicates that whatever slight influence it may have in atmospheric corrosion is rather beneficial than otherwise, especially when the phosphorus has been added to the steel.

Silicon.—Silicon in the small amounts normally present in open-hearth and Bessemer steels is innocuous. However, experiments made by adding silicon in the amount of 0.15 per cent and 0.30 per cent show that the corrosion rate is distinctly increased by silicon in these amounts.

Copper.—It is quite generally conceded that if copper is properly added to molten steel to the amount of approximately 0.25 per cent, the life of the steel under atmospheric conditions is greatly increased. While definite figures from actual losses on weighed test pieces indicate that this increased life is approximately 100 per cent, we are of the opinion that this figure is low. We have reached this conclusion from observations of copper-bearing steels after several years' exposure. It appears that the rate of corrosion of copper-bearing sheets lessens as the time of exposure increases, and that the loss during the first six months' exposure is greater than during subsequent periods.

Any unprotected iron or steel will develop to a thin film of rust in a few minutes when exposed to moisture and oxygen. This oxide film is electro-negative to the underlying metal and will stimulate further corrosion. Moreover, the physical characteristics and texture of this rust film are very important factors in governing the rate of corrosion of the metal. The rust formed on copper-bearing steel is dark brown, closely adherent and smooth, and if it does not really act as a protector to the underlying metal it is at least much less an accelerator than is the rust on a normal steel or iron, which is a limonite red in color, rough, loose and spongy in character. That the latter holds water to a greater extent is strikingly demonstrated by examining sheets which have been exposed for several months, both with and without copper, immediately after a rain. Copper-bearing sheets dry very quickly, while the loose, spongy rust on the sheets without copper holds the moisture for a considerable time, allowing corrosion to proceed for several hours after it has ceased on the copper alloy sheets.

While the beneficial influence of copper in steel and iron is most marked under atmospheric conditions, investigations under soil, water and other natural conditions are indicating superiority under these latter influences as well.

SUMMARY.

To summarize conclusions from our work up to the present time: The influence on corrosion of carbon, manganese, phosphorus and silicon in the amounts normally present in properly made steels and irons is practically negligible. In a steel without copper, high sulphur content stimulates corrosion. A copper content of 0.25 per cent materially increases the life of steel and iron, and the harmful effect of sulphur up to at least 0.14 per cent is neutralized by 0.25 per cent copper. More copper, up to 2 per cent, gives little, if any, additional benefit. Lesser amounts than 0.25 per cent have great influence in lowering the corrosion rate. A content of 0.15 per cent is in most cases quite as good as 0.25 per cent, and tests now under way prove that much lower amounts, down to as little as 0.04 per cent and 0.06 per cent, while not giving the bests results, are remarkably superior to normal steels carrying only the usual traces of copper.

Careful study is being made to determine definitely, if possible, the mechanism of the reactions which take place by alloying copper with steel and iron, and which will explain the remarkable beneficial influence of the copper content. We hope that this information will be available for a subsequent paper.

ACKNOWLEDGMENT.

The foregoing data were abstracted from a paper by Daniel M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., of Pittsburgh, presented before the recent meeting of the American Iron and Steel Institute, in New York.

BRIDGES

A Correction.

Interstate Bridge Over the Columbia River Between Vancouver, Wash., and Portland, Ore.

Mr. Howard requests us to correct an inadvertent error in the article concerning the above bridge, which begins on page 540 of our issue of June 16, 1915. The last paragraph is not correct for the engineering work of this structure is being handled in the name Waddell and Harrington, E. E. Howard and L. R. Ash, Associate Engineers, Consulting Engineers.

The Design of Retaining Walls Founded on Soft Materials.

(Staff Abstract.)

The following data and discussion deal with retaining walls founded on soft materials. For such walls the ordinary rules of design are of little value, and the well-known theoretical treatments present definite limitations. The solutions of the problems presented lead to some novel designs. The studies were occasioned by some track elevation work on which the Chicago, Milwaukee and St. Paul Ry. is now engaged in Milwaukee, Wis., the work being located on the "South Side," between the Kinnickinnic and Menomonee rivers. When this portion of the railroad (about 1½ miles in length) was built in 1871 about two-thirds of the stretch now to be elevated was placed on a pile bridge as the ground surface at that time was but little above the level of the lake and was virtually a marsh. The trestle has been entirely filled in, as has also the surrounding ground, much of which has been improved with buildings. The settlement of the tracks, which has been marked, has been adjusted by placing additional material from time to time.

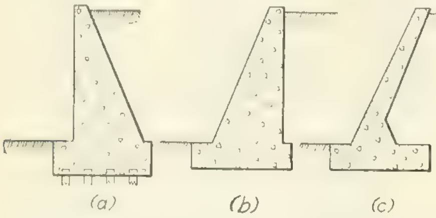


Fig. 1 Types of Concrete Retaining Walls on Soft Foundations—(a) Mass Wall on Piles; (b) Mass Wall with Spread Footings; (c) Reinforced Concrete Type.

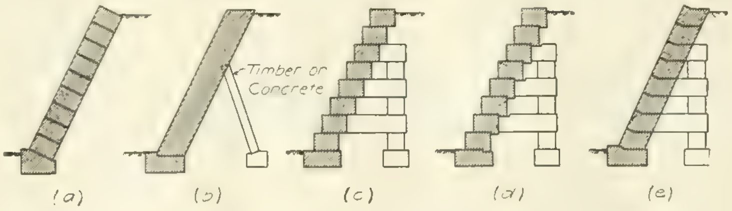


Fig. 2. Various Schemes for Applying Dry Wall Idea to Concrete Block Retaining Walls.

SUBSOIL CONDITIONS.

Because of the uncertain conditions existing at the site, foundation investigations were made at various points, including test piles driven to a depth of 80 ft. and test borings carried to a depth of over 100 ft. The results of these investigations may be summed up as follows: Directly below the surface to a depth of 10 to 15 ft. there is a deposit of filled material varying from gravel and sand under the main tracks to refuse of various kinds under side tracks and unoccupied portions of the right-of-way. Below this to a depth approaching 80 ft. below the ground surface there are numerous, though rather poorly defined, strata of wet, slimy clay and fine sand, the several strata varying in position and thickness at various points along the line. Below this soft material there is a bed of coarse sand and gravel of an unknown depth. The pile driving and loading tests proved beyond any question that piles would have to be driven into this gravelly material to be at all reliable. Owing to a lack of a sufficient number of drivers with leads long enough to handle 75 ft. and 80 ft. piles it was evident that many piles would have to be driven in two sections, connected by a splice; and taking into consideration the results of the pile tests, the great length of the piles, and the presence of a splice, it was concluded to limit the load per pile to 15 tons.

SUGGESTED DESIGNS.

A wall on pile foundations such as is shown in Fig. 1 (a) would prove very expensive under such conditions, so much so as to lead naturally to speculation as to the possible use of walls on natural foundation. Many types of wall in mass and reinforced concrete were investigated, but most of them offered little encouragement, being eliminated either because they gave too great a variation in the toe and heel pressure under the various cases of loading, or were not capable of the large settlement anticipated without possibility of serious damage to them. The only common design that seemed to approach the solution was the mass wall in Fig. 1 (b), or its equivalent in reinforced concrete in Fig. 1 (c), the advantage in cost apparently being with the former.

As a possible source of a solution, Mr. Loweth, chief engineer, suggested that studies be made as to the feasibility of adapting either the timber crib or dry stone wall to plain or reinforced concrete. The dry wall was the first to be studied, and a number of different forms suggested themselves, as shown in Fig. 2. The idea of the dry wall is to incline the wall at such a slope that the resistance line will at all points in the height of the wall fall at the center line of the wall or behind it. If this was carried out exactly the analysis would result in an ideal design which consists of a slab of concrete with a curved front face similar to that obtained on a high gravity type masonry dam.

Naturally, the most primitive design for such a wall would be as shown by Fig. 2 (a). This imitates the dry stone wall very closely and has the joints placed very nearly at right angles to the resistance line. Obviously such a wall would involve difficulties in construction which would make it prohibitive.

A modification of this design is the wall shown in Fig. 2 (b), simply a slab of concrete leaning against the embankment. This slab could be built in place or cast in short sections and erected when convenient. In either case it would be necessary to provide struts of timber or concrete to support the wall until the embankment could be placed.

In the wall of Fig. 2 (c) we have a design which is intended primarily to get cheap construction. It consists simply of a tier of blocks with horizontal beds stepped back to give the desired slope. To avoid the necessity for erecting these walls piece-meal during the placing of the embankment, they are provided at intervals of about 9 ft. with ribs extending back into the fill, composed of headers interspaced with small blocks. This portion of the wall serves simply as a support until the embankment has been placed, and is not intended in any way to add to the stability of the wall against lateral pressures. The weakness of the design is that the resultant at each joint is inclined at rather an oblique angle with the horizontal beds of the blocks, an angle which approaches much too closely to the angle of friction of concrete upon concrete. This naturally suggests the use of a mechanical lock or bond between the various blocks; for example, the surfaces of the blocks may be corrugated by casting them in forms lined with corrugated iron, or a lug may be cast on the bottom of each block as shown in Fig. 2 (d).

The type shown in Fig. 2 (e) is a composite of that shown in (a) and (e), in that part of the joint is horizontal, while the forward portion is inclined at an angle even greater than that of a plane perpendicular to the resistance line. By this means the desired resistance to sliding is obtained without sacrificing anything as to the ease of erection. The forms are somewhat more complicated, but this is not of great importance if any considerable number of blocks are to be cast.

The reinforced concrete equivalent of a timber crib is not, as might seem at first thought, a combination of various shaped concrete sticks dove-tailed or dowelled together. Instead it is a box, or a series of boxes, of reinforced concrete built with not less than one cell complete in one piece. The walls are made of such a thickness as will compromise consideration of the strength, economy and ease of construction. Concrete cribs have been used for some time by the War Department in the construction of breakwaters on the Great Lakes. In this adaptation they do not act as retaining walls but as receptables for stone. A concrete crib for use as a retaining wall is shown in Fig. 3. It is simply a bottomless box, which depends for its stability upon its own weight and the weight of embankment superimposed on the portion buried in the fill, and it is not hard to analyze. This type of wall has a large factor of safety in the passive resistance of the earth on the inside face of the rear wall, which becomes effective as soon as the wall starts to move forward. The wall also affords great frictional resistance to overturning. Neither of these elements, however, ought to be considered in making an analysis for design.

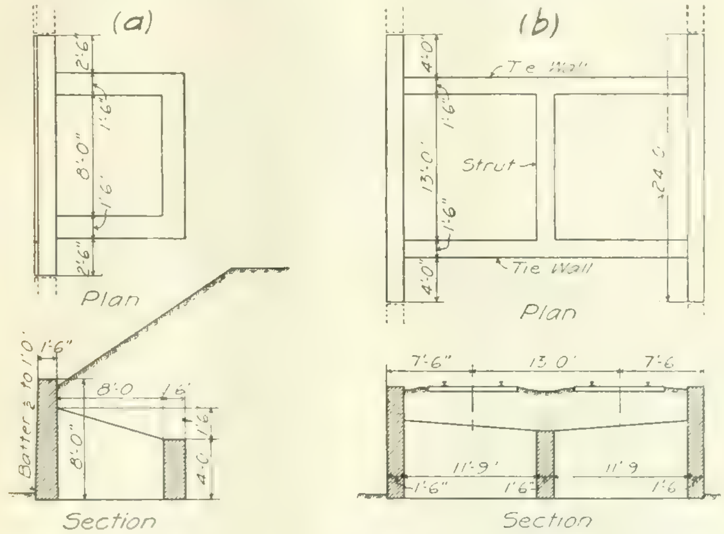


Fig. 3. Cellular Retaining Walls—(a) Unsymmetrical Type; (b) Symmetrical Type.

For a narrow right-of-way a natural modification from the crib wall described above is that shown in Fig. 4. This is in reality an application of the reinforced concrete filled U abutment. The lateral forces are taken care of entirely within the structure itself and only the vertical loads are transmitted to the foundation.

GENERAL THEORY.

Before attempting to analyze any of the types of walls described above, it was necessary to investigate the applicability of the theory and constants commonly used in dealing with the lateral pressure of earth. A question arose in particular as to the proper value for the ratio k of lateral to vertical pressures, and the correct application of the surcharged live load.

Considering the first of these, we find that two solutions are given for the value of k for a wall which overhangs the embankment, as in Fig. 4, where angle Θ is less than 90°. Ketchum gives under what he calls, "Rankine's Theory Modified," the formulas,

$$k = k' \sec(\lambda-\lambda_1)$$

$$k' = (1-\cot\Theta\tan\phi)^2\cos\phi\sec\lambda_1\cos(\Theta-\lambda_1)$$

Cain's application of Coulomb's theory results in the formula,

$$P = \tfrac{1}{2}wh^2\left(\frac{\sin(\Theta-\phi)}{(n+1)\sin\Theta}\right)^2\frac{1}{\sin(\phi'+\Theta)},$$

$$\text{where } n = \sqrt{\frac{\sin(\phi+\phi')\sin(\phi-\delta)}{\sin(\phi'+\Theta)\sin(\phi-\delta)}}$$

The formulas seem rather elaborate but are readily represented in workable diagrams, and for such cases as occur in common practices the results obtained by the two methods agree very closely.

In the case of a wall with an appreciable backward inclination the above formulas give a considerable reduction of the value of k. For a wall with a level top embankment, and a value of ϕ (the angle of repose) taken at 33° 42′, we find that,

when $\Theta=81°$, $k=0.2$;
and when $\Theta=70°$, $k=0.12$.

The effect of a live load upon an embankment is generally represented by a surcharge of additional embankment of equal weight. The practice of the Engineering Department of the C., M. & St. P. Ry. is to make use of the theory of the live load spread. Referring to Fig. 4, a live load of 11,000 lbs. per lineal foot of track is considered as distributed over a width of 8 ft. at the level of the base of rail, and as spreading through the embankment in such a manner that at any given level the live load would be uniformly distributed over a width defined by two planes spreading symmetrically from the center line of track. This is, of course, at variance with the actual conditions, but it is surely much closer to the truth than the equivalent earth surcharge.

The formula for live load spread is simple,

$$P = \frac{11{,}000}{8+2hx}$$

where P=vertical live load pressure at a depth of h feet, and x=the inclination of the spread planes, in fractions of a foot per foot of depth.

Upon analyzing trial designs of the block wall it was discovered that small variations in the factors explained above resulted in great variations in the position of the resistance line. This is shown in Fig. 4, where widely different positions of the resultants are shown for different assumptions as to live load spread. From this it was clear that more definite knowledge concerning the questioned points were necessary before a really intelligent analysis was possible. To this end, authority was obtained to build and test a model wall of the concrete block type.

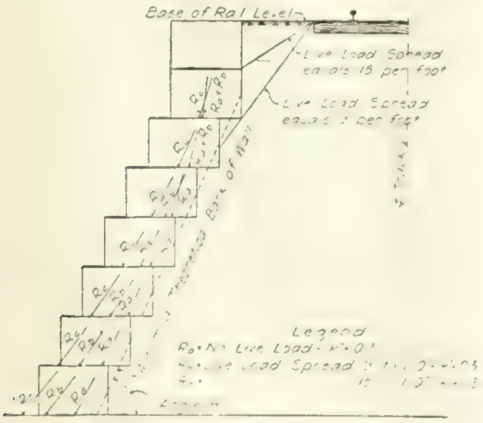

Base of Rail Level
Live Load Spread equals 1.5 per foot
Live Load Spread equals 1 per foot
Back of Wall
Legend
R₀ No Live Load

Fig. 4 Positions of Resultant Pressure on Each Joint for Three Loading Assumptions.

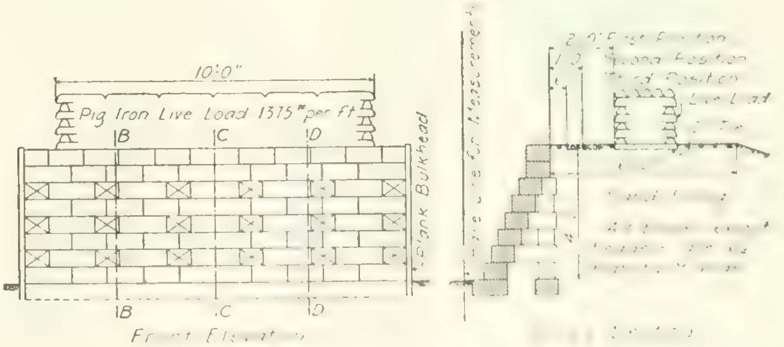


Fig. 5. Front Elevation and Cross Section of Test Wall and Loading Used on Same.

TEST WALL.

The wall as shown in Fig. 5 was one-fourth as high as a full size wall for a 17-ft. embankment; it was made 12 ft. long between bulkheads, and was backed with a sand embankment. The live load was pig iron piled on wooden cross ties 2 ft. long.

The question arises as to the correctness of results obtained with a small sized model, particularly when dealing with earth pressures.

A very simple demonstration (which cannot be given space here) will prove that the ratio of the weight of wall to the total lateral earth pressure will be the same in the model as in the full size wall; hence, since the walls are similar, the factors of safety against overturning and sliding will be the same. To maintain this relation for the live loading the load per square foot must be one-fourth as much, and therefore, ince the ties are one-fourth as long, the load per lineal foot must be one-sixteenth as much. Actually the load in the test was just double this, 1,375 lbs. per lineal foot.

When we come to foundation bearing pressure the value of the test wall is nil. The pressures are just one-fourth those for the full size wall and therefore of no value.

TESTING PROCEDURE.

The program for making the test was as follows:

After the wall is erected, take levels in the planes *BB, CC,* and *DD* (Fig. 5) on the toe of the front wall footing and on the front edge of each course of blocks. With a transit set on the base line and a level rod held horizontally in the above planes against the front top and bottom edge of each course of blocks measure the distances from the plane of the base line.

Place fill behind the wall, the fill to be well tamped, using plenty of water, and to be level with the top of the wall for a distance back of 6 ft.

Take levels and base line measurements twice at intervals of four days at each point where they were originally taken before the wall was filled.

After completion of the eight-day test of the wall under earth load only, lay 2x4-in. ties 2 ft. long and 5 ins. center to center, the ends of the ties to be 2 ft. from back of top block. Load the middle 10 ft. of the wall with a uniformly distributed load on the ties of 1,375 lbs. per lineal foot of wall. Take levels and base line measurements twice at intervals of two days at all points where they were previously taken.

After completion of this step move the live load to the second position, 1 ft. nearer to the wall, and repeat all measurements in the same manner. Then move the load to the third position 6 ins. closer to the wall, and repeat measurements. Then increase the live load by 50 per cent in the same position, and repeat measurements.

The blocks were made with a rough sanded surface without any mechanical bond. Thus the wall was weaker in resistance to sliding than overturning; this resistance to sliding was then used as a measure of the lateral pressures obtained, as will be shown. As a check on the sliding resistance tests were made to determine the coefficient of friction for concrete surfaces like those on the blocks, which gave values varying from 0.53 to 0.75 with a mean for dry surfaces of about 0.66 and for wet surfaces about 0.63.

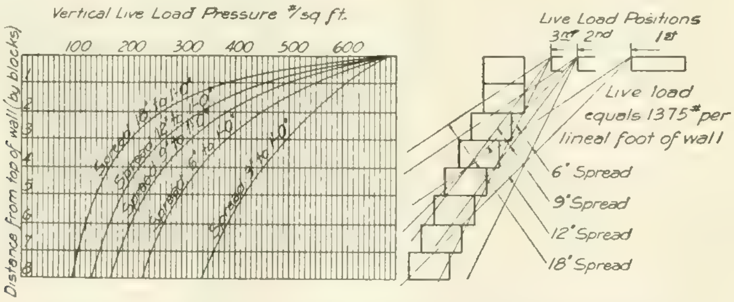


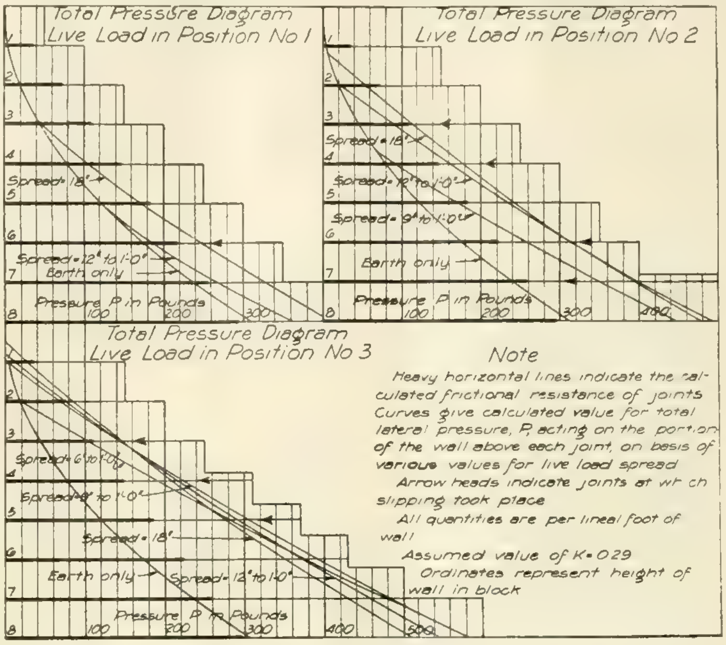
Diagram shows intensity of live load pressures on a horizontal plane, for various depths of fill and various assumptions as to spread. Figure shows relation between the model wall and lines representing live load spread

Fig. 6. Diagram Showing Intensity of Live Load Pressures on a Horizontal Plane For Various Assumptions.

As anticipated, the test wall failed by sliding on the several joints between the blocks. Complete destruction was dispensed with as a matter of no consequence. The test was discontinued after placing the 50 per cent additional load in position, as a sudden and general sliding caused a settlement of the embankment which tipped over the live load.

RESULTS OF TEST AND ANALYSIS OF SAME.

A careful study was made of the results of this test to determine at what stages of the test the slips took place, and the amount of each. This is shown, for an average for the three planes of measurement, in Table I. The figures show the amount of slip, in decimals of a foot, which has taken place since the last preceding measurement no entry being made unless the slip was more than 0.001 ft. Thus the load applied previous to measurement No. 4 caused sliding at joints 10-11, and possibly at 12-13; that the load applied previous to measurement No. 6 caused sliding at joints 8-9, 10-11, 12-13 and 14-15.



Note

Heavy horizontal lines indicate the calculated frictional resistance of joints Curves give calculated value for total lateral pressure, P, acting on the portion of the wall above each joint, on basis of various values for live load spread

Arrow heads indicate joints at which slipping took place

All quantities are per lineal foot of wall

Assumed value of K=0.29

Ordinates represent height of wall in block

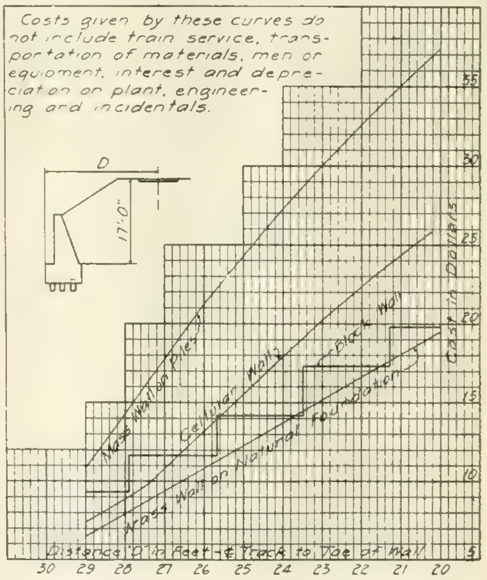
Fig. 7. Curves Representing Total Pressures for Three Positions of the Live Load.

If we assume a value for the coefficient of friction between the blocks at 0.63, by computing the weights of all the blocks above any given joint, we can determine the sliding resistance of the joint and thus have a measure of the pressure behind the blocks above this joint necessary to cause sliding. This, then, may be compared with curves representing the theoretical pressure as obtained according to various assumptions.

TABLE I.—AVERAGE SLIP OF EACH TIER OF BLOCKS.

	Measurements				
Joints.	1.	2.	4.	6.	8.
2- 3....	......	......	......	......	......
4- 5....	......	......	......	......	......
6- 7....	......	......	......	0.0013	0.0017
8- 9....	......	......	......	0.0023	0.0013
10-11....	......	......	......	?	0.0020
12-13....	......	......	0.0020	0.0030	?
14-15....	......	......	?	0.0030	?

First, let us consider Fig. 6, which illustrates the effect of modifying the assumption as to the live load spread. The portion of the diagram on the right shows the outline of the model wall in relation to spread of the live loading according to various inclinations of the limiting planes. The portion of the figure to the left is a diagram which shows the intensity of the vertical live load pressures for the various spreads at various depths, in relation to the blocks making up the wall. By applying the proper coefficient *k* we obtain from these the lateral pressures, which (when combined with the lateral pressures due to the weight of the embankment alone) give us the total unit pressures, it being understood, of course, that there is no live load pressure on the wall above the point where the given live load spread line intersects the back of the wall.



Costs given by these curves do not include train service, transportation of materials, men or equipment, interest and depreciation on plant, engineering and incidentals.

Fig. 8. Curves Showing Comparative Cost of Different Types of Walls.

From Fig. 6 we have constructed the diagrams of Fig. 7, one for each position of the live load during the test. The curves give values of *P*, the total lateral pressure obtained between the given ordinate and the top of the wall. Ordinates indicate distance from top of the wall by blocks.

On these same diagrams have been shown the values of the sliding resistance for each joint in the wall based on the weight of the blocks above each joint and a coefficient of friction of 0.63. The joints at which slipping was recorded under the particular loading have been marked with an arrowhead.

If our assumptions as to live load spread and coefficient *k* are correct (accepting ordinary theory as to earth pressure), the curve for values of *P* should intersect the heavy black lines of the sliding resistance for all joints where no slipping occurred, and should fail to intersect, i. e., pass to the right of ends of all the black lines for joints where slipping did occur.

The curves for *P* given in Fig. 7 were selected after a number of trials; the value *k* is 0.29, while curves for live load spread are given for values carrying from 6 ins. to 1 ft. 0 in., to 18 ins. to 1 ft. 0 in. An examination of the diagrams will show that the curves for spreads of 12 ins. to 1 ft. 0 in. and for 18 ins. to 1 ft. 0 in. seem to conform best to the proposition outlined above. The absence of any sliding at joint No. 7 for loads in positions No. 1 and No. 3 is contradictory, and no satisfactory explanation has been suggested. No data on sliding at joint No. 8 were taken.

CONCLUSIONS.

Conclusions to be drawn from this test must be made with a knowledge of a somewhat unfortunate circumstance. Through a misunderstanding of instructions the amount of water applied to the filling after the placing of each load was excessive, so much so as to make conditions much more severe than could be obtained under ordinary actual conditions. This has been compensated for, in part, by taking the weight of the filling at 124 lbs. per cubic foot, determined by test. According to Ketchum and Cain, the value for *k* should have been about 0.12 for an assumed value of the coefficient of internal friction of the material of 0.67 (1½ to 1 slope). The fact that the test points to a much higher value does not conflict with the theoretical results, but indicates that the material had a much lower coefficient of internal friction due to the use of too much water.

Owing to these circumstances, the results of the test are rather disappointing. They indicate that the live load spread is much greater than had been supposed. Beyond this, the results are qualitative rather than quantitative. It is believed that the test will prove of value in pointing out a field for extension investigation and in suggesting a simple means for making a test.

As to the design of a block wall the test proves clearly that horizontal beds without a form of bond or lock give the wall a low efficiency, as failure by sliding will take place at loads much below those required to cause overturning. With a properly designed joint such as is shown in Fig. 2 (e) the block wall presents advantages under certain circumstances that justify its serious consideration.

In Fig. 8 are shown diagrammatically the relative cost of the heavy front batter mass wall on natural foundation, the block wall, the cellular wall, and the mass wall on piles. This comparison is based on the assumption of very expensive piles, such as are required on the work at Milwaukee. The relative economy of the several types, excluding all other considerations, is directly in the order named above.

In conclusion, the following advantages and disadvantages are listed for the several types:

Advantages of the block wall: It is economical; settlement in an irregular manner will not be conspicuous; it may be constructed in several stages; it does not occupy much space before filling. Disadvantages: The heavy front batter causes a waste of property which will encourage encroachments, and unless built with a smooth front batter will encourage trespassing. Because of its loose-jointed nature the block wall does not, under some circumstances, possess as much of a potential factor of safety against the unforeseen co
tingency as a monolithic structure.

The heavy batter mass wall is econom
but it will cause criticism if it settles or
appreciably, and is subject to the same
tions as the block wall on account of the
front batter.

i-
cal,
tips
bjec-
heavy

Advantages of the cellular wall: It
the right-of-way in such a way as
little opportunity for encroachment
settle considerably, but it offers g
ance to overturning or sliding. I
ready driving of a pile trestle dir
Disadvantages: It occupies cons
before filling, and may thus int
use of tracks. Settlement ma
unpleasing appearance.

occupies
to afford
. It may
reat resist-
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derable space
rfere with the
y also give an

The mass wall on piles gi
curity, but it is expensive
difficulties because of poss
the pile driving may do t
on insecure foundation, a
was given much weight
substitute for the struc

es maximum se-
and may lead to
ble damage, which
adjacent buildings
consideration which
in the search for a
ure on piles.

Up to the present, o
rugated horizontal b

ne block wall with cor-
ds and two cell walls

have been built at Milwaukee. Plans
use of the cell wall at a number of oth
on the work have been made. The
has been favored on account of
utilization of the right-of-way, an
number of cases because of the r
driving a pile trestle for an adja
track directly over the wall.

for the
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ACKNOWLEDGMEN

The foregoing data were a
paper by Walter S. Lacher,
the Western Society of Eng

stracted from a
presented before
ineers.

A Bridge With Cul vert Pipe Piers.

Contributed By L. R. W. Allison, Newark, N. J.

A novel type of pier
is shown in Fig. 1,
bridge built in Tular
piers required for
an outer shell of
vert pipe filled w

for a highway bridge
which is a view of a
e County, Cal. The six
this structure consist o
corrugated ingot-iron cul
ith concrete, and supporte

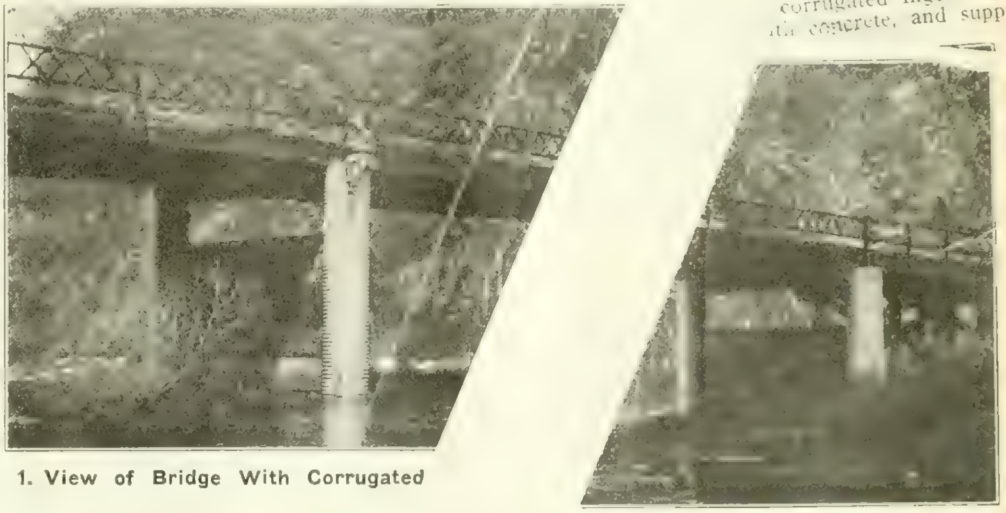


Fig. 1. View of Bridge With Corrugated Culvert Pipe Piers in Tulare County, Cal

on reinforced concrete foundations 4 ft. wi
4 ft. thick and 22 ft. long. The concrete
the piers is reinforced with steel, the latt
being wrapped around the corrugations, i
side of the pipe, to provide a rigid support
cylinder. These piers are 15 ft. high, fro
low water level to the bottom of the floo
beams.

The bridge consists of two 40-ft. be
spans and an approach span at each end,
latter being of wood construction, while
two main spans have steel stringers and f
beams. The structure has a clear roadwa
18 ft. and is provided with a latticed
railing. The floorbeams are embedded in
are flush with, the tops of the piers, the i
faces of the culvert pipe being cut t
ceive the ends of these I-beams.

These culvert pipe piers have proved
very effective, affording simplicity and
omy in construction, and offering littl
sistance to high floods. Since the constru
of the bridge there have been floods s
enough to damage the superstructure;
have, however, had no effect on the piers
bridge was designed and erected by Ro
Horbach, supervisor of Tulare County

CONSTRUC TION PLANT

MACHINES D EVICES MATERIALS

An "Oil Geared" Construction Locomotive.

(Contributed.)

This class of locomotive is of original design and construction. It contains nearly all of the advantages claimed for the gasoline and electric locomotives, without including their objectionable features. Any liquid fuel may be used; the exhaust is free from smoke and sparks; the operation is extremely simple; the co
is quiet in
it rides s
possible
which, w
erate fir
thing t
tive.

Th
a g
hor

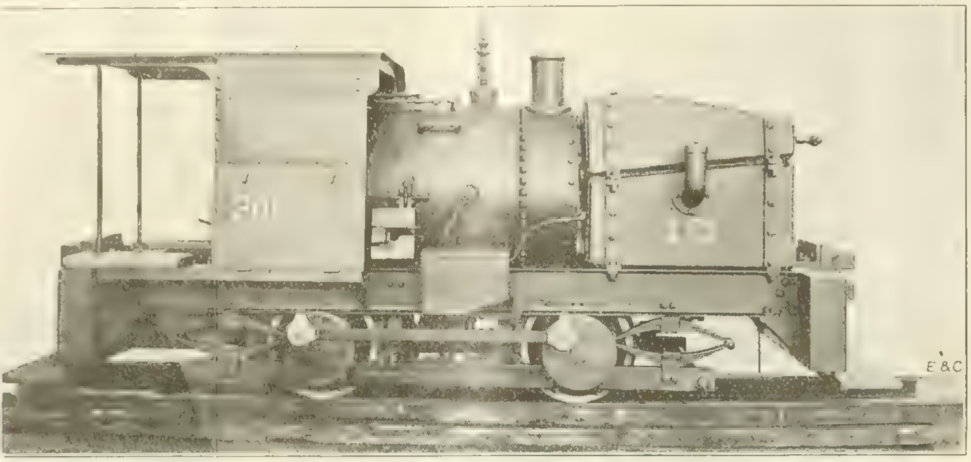
nplete locomotive is compact; it
operation, is well balanced, so that
noothly, and develops the greatest
drawbar pull for its weight, all of
hen coupled with low fuel cost, mod-
st cost, and long life, make for every-
hat means satisfaction from a locomo-

is new design includes such features as
ared unit engine, a cylinderical type of
izontal boiler with firebox and smokebox

included in one shell; double frame, includi
ng [illegible] springs and axle driving bo
bolted [illegible] to the sub-frame, roller be
ings throughout the engine, with dropforg
engine parts, and a number of other new a
improved features.

The unit engine is the principal feature,
only in its design, but also in its constructi
Though this engine is in most cases gea
two to one, or lower, it is so perfectly b
anced and runs with so little friction, due

the use of roller bearings, oil bath lubrication, and ground finish cylinders, pistons, etc., that it will run sufficiently fast to give as much speed to the locomotive as our direct-connected machines designed for similar service. It is light and small, and permits of low head and side clearance. The fact that it is geared makes possible a much more even torque on the driving wheels, which gives these locomotives very much greater traction qualities than the direct-connected engines. When running fast there is no tendency for the engine to "nose" or sway from side to side, and the acceleration possible is very great. Furthermore, this engine is more efficient and consequently uses less steam and fuel.



Porter "Oil Geared" Locomotive.

The boiler perhaps is the next most important feature. It is made of a straight shell long enough to include fire and smoke boxes.

The heads are of the usual flanged type, riveted in. The tubes are copper and bushed at both ends with steel. A large number is used but they are very small and short, in most cases being only a half inch in diameter by sixteen inches long. This design makes a compact, powerful, quick-firing boiler, is easily cleaned and absolutely safe.

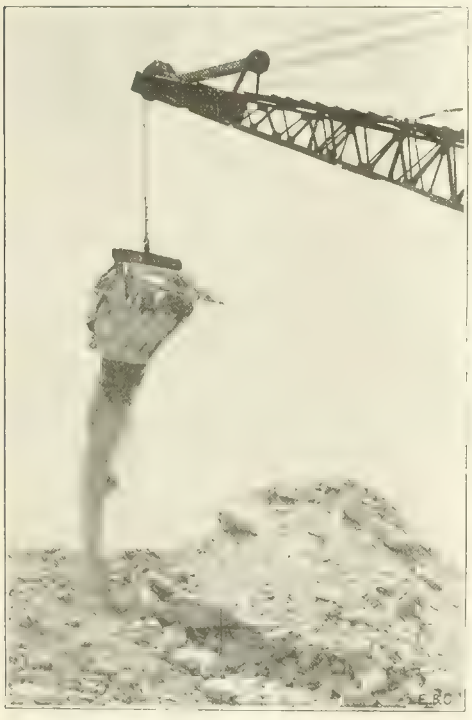


Fig. 1. Bucket Dumping on the Swing.

Of course, boiler sizes vary; but to illustrate how compact they are, on the five-ton locomotive the complete boiler with firebox and smokebox only measures 34 ins. in diameter by 37 ins. in length. It may be fired up in fifteen minutes, and will make more steam than the locomotive can use under the worst conditions.

The frame is another feature worthy of note. It consists of two members, which are called sub and main frames. The sub-frame has rigid side members to which the driving boxes are bolted, but these members have loosely fitted tie cross rods at each end and which permit them to travel vertically and separately with the wheels on rough track. There are four full elliptic springs secured to the sub-frames, on which the main frame rests. The main frame is constructed of channel steel and is carried by the four subframes springs. The drive is taken through these springs and a set of angle bars mounted between the side members of the two frames. The advantages include strength, flexibility, elimination of wedges and wearing parts, and that even after a severe accident any blacksmith can readily straighten and repair any damaged parts.

The makers are prepared to furnish this locomotive in sizes from 2 to 12 tons, any gage, and in minimum heights from 40 ins. up. Any liquid fuel can be used, but we recommend kerosene or fuel oil for outside haults, and gasoline for tunnel or mine work.

The makers are the H. K. Porter Co., Pittsburg, Pa.

A New Form of Dragline Bucket.

(Contributed.)

The Brownhoist Shnable Patent Drag-line Bucket as illustrated here has been given a 5-year try-out on the Calumet-Sag and North Shore channels, which are additions to the system of the Chicago Drainage Canal. The material at different sections consists of a thin soil covering over a glacial conglomerate of sand, gravel and boulders cemented with clay and very tightly packed; below this is what is termed "Marl," hardpan which has the color of bluish clay, and is full of pieces and ledges of limestone; and at the bottom is solid limestone rock which has to be blasted. The bucket successfully dug this material, and stood up under the hard work. The illustrations show the bucket in actual service, and indicate the nature of the material.

The bucket is back-dumping, Fig. 1. It consists of a shell, a pulling bail, and a combination hoisting bail and back-gate. In its digging position the pulling bail is connected to the shell at points which are located above the center of gravity of the shell. The pulling bail is also connected by means of links to the hoisting bail and back gate in such a way that tension on the drag-line forces the gate to close and remain so. When the bucket is suspended on the hoisting bail and the tension on the drag-line is released, the back of the shell tips down away from the back-gate allowing the load to slide and drop out. The pulling bail is connected to the shell by means of bronze sliding blocks carried in slots in the shell. These slots give to the link connections between the pulling bail and the back-gate, the required motion to permit the bucket to dump when the tension on the drag-line is released. Special attention is given to flexibility of the bucket and to the prevention of binding in any of the parts, by providing loose-fitting connections.

All standard buckets are equipped with teeth bolted to the digging edge at an angle to give the proper "suck." For extra heavy digging in rock, the bucket is furnished with rock teeth set at the proper angle for this service. The teeth are tipped with removable manganese steel points so that only the points need be replaced when worn.

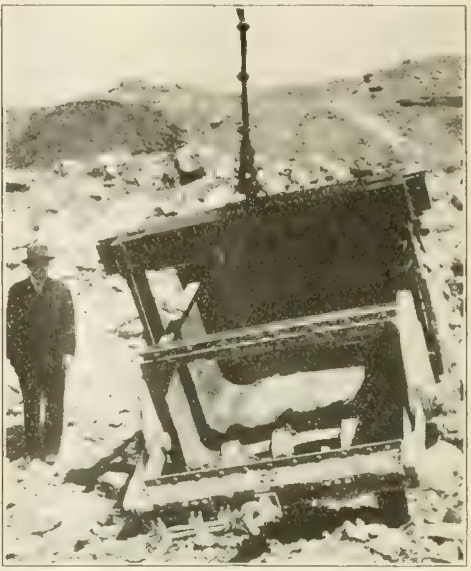


Fig. 2. Bucket in First Loading Position.

The bucket is operated with two single-part lines, the drag-line and the hoist-line. The bucket is placed in different positions by the manipulation of these two lines. Figure 2 shows the bucket as it starts to dig. The pull is being applied through the drag-line and at the same time, the hoist-line is being played out. The bucket may be made to dig at any desired slope by varying the tension on the hoist-line while paying it out. Figure 3 shows the bucket filling with large pieces of blasted rocks. When the bucket is filled, it is raised to the dumping position at the end of the boom by pulling in on the hoist-line at the same time keeping a tension on the drag-line. When the tension on the drag-line is released, the bucket is dumped. After the load has been dumped, the shell automatically resumes its closed position and the bucket is again ready to dig.

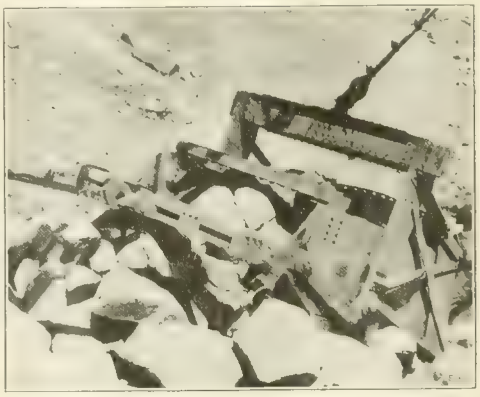


Fig. 3. Bucket Loading in Blasted Rock.

As shown in the illustrations, the bucket has been working in rock handling very large pieces. It has picked up rocks as big as an ordinary office-desk. The operator with proper manipulation of the line can pick up a rock larger than the bucket itself, by clamping the rock as in tongs, between the pulling bail and the digging edge, and this rock then is dumped front-wise. Another remarkable service of the bucket is in digging or breaking into rock which has just been blasted and which serves as a lever in separating the mass.

The bucket is of simple construction so that repairs can be made in the field with the average contractor's tool or shop equipment. This is an important factor because if the bucket has to be sent to a shop, it means a serious delay. All bushings are made from bronze and steel tubing. This makes it very convenient and inexpensive for the contractor as the tubing may be kept on hand and when a new bushing is required, a piece can be cut to the proper length.

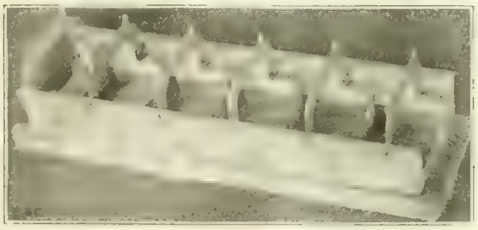


Fig. 1. Mold With Bottom, Sides and Partitions Placed.

The front section of the bucket is removable so that it can be replaced without the necessity of replacing the entire shell. To this front section is attached a manganese steel cutting plate, which is also removable for repairs. The teeth are bolted to the cutting plate and have removable points. Thus it will be seen that the part of the bucket subjected to the greatest wear is constructed of four separate removable parts any of which can be quickly renewed, namely, the front section of the shell, the cutting plate, the teeth and the teeth points.

As seen in the illustrations the Brownhoist Shnable Bucket has no locking or tripping device on the gate. The necessity of the locking device is eliminated by the patented construction whereby the gate is closed and kept closed by the pulling on the drag-line.

Because the load is dropped out at the back, it does not strike any part of the bucket or lines.

A big advantage in using the bucket is that it can be worked down a slope opposite the machine without changing the location of the connection of the pulling-bail to the shell. The relative location of the digging edge and the points at which the two balls are attached, gives a resulting force by which it is possible to dig down a slope though the drag-line is pulling up at an angle. This same feature makes it possible to take any depth cut desired. Therefore, by varying the pull on the hoist line, a thin slice can be taken which serves as a finish to a grade. The operator has perfect control of this operation, because the hoisting bail is attached in front of the center of gravity of the bucket and load.

The bucket can be placed on its bottom and the gate opened by slacking the drag-line and going ahead on the hoist line. This raises the bucket away from the load depositing the same as from a clam shell bucket. This feature permits the loading of cars without damage to them, as it eliminates any swinging of the bucket against the side of the car, and also the dropping of the load into the car. Figure 1 illustrates how the load is dumped at a greater radius than the radius of the machine. Being a back-dumping bucket, the load is always thrown away from the machine, and the centrifugal force acquired while the machine is rotating assists the bucket to dump its load and also throws it farther out. It will be noticed that both bails are very short. This permits the bucket to dig right up to the machine and also permits the bucket to be dumped close under the end of the boom, giving the operator the maximum radius of action and maximum height of spoil bank.

The new bucket is manufactured by the Brown Hoisting Machinery Co., of Cleveland, Ohio.

Armored Wire Rope.

(Contributed.)

The tensile strength of wire rope of standard construction begins to decrease immediately it is put into service. This deterioration is frequently quite rapid, especially when the ropes are used on outdoor work where they are subjected to sudden changes in atmospheric conditions and to the abrasive action of gritty substances, such as sand, pulverized rock, coal dust, etc.

Waterbury Armored Rope (Gore Patent) embodies a radical and important improvement in wire rope construction. Each strand of the rope is wound with flat steel wire having convex edges and this forms a protective armor which relieves the tensile strength wires of all abrasive wear and retains intact the strength of the rope until after these flat wires have been worn completely through. The new rope in various lines of work has demonstrated that its life is from two to three times that of similar quality rope of standard construction. It is composed of 6 strands, 19 wires to the strand; 6 strands, 37 wires to each strand or 6 strands, 61 wires to each strand, with hemp center or wire center as the conditions may demand. This rope is produced by the Waterbury Co., 80 South St., New York, N. Y.

Mold for Precast Concrete Block Culverts.

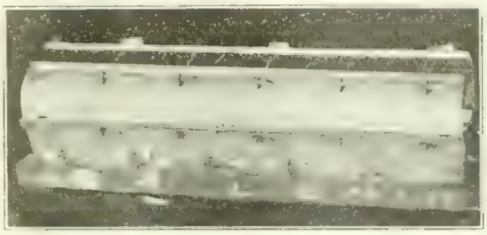


Fig. 2. Mold With Haunch Boards in Position.

The illustrations show a mold for casting concrete blocks, which interlock and form the barrel of a culvert. Referring to Fig. 1, the bottom board is placed first and the iron partitions are set into suitably placed slots. Concrete is then filled into the bottom to the level of the top edge of the bottom transverses of the partitions. The side boards and the core are then placed and the filling continued to the tops of the side boards. Next the haunch boards, Fig. 2, are placed and the filling is completed. After hardening, the parts of the mold are taken down, and the blocks are separated and stored for curing. Figure 3 shows the method of assembling the blocks into the completed culvert. Separate molds are employed for forming the end blocks. The inventor is B. S. Hall and the eastern distributors of the mold are Schulz & Hodgson, 918 Association Building, Chicago, Ill.

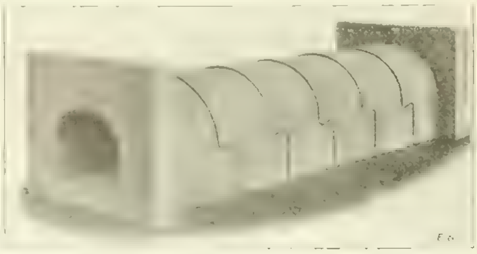


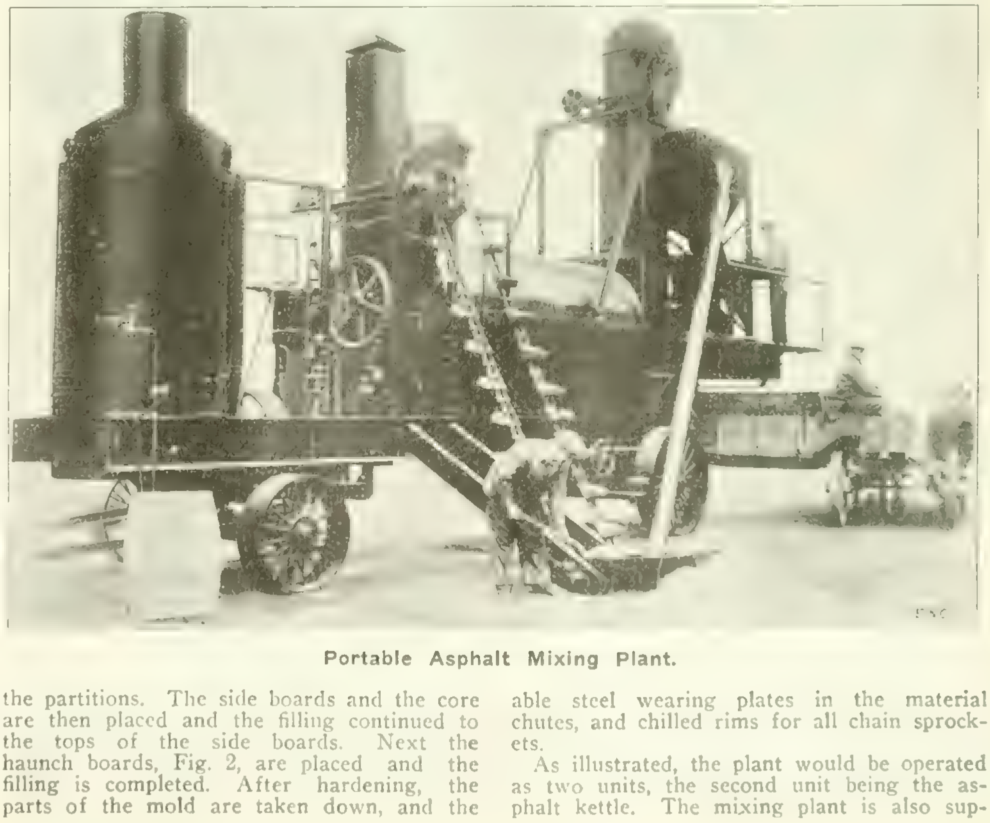
Fig. 3. Completed Culvert of Interlocking Blocks.

New Portable Asphalt Mixing Plant.

(Contributed.)

A new portable asphalt mixing plant having a number of distinctive features has just been put on the market by the Iroquois Works of the Barber Asphalt Paving Co., Buffalo. For a plant of its size and cost it is unusual in having a minimum capacity of 800 sq. yds. of 2-in. sheet asphalt topping per day of ten hours. The capacity for asphaltic concrete, Topeka mix, or asphalt macadam is much larger.

The mixing platform of the plant is so elevated that a wagon can be driven under it to receive the load from the mixer without elevating the plant on its wheels or excavating for this purpose. The platform is arranged for one-man operation, the levers for controlling clutches and plant being within easy reach. The mixer is a two-shaft, pugmill type, with removable side and end liners; provided with two full sets of blades, the binder blades being solid manganese. The sand-measuring box and asphalt bucket are supported on scales. A drying drum of special construction has been designed for this plant to obviate the difficulties so often encountered in heating a sufficient amount of sand and stone. Features that count in the economical upkeep of such plants as this are the removable steel wearing plates in the material chutes, and chilled rims for all chain sprockets.


Portable Asphalt Mixing Plant.

As illustrated, the plant would be operated as two units, the second unit being the asphalt kettle. The mixing plant is also supplied, however, without boiler and engine. In other words, the contractor or municipality already provided with portable boiler, engine and kettles, can secure the mixing plant without making an additional investment for these units.

The plant is designed especially to meet the requirements of contractors and municipalities having new construction and maintenance work to perform in scattered territory, or in an amount insufficient to make a stationary plant economical.

Apparatus for Making Accelerated Comparative Durability Tests of Small Pipe.

(Contributed.)

On the corrosion testing apparatus, illustrated herewith, it is possible to run comparative durability tests in from six to eight months. Such tests are now being run on the coast. The apparatus illustrated is a part of the exhibit of the National Tube Co., Pittsburgh, Pa., as a part of the United States Steel Corporation exhibit at the Panama-Pacific International Exposition.

This apparatus consists of a hot water tank, a water heater with thermostat, an air pump, and several coils of pipe made of alternate lengths of wrought iron, ordinary steel pipe and "National" pipe. Air is injected into the hot water which is forced up through these coils into the tank. The corrosion is rapid as the service is very severe. The object of this test is to obtain a comparative result on the life of the kinds of pipe tested.

A great deal has been said concerning the relative merits of various materials from a corrosion resistance standpoint. Many schemes for comparative tests of materials have been proposed, including various laboratory tests of short duration using rather small samples of materials. Unfortunately, in these tests, conditions of actual service have not been maintained and it has often been found that the results of laboratory tests are not borne out by actual service tests. Also a test that might be useful as a method of judging the relative merits of sheet metal, or structural materials, etc., might not be useful in judging the relative merits of materials made into pipe for use as water conductors. It is then highly desirable that a reliable method of making comparative corrosion tests of pipe materials be used, a method whereby the merits of the materials may be ascertained in a reasonable length of time.

It is the purpose of this apparatus to furnish such a test as is needed for comparing pipe materials. This purpose is attained by circulating air and hot water through a test coil, made up of materials which are to be compared. As the pipes which are to be compared are alternated in the coil, and the same air and water at the same temperature and pressure are forced through each pipe, each has an equal chance to corrode, thus making the test one of actual service conditions. But as the circulation of water is constant and the water is kept constantly saturated with oxygen from the air, corrosion proceeds at such a rate that it has been found one month of this test is equivalent to one year in the average hot water line.

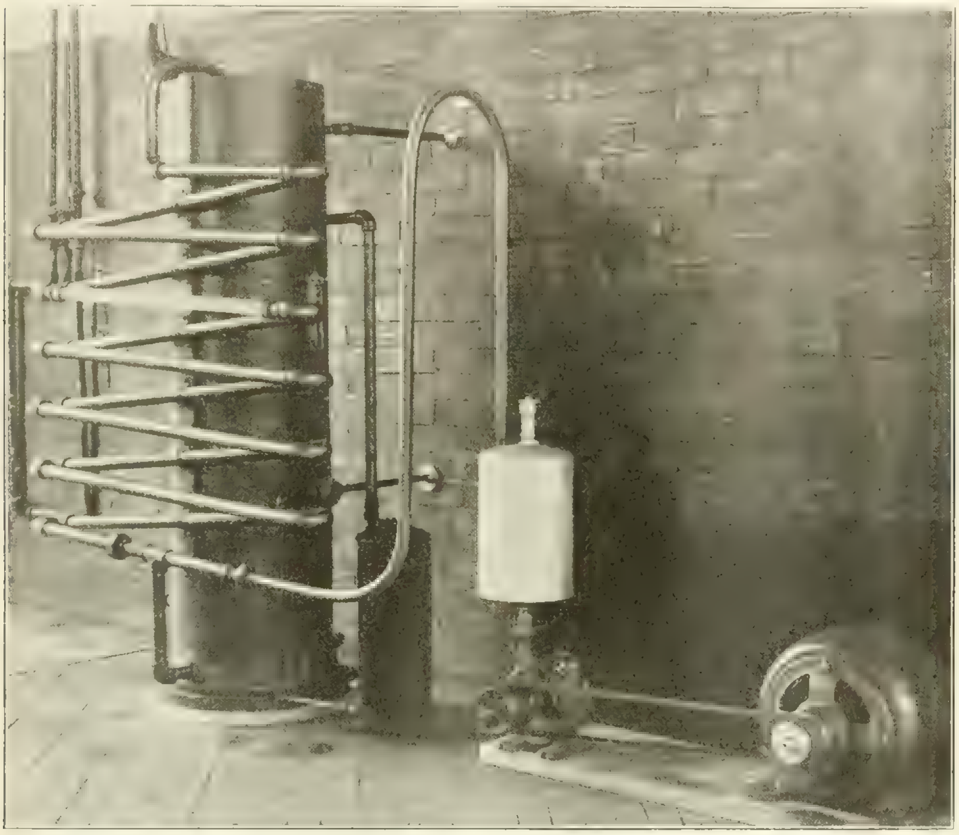


Illustration of Apparatus for Making Accelerated Corrosion Tests of Metal [illegible].

More particularly, the apparatus, as shown, consists of: (1) a tank made out of piece of Matheson Joint pipe in which a bottom has been welded; (2) a Lawson heater for keeping the water hot in the tank; (3) a blower or other source of air supply, and (4) the test coil, made up of alternate pieces of the various pipes under test, with auxiliary fittings and a glass observation tube. The water is kept at a constant temperature by means of a thermostat controlling the gas supply. A thermometer is attached to the side for the purpose of observing the temperature. The water is kept at a constant level by means of a ball cock attached to the outlet from a service line.

Tests are made by circulating the hot water from the tank through the coil by means of the air which is brought in at the bottom of the coil through an injector, which acts as an air lift for the water. By proper control of the air supply, the water may be made to flow from the bottom of the tank through the coil and spill over the top into the tank at such a rate that there is just a gentle surging in the pipes, and the products of the corrosion are not stirred up with resultant coloration of the water. Under these conditions, circulation of the water will be at the rate of about 1½ gals. per minute.

Engineering and Contracting

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Power Driven Distributing Spout for Road Mixers.

(Contributed.)

An unusual feature of the Koehring mixer line, is a platform-controlled, power-driven distributing spout 20 ft. long, which swings on an angle of 180°. The purpose of this arrangement is to do away with the labor of pushing the spout into position by hand, and to bring its control into the hands of the mixer operator, who also controls the loading skip, water tank, etc. Control levers for the spout are all within reach of this operator, who lengthens and shortens, and swings the spout to any position.

Besides the platform-control, the new spout has two especially important automatic actions, both of which overcome objections to the spout methods. When the spout is shortened, and the un-used sections elevated out of the way, the point of discharge of the sections in use, automatically lowers. This maintains the point of delivery at a low uniform distance from the ground, regardless of how few sections are in use, and prevents the separation of aggregates occasioned by a high drop. The other feature is an automatic lock which prevents the swinging of the spout by gravity, when the mixer is not standing on a perfect level.

The advantages of the new spout are: The elimination of the extra man to swing the spout, other than the regular mixer operator, and its more positive, faster action, which is practically equal to the boom and bucket method. The Koehring Machine Co. of Milwaukee, Wis., make the Koehring line of mixers.

CURRENT NEWS

The Doings of the Week.

Many developments favorable to the finance and industry of this country occurred during the past week. General business conditions reflected well sustained activity. The lumber and copper industries secured substantial increases in demand; steel orders of the U. S. Corporation showed a daily average in excess of maximum production. A statement issued Thursday by the U. S. Controller of Currency indicated that business conditions throughout the country are steadily improving. Governmnt statistics of trade for the fiscal year ending July 1 will show the largest trade balance for this country in its history. The balance will be about $1,000.000,000, a gain of almost $300,000,000 over the figures for the previous year. In the construction field, judging from the new work coming up for bids, there has been no slowing up of activity from previous weeks. State and county highway building and street paving continue to offer many construction opportunities and there is no indication that work in these lines will fall off for some months. Several states have hardly made a beginning as yet on their road construction programs for the present year. Bridge building is offering many contracts, and municipal sewerage and waterworks developments also made a good showing the past week. A number of good-sized contracts in the municipal field were let and several big jobs were brought nearer the call for bids stage. Even in the railway field there were some signs of activity and several small contracts were awarded. In the iron and steel trade considerable advance was made during the past week. The plants of the U. S. Steel Corporation are now operating at over 90 per cent capacity. There was larger production of coke and an increased pig iron output. Several steel plants which have been idle for more than two years have now been started. European inquiries for 200,000 tons of rails have been received. Domestic rail business, however, was light, although railway inquiry for tie plates, spikes and bolts was larger. Some makers have advanced spikes and bolts $1 per ton. The *Iron Age* prices for finished iron and steel and for sheets, nails and wire for the week ending June 23 were as follows:

Finished Iron and Steel.	June 23.	June 16.
Per lb. to large buyers.	Cts.	Cts.
Bess. rails, heavy, at mill.....	1.25	1.25
Iron bars, Philadelphia......	1.22½	1.17½
Iron bars, Pittsburgh........	1.25	1.25
Iron bars, Chicago............	1.20	1.20
Steel bars, Pittsburgh........	1.20	1.20
Steel bars, New York.........	1.369	1.369
Tank plates, Pittsburgh......	1.15	1.15
Tank plates, New York.......	1.319	1.319
Beams, etc., Pittsburgh......	1.20	1.20
Beams, etc., New York.......	1.369	1.369
Skelp, grooved steel, P'gh....	1.15	1.15
Skelp, sheared steel, P'gh....	1.20	1.20
Steel hoops, Pittsburgh.......	1.30	1.30
Sheets, Nails and Wire.		
Per lb. to large buyers.		
Sheets, black, No. 28, P'gh...	1.75	1.75
Galv. sheets, No. 28, P'gh....	5.00	5.00
Wire nails, Pittsburgh........	1.55	1.55
Cut nails, Pittsburgh.........	1.55	1.55
Fence wire, base, P'gh......	1.35	1.35
Barb wire, galv., P'gh........	2.40	2.40

For structural material f. o. b. Pittsburgh the *Iron Age* prices were as follows: I-beams, 3 to 15 in.; channels, 3 to 15 in.; angles, 3 to 6 in. on one or both legs, ¼ in. thick and over, and tees, 3 in. and over, 1.20 cts.

Railways.—There have been some signs of coming activity in the railway field during the past week. Nothing, however, has taken place that would lead to the conclusion that any big construction jobs were to come up in the immediate future. A few contracts have been let in the last few days. J. N. Gillis & Son secured some work on the Gulf, Florida & Alabama R. R., which has resumed construction; P. T. Clifford & Son were awarded contract for filling at Chicago for track elevation work; Twohy Bros. were awarded the Pilot Rock Junction, Ore., terminal by the Oregon-Washington R. R. & Navigation Co.; C. G. Kershaw, Birmingham, Ala., secured about 200,000 cu. yds. earth work from Meridian & Memphis R. R. The contract for erection of structural steel for the freight station at Chicago for the Union Station Co. was let to Thompson-Starrett Co.; steel will be furnished by McClintock-Marshall Co.

Roads and Streets.—A considerable amount of state, county and district highway work came up for advertising last week. California is calling for bids on 36 miles of state highway; New York is asking proposals on two lettings covering an aggregate mileage of 146; Connecticut is taking bids on several contracts. The county commissioners at Clearwater, Fla., open bids July 8 on 50 miles of brick road; County Freeholders at Hackensack, N. J., are asking bids on several large jobs; Allegheny County, Pennsylvania, is advertising work to cost about $130,000; Kaufman County, Texas, is ready for bids on $150,000 worth of bridge and road construction. New Orleans, La., is asking proposals on a large highway undertaking calling for esceral hundred cubic yards of earth embankment. The contracts let include $92,000 worth of asphalt pavement at Milwaukee, Wis.; a $155,209 bituminous gravel job at Baton Rouge, Ia.; an $83,000 brick paving contract for Beloit, Kan.; a $700,000 road contract for Collin county, Texas; $200,000 of street paving for Albany, N. Y.; and $52,000 contract at Clarksville, Tex.

Bridges.—Many small bridge and culvert undertakings reached the call for bids stage during the past week. Illinois and Minnesota are offering a number of opportunities in this line. Two Minnesota counties are advertising bridge and culvert work calling for expenditures of $14,000 and $20,000 respectively. Philadelphia is calling for bids on three good-sized bridge contracts, and Springfield, Mass., is advertising a structure estimated to cost $40,000. Tibbits-Pacific Co., San Francisco, Cal., secured contracts for two steel drawbridges to cost about $280,000; A. J. Yawger Co., Indianapolis, Ind., was awarded a $96,000 contract for a bridge at Wood St., Hamilton O.; County Commissioners at Wilkesbarre, Pa., have authorized construction of a $500,000 reinforced concrete arch at Market St., Wilkesbarre.

Drainage and Irrigation.—One of the largest irrigation developments to come up for bids so far this year is now being advertised. The county commissioners of Okanogan county, Washington, are asking bids on a $600,000 project. The Big Snake Creek Drainage District of Selmer, Ten., is asking bids on 250,000 cu. yds. of ditch work. Aside from these, no large undertakings either in the drainage of irrigation fields appear to have reached the advertising stage. Winston Bros., Minneapolis, Minn., were low bidders June 24 for main channel excavation for Sanitary District of Chicago.

Waterworks.—Several good-sized waterworks undertakings are being advertised. An Improvement District at Malvern, Ark., is asking bids on waterworks to cost $90,000. Paris, Ill., opens bids July 2 2on a 1,500,000-gal. rapid sand filter plant. Port Henry, N. Y., opens bids July 7 on a 1,000,000 concrete-lined storage reservoir and slow sand filter; Maryville, Tenn., is asking bids on waterworks to include 10 miles of mains.

Sewerage.—Peoria, Ill., is calling for bids on sewer construction estimated to cost $221,000; Eveleth, Minn., is asking bids on a sewage disposal plant; Philadelphia, Pa., opens bids July 13 on a good-sized contract calling for enlarging and relocating sewers in Buttonwood St. The Sanitary District of Chicago opened bids June 24 on Contracts Nos. 2 and 3 of the Calumet intercepting sewer; low bids were $195,583, and $331,882 respectively. Indianapolis, Ind., opened bids on a $157,000 sewer job, J. H. Cahill, Louisville, Ky., being the low bidder. F. H. Goddard, Detroit, Mich,. was awarded the contract for a reduction plant for Detroit.

Rivers and Harbors.—East Side Levee at Sanitary District, East St. Louis, Ill., is calling for bids on 800,000 cu. yds. of levee work; the Third Mississippi River District, Vicksburg, Miss., opens proposals July 12 on 1,415,000 cu. yds. of levee work. H. S. Kerbaugh, Inc., Buffalo, N. Y., at $78,606, was low bidder for government breakwater at Buffalo, N. Y.

A Few Big Jobs.

There are some bright spots in the construction situation. In fact a considerable amount of work is being undertaken these days. The railways, to be sure, are not doing anything, and this has forced many contractors into other lines of construction. This in a measure accounts for the number of bidders and close competition, especially on earth-moving jobs. Many big contracts have been let this spring, and many big jobs are slated to come up for bids in the near future. A couple of weeks ago Multnomah County, Oregon, awarded contracts for one of the largest road improvement programs ever undertaken by a county. Allegheny County, Pennsylvania, opens bids in a few days on a $2,000,000 highway tunnel, perhaps the biggest undertaking of its kind attempted for years in that section of the country. Then there is the new circular court house at New York City, bids on which probably will be taken in August. This will represent a possible expenditure of $8,000,000 to $10,000,00; owing to the cost and to its design it will be one of the notable structures of the country.

Why He Didn't Secure Contracts.

An Eastern contractor after bidding on about a dozen jobs this season without landing a contract, began to look around for the reason for his continued ill-luck. He finally, half jestingly, ascribed it to his cost-keeping system. He has a very excellent system and has accumulated a large amount of valuable data. He consequently has a definite idea of what it will cost him to do certain work. He has used this knowledge in preparing his estimates and there has been no guess work in his bids. On several jobs he lost out by a narrow margin; but on others the contracts went at prices that indicated the low bidders had no conception of the cost of the work. The Eastern contractor, thanks to his experience and cost-keeping system, had a pretty good idea of what the work could be done for at a reasonable profit; the other fellows didn't, and as a result they now have something to worry about.

Contracts for Power Developments.

An encouraging sign of better times in the construction field is the number of contracts awarded recently for work for private companies. In the last two or three weeks several good-sized hydro electric development jobs have been placed under contract; one or two irrigation projects also have been up for bids, and a number of manufacturing concerns have let dam construction jobs. During the past two years very little work in these lines has been undertaken. There has been practically no market for the securities of public utility companies and irrigation companies, and as a consequence their improvements have been held in abeyance. That some of this work is now being let is a most encouraging indication.

The Lighter Side of Engineering and Contracting

WATER WORKS TEAM GETS SOAKED

Boston Soc. C. E. Wins Close Game by Narrow Margin of 13 Runs.

Pitchers of N. E. W. W. Association Display Great Skill in Hitting Bats of Opponents.

BOSTON, MASS., June 16—The Joint Field Day of the Boston Society of Civil Engineers and the New England Water Works Association, held at Pemberton, Mass., today, was featured by a brilliant victory for the Engineers, who won a hard fought five-inning baseball game by the narrow margin of 20 to 7. The score does not show the relative strength of the two *tens* as each nine had its own duly elected umpire who was placed under bonds of $10,000 per inning conditioned upon all of his decisions being unsatisfactory to the opposing team. Bill James and Hank Gowdy failed to show up for the Water Works team and when this became generally known the betting odds were quietly shifted. There were two box *artisans* for each side, Sampson and Bryant hurling for the Engineers while Hersey and Symonds substituted for Bill James on the Water Works nine. Their control of parobolic curves and empirical in-shoots was the more remarkable when noting that the cold weather of the past spring has prevented them from calibrating their Lombard governors and adjusting their lines of collimation. The big green Dartmouth varsity letters on Sampson's shirt may also partly account for the batting slump of the Water Works sluggers.

At the receiving ends were Jack Andrews for the Engineers and "Wild Charlie" Glavin for the Water Works Association, and it is only necessary to state that both of these sterling catchers were signed up by one of Hughey Jenning's scouts immediately after the game. Glavin's work was unusually brilliant, especially when he pulled a red hot low spinning foul out of the ether with his ungloved hand in the second. We believe it was intentional.

James W. Rollins, of Holbrook, Cabot & Rollins, and William S. Johnson, of Boston, were the official umpires and their bonds (see above) were not forfeited. Class is no name for the majority of their decisions. They were given martial powers.

The official scorers were Robert Spurr Weston and S. G. Taylor and not a play, even the most complicated, escaped their pencil points, as the box score, given below, will indicate.

The Water Works team was organized and managed by Henry A. Symonds of the Hanscom Construction Co. of Boston. Edmund M. Blake of the State Department of Health drafted and managed the players of the Engineers' nine and also had general charge of the Field Day events.

Battery signals were not stolen by either side. Official coaching megaphones were vocalized by Col. "Teddy Roosevelt" Keyes of Concord and John M. Diven, secretary of the American Water Works Association, who motored over from Troy, N. Y., for the game. The contest from start to finish was witnessed by more than 200 members and guests who attended the excursion. The day was perfect and the game was played one hour after a clam chowder-broiled live lobster-fried chicken dinner, served in inimitable style by George A. Dodge, proprietor of Pemberton Inn and Paragon Park. Several pails of iced drinks reposed awhile near third base for those fortunate players who reached that advanced position, and their friends, which caused intermittent interruptions of a very quaffable nature.

Among the features of the game were Hersey's thrilling steal of second in the second; a heart-rending one-hand running catch of a high Texas leaguer by Sherman in deep center, and stinging doubles to the water's edge by Craig and Coghlan in the fourth. "Spider" Allen played an errorless game at short with no chances. "Rabbit" Gammage, of the Engineers, led in batting with an average of .750, Glavin and Johnson batting for .667, and Andrews and Ambrose for .600.

Each member of the winning Engineers' team is to be presented with a special bronze medal engraved to commemorate the victory. The box score of the game follows:

BOSTON SOCIETY C. E.

	R.	H.	P.	A.	E.
Cashman, 2b......	2	1	1	0	0
Bryant, ss., p..........	4	1	0	6	1
Andrews, c.............	3	3	11	0	4
Ambrose, cf...........	1	3	0	0	0
Sampson, p., ss	2	2	0	6	0
Craig, rf...............	2	2	0	0	0
Coghlan, lf............	3	2	0	0	0
Gammage, 3b..........	3	3	0	1	0
Wason, 1b.............	0	0	2	0	2
Totals	20	17	14*	13	7

N. E. W. W. ASSOCIATION.

	R.	H.	P.	A.	E.
Conley, 3b.............	1	0	2	1	1
Heffernan, 1b, c........	1	0	2	0	2
Glavin, c., 1b..........	1	2	7	0	8
Allen, ss................	0	1	0	0	0
Hersey, p., c...........	2	1	0	5	1
Johnson, lf.............	1	2	1	0	0
McBride, rf............	1	1	0	0	1
Sherman, cf...........	0	1	3	0	0
Mulque, 2b.............	0	0	0	0	1
Symond, p.............	0	0	0	3	0
Simmons, 3b...........	0	0	0	0	0
Totals	7	8	15	9	14

*Allen hit by batted ball.

Time of game—1.15. Umpires—James W. Rollins and W. S. Johnson.

SOME years ago when the Santa Fe was building a new line in Oklahoma one of the construction outfits had its camp near an Indian settlement. One day an Indian came into camp carrying an ax with a broken handle. The blacksmith's helper thinking to do a kindly act fitted out the tool with a new handle from his own stock. The ax had an edge like a saw so the helper decided to sharpen it, and asked the noble red man to turn the grindstone. The Indian was much pleased with the job. "Heap much sharp," he grunted, and sat down on a box. After he had been there for a couple of hours, the white man asked him what he was waiting for. "You no pay me," said the Indian. "Pay you! Pay you!" inquired the helper, "for what?" "I turn grindstone," was the reply, "that worth 15 cts."

JOHNNY CLAUSSEN, the ditch digger, overheard an argument between two of his dredgemen. They were discussing religion. "Why," said one of the men, "you don't know what you're talking about. You don't even know the Lord's Prayer.' "I'll bet you two bucks you can't repeat the first line of it." "You're on," replied the other man, "I'll take your bet." They asked Johnny to hold the money. "Now, what is the first line," inquired the challenger. The man hesitated and then said: "Praise God, from Whom all blessings flow." "By George, you win," said the first man, "I was sure you didn't know it." "Hold on," said Johnny "you both lose. The first line goes like this: "Now I lay me down to sleep."

A CERTAIN paving contractor, whom we will call Olson to distinguish his nationality, came out to view the work on an alley he had the contract to pave. Not being satisfied with the apparent rate of progress he "called" his foreman and said: "Yonson, I am afraid we will haf to get *another* foreman." "That bane all right, Meester Olson," replied the man, "there bane work enough here for *two* men."

On another occasion a paving inspector came upon the job and saw the foreman standing against the fence with no interest in the work in hand. "Well, Mike," said the inspector, "what's the matter?" "Oh!" replied Mike, "I quit on account of a remark Mr. Fowler made." Mr. Fowler not being a man given to excess verbal emphasis the inspector was rather surprised and said: "Well, now, I don't believe he would insult you. You must have misunderstood." "No, persisted Mike. "Well, what was it?" "All he said," replied Mike, "was—you're fired!"

Skinner Mulvey says: It's mighty easy to cure yourself of the smoking habit; why, I done it myself three times last week. Jim Powers says there's big money in contracting; says he's put $300,000 into it himself.

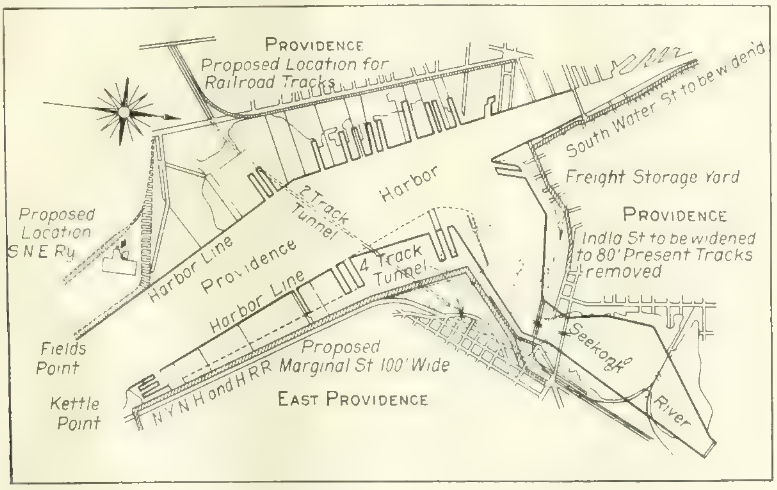
HARBOR DEVELOPMENT FOR PROVIDENCE, R. I.

Suggested Plan for Complete Improvement of Water Terminal Facilities.

Piers—Quay Walls—Railway Tunnels—Street Changes.

A general plan and suggestions for the development of the harbor of Providence, R. I., have been submitted to the sub-committee of the Metropolitan Terminal Commission by O. Perry Sarle, Engineer of the State Harbor Commission. This plan is preliminary to the development of the harbor and there is no prospect of any construction activity under it this season. The plan has been developed with the idea of laying out an ultimate arrangement of facilities for the port, and it is possible that construction will be carried out along the lines laid down.

The development of the Providence side of the harbor in the area along Allen's Ave. was started many years ago by the State Harbor Commission on the basis of requiring slips 600 ft. long measured from harbor line to bulkhead line. The state and United States harbor lines make the width of the harbor at Kettle Point about 1,340 ft.; at the angle in the harbor line on the west side of the harbor, just above Harbor Junction pier, about 1,830 ft.; between the end of Wilkesbarre Pier and the west side about 1,350 ft. The harbor area is largely dredged to a depth of 25 ft. at mean low tide, with prospect of being increased to 30 ft. in the near future.



Proposed Plan for Development of Harbor Facilities at Providence.

The new plan provides for securing a greater width between pier heads and for increasing the facilities for turning vessels in the upper harbor. The lines adopted call for cutting 400 ft. off of Wilkesbarre Pier and making the harbor line in that locality parallel with the line on the westerly side of the harbor, thus giving a width of about 1,750 ft. for a distance of over 4,000 ft. from Fox Point. The line is prolonged about 250 ft. beyond Wilkesbarre Pier, and it is suggested that from that point it shall run northeasterly to meet the curve in the established harbor line a few hundred feet southwesterly of the railroad bridge. This line would cut off and leave in the harbor area the dry dock and Bold Point and would form the southerly boundary of an approach to the Seekonk River. The plan provides for developing the west front by means of piers and slips. A combination of piers and slips, together with about 1,600 ft. of quay wall is suggested for the westerly front of the railroad property in the vicinity of Wilkesbarre Point. This quay wall might be located a short distance inshore of the harbor line and a wooden wharf built out to the line. Similar construction might be undertaken at the other quay walls. A location has been indicated for a dry dock and marine railway on the westerly side of the harbor which should be built to take the place of the one which would be removed at Bold Point. The harbor front is reached in part by the New York, New Haven & Hartford R. R. and some parts of the west frontage are to be reached by the Southern New England R. R. This latter line will have its freight terminals at the city quay at Field's Point, and also will reach the major part of the western harbor front along Allen Ave. by tracks already laid. It is suggested that a sufficient width should be set off on the easterly side of Allen Ave. to accommodate all railroad tracks and that all rails except crossings should be removed to this location, leaving the avenue for use as a highway. It is suggested that on the East Providence side of the harbor the railroad should be carried through tunnels under Fort Hill, leaving the present tracks near the East Providence station and joining them again near the southerly end of Railroad Pond. In order to divert freight so that it need not pass through the Union Station, it is suggested that a tunnel be constructed under the harbor. The tracks through this would connect with the present tracks near Providence and about opposite the tunnel entrance in East Providence. The roof of this tunnel should be about 40 ft. below mean low tide between the harbor lines and the grade out at either end will not exceed about 1¼ per cent.

A freight storage yard is proposed at India Point on the Providence side of the river, sufficiently large to support the harbor front between Fox and India Points. Supporting yards also are proposed on the East Providence side for the harbor front in that locality. One of these would be in the location of Railroad Pond and one on the harbor front property owned by the railroad. It also is suggested that a supporting yard be installed on railroad property on the west side of the harbor near Harbor Junction Pier.

On the easterly side of the harbor line the highway approaches could be improved by widening South Water St. to 60 ft., from Crawford St. bridge to Transit St., to 70 ft. from the latter street to Point St., and to 80 ft. from Point St. to India St. All tracks should be removed from India St. and this street widened to 80 ft. as far as Ives St. The plan provides for a new Marginal street 100 ft. wide from Watchemoket Square. This would be formed by widening First St. It would pass over the tunnels, make a turn to the south and follow the railroad to Kettle Point, where it would have an outlet on a bridge over the tracks. Morgan St., under the plan, would be closed at the railroad crossing and a new street built at wharf level to connect with the 100-ft. marginal street to afford an outlet for the harbor front above the bridges.

Grade Crossing Elimination Near Kansas City, Mo.

Two grade crossing elimination jobs near Kansas City, Mo., are now ready for bids. One of these calls for the construction of approaches to the subway at the separation of grades on Blue Ave. and the Missouri Pacific Ry. tracks, about 2½ miles east of the corporate limits of Kansas City. This work involves 33,000 cu. yds. of earth excavation, a reinforced concrete retaining wall containing 950 cu. yds. of concrete, a plain concrete arch culvert containing 250 cu. yds., and 8,880 sq. yds. of asphaltic macadam.

The other job provides for the construction of a reinforced concrete viaduct at the separation of grades on Blue Ave. and the Chicago & Alton R. R., about 2 miles east of the corporate limits of Kansas City. This improvement requires 1,146 cu. yds. of concrete, exclusive of that in the 910 lin. ft. of hand rails, 139,000 lbs. reinforcing steel, 8,700 cu. yds. of embankment and 1,400 sq. yds. of macadam.

Plans were prepared by Allen C. Southern, county surveyor, Kansas City, Mo., and bids will be received by him until 10 a. m., July 7.

Brndges and Culverts in Kansas Damaged by Floods.

Recent floods in Kansas have caused much damage to bridges. It is estimated that counties in the valley of the Kaw River alone will have to expend nearly $1,000,000 for replacing and repairing structures. Some counties in this locality are stated to have lost more than half of their small bridges. In Pottawatomie County it is estimated that 60 bridges have been washed out. The following tabulation is an estimate of the approximate bridge damage in counties in the Kaw Valley watershed:

County.	County seat.	Est. damage.
Clay	Clay Center	$100,000
Cloud	Concordia	150,000
Douglas	Lawrence	20,000
Geary	Junction City	125,000
Jackson	Holton	10,000
Jefferson	Oskaloosa	75,000
Leavenworth	Leavenworth	50,000
Marshall	Marysville	75,000
Mitchell	Beloit	25,000
Ottawa	Minneapolis	10,000
Pottawatomie	Westmoreland	100 000
Republic	Belleville	100,000
Riley	Manhattan	50,000
Wabaunsee	Alma	20,000
Washington	Washington	25,000

These estimates do not include the losses along the Neosho, Marais des Cygnes and Cottonwood Rivers, nor do they take into account the cost of repairing roads or new work necessary for channel changes. In Clay and Cloud Counties the Republican River is reported to have cut several new channels which will have to be bridged. Much damage also was caused to the trackage and bridges of railroads.

Well Filtration System Proposed for Wheeling, W. Va.

Another plan for improving the water supply of Wheeling, W. Va., is now being considered by the city council. On June 21 a report was submitted on the installation of a well system of filtration. This report was prepared by City Engineer C. B. Cooke and C. C. Smith, C. E. It provides for an estimated expenditure of $258,265, of which $189,350 is for the plant, $45,436 for the wells and $23,478 for engineering and contingencies.

The installation proposed in this report consists of three groups of wells placed in the gravel bar, below the Sister's Islands and off the east shore of the Ohio River, opposite Warwood, W. Va. These wells will be 10 ins. in size and there will be 102 of them. From the wells four 16-in. mains will lead to a dry pump well located on the east shore of the Ohio River east of the harbor line and between 8th and 9th sts. in Warwood.

The dry well will be constructed of brick, its design being similar to the present well. There will be three 10,000,000-gal. motor-driven centrifugal pumps for lifting the water into the clear water reservoir. This will have a capacity of 5,000,000 gals., will be constructed of reinforced concrete, and will be located between 8th and 9th Sts. A 42-in. cast iron gravity main will lead from the reservoir to the present pumping station of the city.

Bridge and Culvert Construction in Iowa.

Several million dollars are being expended for bridge and culvert construction in Iowa. The Service Bulletin of the Iowa Highway Commission estimates that more than $3,000,000 worth of this kind of work is now in progress or in prospect for 1915. Since Jan. 1 contracts for $495,000 worth of bridges and culverts have come into the office of the State Highway Commission for approval. These contracts have come from 38 counties only. In many of these counties there is a large amount of work being done by day labor and under contracts not requiring the approval of the commission. In the 61 other counties of the state there also is much work under way or soon coming up. The following list includes practically all the bridge contracts that have come into the commission office since Jan. 1, and which have been approved:

County.	Total.
Benton	$ 4,238
Black Hawk	19,568
Bremer	10,975
Calhoun	16,831
Carroll	6,481
Cass	5.726
Cedar	13,200
Cherokee	19,524
Chickasaw	13,200
Clark	3,187
Clay	33,701
Clayton	7,148
Crawford	8,555
Dallas	4,387
Decatur	2,537
Fayette	11,889
Floyd	1,748
Greene	9,302
Harrison	17,480
Howard	10,110
Ida	21,125
Jefferson	7,913
Johnson	5,099
Jones	5,513
Lee	10,610
Linn	22,367
Madison	5,610
Marion	31,028
Marshall	14,550
Mitchell	10,806
O'Brien	13,119
Osceola	6,475
Palo Alto	9,488
Plymouth	9,000
Story	34,822
Tama	39,980
Warren	9,250
Winneshiek	18,100
Total	$494,672

Details of some of the recent contracts let by Iowa counties are given in TableI:

TABLE I.

County.	Contract signed.	Number structure.	Total price.	Extra concrete per cu. yd.	Piling in place, per lin. ft.	Structural steel per lb., cts.
Carroll	May 12	2[1]	$ 6,482	$15	$0.50	3½
Cass	....	7	2,026	..	...	..
Clayton	May 20	2[2]	3,160	15	.80	..
Clayton	May 20	1[3]	3,684	13	.65	..
Ida	May 7	11	21,125	14	.40	..
Mitchell	May 25	2[4]	7,415	9	.50	3.17[5]
Mitchell	May 25	1[5]	1,657	14	.45	4
Mitchell	....	1[7]	1,734	12	.50	3½
Plymouth	Apr. 30	9	9,000[8]	10	...	..
Tama	May 17	53	39,980	15	.50	..
Warren	May 17	5	9,250	15[9]	.45	4

[1] 60x16-ft. pony truss with concrete floor and abutments and 30x18-ft. concrete deck girder. [2] 40-ft. concrete girders; unit price concrete, $10. [3] 38x6-ft. steel girder; 24-ft. roadway. [4] 100-ft. trusses. [5] 2-mile haul; contract price concrete, $12.90. [6] 50x16-ft. pony truss with concrete floor and abutment; county furnishes cement, but contractor hauls it; haul 4 miles; contract price concrete, $11. [7] 50x16-ft. pony truss; haul 5 miles; contract prices for concrete, $11.90. [8] County furnishes cement and reinforcing steel at railroad station. [9] Contract price, $12 for concrete.

FLOOD PREVENTION WORK IN OHIO.

Prestnt Status of Miami Valley Conservancy District.

Progress Made in Engineering and Legal Features.

Progress is being made looking to the beginning of actual construction on the flood prevention works for the Miami Valley, Ohio. The Supreme Court has rendered a decision upholding the constitutionality of the Conservancy Act under which the developments will be carried out. Engineering work for the complete plan for the valley has now reached such a stage that certain construction in the city of Dayton can be undertaken. This includes the railroad bridge at 6th St., the 5th St. bridge and the Webster and Keowee St. bridges. It also has been determined that the contract of the city with Gephart & Kline for the straightening of the river can now be executed. All other local channel improvements, however, must be deferred until the official plan is approved by the Causeway Court.

The present status of the flood prevention work was outlined in a report submitted a few days ago by the Miami Valley Flood Prevention Committee. The preparation of construction plans is now in progress, 21 engineers, assistants, draftsmen and computors, being engaged on this work. Sufficient progress has been made to determine the general character of the work, but there remains a tremendous amount of detail yet to be done before actual construction can proceed. Bonds cannot be sold and construction proceed until the appraisal roll has been approved by the court. These appraisers are not appointed until the Causeway District is organized. In the meanwhile, however, to facilitate the work of the appraisers, everything possible is being prepared in advance for them in the form of maps and data. A small map has been made of every piece of property in the six proposed reservoir sites, showing location of buildings.

As a result of completing the surveys and balancing the reservoirs the reservoir proposed at Port Jefferson has been eliminated from the plan, and this will save over $500,000 without changing the efficiency of the system. The survey of this reservoir site had not been completed at the time the preliminary report was made. The survey later developed the reservoir's inefficiency. Its loss is more than compensated for by the increased efficiency of the other six reservoirs as developed by the final calculations based on the completed surveys.

Some idea of the engineering that has been accomplished is given by the following figures: A topographical survey covering 240 square miles has been made with an average of 5 ft. contours. Local surveys have been made in Piqua, Troy, Tippecanoe City, Osborn, Fairfield, Dayton, West Carrollton, Miamisburg, Franklin, Middletown and Hamilton. A property survey has been made of every piece of property in the proposed reservoir sites. Relocation surveys have been made for all railroads and electric lines affected by the proposed reservoirs. Test borings amounting to 12,000 ft. have been made on the dam sites to determine preliminary foundations. Several test pits have been opened to determine the character of the materials available. A rainfall investigation has been made of every storm of any size which has occurred east of the Rocky Mountains since the weather bureau was established. An accurate measurement of the flood flow of the 1913 flow has been made. A complete investigation also has been conducted of the flow of streams around bends and through rough channels. Studies have been made of earth dams, and conclusions reached as to the proper cross section, type of spillways and shape of the outlet tunnels.

The legal foundation for the Miami Causeway District was established by the recent decision of the Supreme Court. After the disposal of a few minor questions, the next step will be the convening of the Conservancy Court and the organization of the district. After this has been accomplished the work will proceed in the manner laid down in the law. It is probable, however, that there will be many months of legal process before construction work can be started.

Bids Asked for New Immigration Station, Baltimore, Md.

Bids are now being asked for the construction of the new government immigration station at Baltimore, Md. About $550,000 has been appropriated for this structure, but only $350,000 will be available this year. The station will be erected at Fort McHenry, near the city.

The work on which bids are now being taken calls for the construction (except mechanical equipment, elevator, lifts and dumb waiter) of the station, including pipe tunnels, approaches and wharf. The structures include one 4-story, one 3-story and two 2-story buildings of fireproof construction, with slate, tile and composition roofs. They will be faced with brick, will have a stone base, and stone and terra cotta trimmings. They will occupy approximately 43,000 sq. ft. of ground area. The wharf will be 25 ft. by 260 ft. in size and of wood construction. The bids will be received until 3 p. m., Aug. 16, by Jas. A. Wetmore, Acting Supervising Architect, Washington, D. C.

Contract for 300 Mile Railway in Canada.

The National Engineering Co., Marshall Bldg., Cleveland, O., has been awarded a contract by the Lake Huron & Northern Ontario Ry. Co. for the construction of 300 miles of railroad, including telegraph lines, stations, repair shops, engine houses, and office buildings. The railroad will begin at Bruce Mines on the Soo branch of the Canadian Pacific Ry., and will run northeasterly along the Missisaga River through the Missisaga Forest Reserve through the district of Sudbury crossing the main line of the Canadian Pacific, thence across the Canadian & Northern Ontario Ry Co., terminating at its junction with the Grand Trunk Pacific at Alexandria in the district of Timiskaming, whence it is proposed to continue northeasterly to the outlet on salt water on James Bay. Present project from Bruce Mines to Alexandria comprises about 300 miles. The National Engineering Co. has the general contract for all engineering and all construction of this road. There are about 14 bridges to be built on this route, one of which will be in the neighborhood of 700 feet long.

The chief revenue derivatives of the railroad will be timber, iron ore, copper ore, pulp wood, wheat and coal.

$8,300,000 for State Highway Department of Pennsylvania.

The Governor of Pennsylvania has approved the legislative appropriations to the State Highway Department almost in full. As passed by the Legislature, $8,400,000 was appropriated to the State Highway Department; as approved by the Governor, the sum is $8,300,000. He cut $100,000 from the Highway Department appropriation bill by reducing the item appropriating $300,000 for the payment of the expenses, costs and awards in the purchase or condemnation of turnpikes forming part of State Highway Routes to $250,000. The other $50,000 he deducted from the $100,000 appropriation for the purpose of rebuilding, repair and maintenance of the National, or Cumberland Road. In the general appropriation bill the sum set aside for engineers. clerks, etc., was cut from $358,800 to $350,000. The item for traveling expenses for engineers, superintendents, paymasters, etc., was cut from $120,000 to $110,000. The salaries and expense item of the Automobile Division, which includes the money paid for the purchase of automobile tags and plates, was cut from $200,000 to $180,000, and the item for completing the surveys and plotting of county and township roads was cut from $50,000 to $40,000.

BRIDGE CONSTRUCTION AT PHILADELPHIA PA.

Bids Asked on Fisher Ave., 3d St., and 5th St. Structures.

Steel Superstructures; Concrete Substructures.

Bids are being asked by the city of Philadelphia, Pa., on three interesting bridge jobs. One of these calls for the construction of a bridge on the line of Fisher Ave. under the North Pennsylvania R. R. The second provides for a bridge on the line of Third St. under the Philadelphia & Newtown Connecting R. R., and the third involves the building of a bridge on the line of 5th St. over the North Pennsylvania R. R.

This latter structure will be a highway bridge replacing a light girder bridge with a wooden floor. It will cross the tracks on a skew, the angle included between the axis of the tracks and that of the bridge being 27° 57'. The bridge will span two railroad tracks and will carry a 50-ft. 1½ in. roadway and two 13-ft. sidewalks. It will consist of two outside latticed girders, encased in concrete, and a floor system consisting of I-beams, spaced 6 ft. centers, between which there will be concrete jack arches. These beams are supported also at the curb line by rows of columns. The bridge will have a 3-in. asphalt pavement. On account of the skew the beds of part of the beams will rest on the girders, while others will rest on concrete abutments.

The work at 5th St. requires the construction of a detour to divert travel from the site of the bridge. This will carry electric railway passenger cars and commercial vehicles. The contract comprises removing the old bridge, excavation for and furnishing and constructing complete the bridge substructure and superstructure, grading, paving, water pipes, ducts, the dtour, adjusting railroad siding connection and excavating the cores between piers and abutments for future tracks. The contract time is 10 months.

The bridge on Fisher Ave. will be a through plate girder structure with a buckle plate floor, concreted and waterproofed. It will be a double-track railway bridge with a central girder of 65 ft. span c to c of bearings, and two side girders each of 64 ft. 10 in. span. The girders will be spaced 14½ft. on centers and will rest on U-shaped concrete abutments having 19 ft. wing walls.

On this contract the railroad tracks will be detoured around the site with short trestles at the wings. An alternate approved method may be employed which permits the building of the masonry complete in one operation, and the erection of the superstructure and its waterproofing in the final location. The contract comprises the excavation, masonry, superstructure, waterproofing, drainage, inlet, sidewalks, curbs, sodding, temporary road and appurtenances. The time for completion is 5 months.

The bridge on Third St. will be a through plate girder structure with a concrete and I-beam floor. The I-beams will be embedded in the concrete, the upper part of which will be reinforced with wire cloth. The floor will be waterproofed with five layers of tar felt. The bridge will carry two tracks and will consist of a central girder of 57 ft. 10 in. over all length and two side girders of the same length. The girders will be spaced 14½ ft. on centers. The bridge will provide a clearance of 16 ft. 2 in. The girders will rest on concrete abutments, which will have curved ornamental wingwalls, inclosing plats which will be sodded and planted.

The order of operation on this contract will be as follows: The contractor will construct the south wing walls complete except the portion of the pylous above bridge rests. The Philadelphia & Reading Ry. will at the same time fill for the temporary detour embankment, and when the contractor has the wings completed and protected against injury the railway company will fill over them, lay temporary tracks and transfer traffic to them. The contractor will then complete masonry, shoring the detour fill as may be required for his excavation, and will erect and waterproof the superstructure. The railway company will lay its permanent tracks and transfer traffic and remove track materials from the detour. The contract time is 6 months.

Bids for the construction of three bridges will be received until noon July 8 by Morris L. Cooke, Director Department of Public Works, Philadelphia, Pa. George S. Webster is Chief Engineer, Bureau of Surveys of the Department.

Bids Asked for 37 Miles of State Highway in California.

The California Highway Commission is calling for bids on its first road letting the present month. Proopsals are asked on five contracts covering a total of 36.9 miles of highway. The estimated quantities in each of these contracts is given in Table I.

TABLE I.

	II- Teh-3-C	III- Gle-7-B	IV- C.C-14-B	VI- Tul-4-D	V1- Tul-10-A
Excavation without classification, cu. yds	83,400	14,700	65,000	......	......
Excavation ordinary, cu. yds	......	......	......	14,350	2,970
Barrow excavation, cu. yds	......	......	......	2,000	2,220
Corrugated iron pipe, 12-in., lin. ft	2,268	300	640[2]	210	210
Corrugated iron pipe, 18-in., lin. ft	670	210	470	130	174
Corrugated iron pipe, 24-in., lin. ft	288	120	370	195	......
Concrete (Class B) culverts and monuments, cu. yds	700[1]	176	555	218	11
Concrete (Class B) pavement, cu. yds	......	9,190	......	6,350	3,840
Guard rail, lin. ft	......	440	......	1,500	......
Monuments, haul and place	226	62	147	51	16

[1] Also 120 cu. yds. Class B concrete for retaining walls. [2] Also 680 ft. 15-in., 92 ft. 21-in. and 72 ft. 30-in.

Contract II—Teh-3-C is located in Tehama county and extends from Red Bluff to the northerly boundary, a distance of about 12.7. This section is to be graded. Contract III—Gle-7-B is in Glenn county and covers about 9.4 miles of highway extending from Willows to Grapit. This is to be paved with Portland cement concrete. Contract IV—c.c.-14-B—calls for the grading of about 3½ miles of highway in Contra Costa county from El Cieroo (Tormey) to Eckley. The other two contracts are in Tulare county, and both call for paving with Portland cement concrete. Contract VI—Tul-4-D and 10-B is about 6.4 miles in length and extends from Goshen to Visalia. Contract VI—Tul-10-A extends from the western boundary of the county to the Southern Pacific R. R.; it is about 3.9 miles in length.

Bids on the above work will be received at the office of the California Highway Commission, 515 Forum Bldg., Sacramento, until 2 p. m., July 6.

NEWS LETTERS

St. Louis Items.

The "Newlyweds," Mr. and Mrs. Mike Costello, spent a couple of days here with Mike's relatives, on their return from the Frisco and San Diego fairs. Left here for Indianapolis, Ind., where they expect to go to housekeeping.

Plans for a concrete municipal dock and steel warehouse at the Chain of Rocks have almost been completed by the Director of Public Works Hooke. The construction of this dock, equipped with automatic machinery for loading freight, is designed as the first definite step in municipal control of the wharves and river terminals.

Morris & Walker of Dermott, Ark., secured the contract from McWilliam Bros., in southeast Missouri, for clearing 500 acres of right of way.

The Illinois Board of Public Utilities has granted permission to the A. J. & P. R. R. at Alton to issue $694,000 in bonds and stock in equal amounts to be used in extending the road and making needed improvements. More than a year ago the reorganizers of the A. J. & P., who bought in the property at a sale, asked the Board of Public Utilities to give consent to the issuing of $1,250,000 in additional securities, a half million in bonds and three-quarters of a million in stocks. The request has been held up a year.

John Kenney has moved his outfit on to a grading job at Paducah, Ky.

The Mississippi River Commission, which has been in session in the International Life Bldg. for several days, preparing its annual report on the condition of the river and levees in this district, adjourned at noon, June 23, and the signed report was sent to Washington. J. C. Ockerson, chairman of several of the standing committees said the report pointed out where much money could be spent to advantage in the improvement of banks and general river work. Ockerson would not state the amount asked by appropriation. The commission will meet again in November, when the annual low-water inspection trip to New Orleans will be made.

Gist Bros. Construction Co., Oak Park, Ill., have a standard gage steam-shovel outfit in West Virginia and another narrow gage steam-shovel outfit near Chicago idle. In addition to this they have 15 teams on pasture that they can place on grading on a moment's notice.

M. C. Connors & Co. secured the contract for putting in a switch from the Vandalia R. R. into the St. Louis Smelting & Refining Co.'s plant at Collinsville, Ill. Richard Watson is engineer on this job.

The high water in the Mississippi and Missouri rivers put McInerney & Kelly out of business temporarily on their levee work near Apex, Mo.

Wreckers began last Friday to tear out the back and side walls of office of Koenig's Labor Agency preparatory to enlarging this office, which is going to be extended 8 ft. further west and 50 ft. south. The second floor is going to be remodeled and the contract calls for three rooms to be used for the sole and exclusive use of contractors, as reading and writing rooms. Also a convenient place for contractors to display and show profiles and sublet work. When completed Koenig says that he is going to have the most up-to-date labor office and contractors' headquarters in the United States.

Chester H. Krum, special master appointed by the United States District Court to sell the Wabash R. R. under foreclosure proceedings, states that the sale will take place July 21. The date had been announced as July 8 by E. B. Pryor, one of the Wabash receivers, but Attorney Krum said he had been requested to postpone it. The sale is one step in the reorganization of the Wabash, and the postponement does not indicate any hitch in the reorganization plans.

Wells Lasswell Dredging Co. secured 70 miles of laterals from R. H. & G. A. McWilliams on their big ditch work near Kirk, Mo.

J. W. Woodward is in charge of R. H. & G. A. McWilliams' big ditch job between Kirk, Mo., and the Arkansas line. There is over 3,000,000 yds. of earth to be moved on this job.

The Mississippi River Commission here opened bids on June 17 for construction of about 175,000 cu. yds. of levee work in the East Side Levee and Sanitary District. There were only three bids. List & Gifford Construction Co. of Kansas City bid 48 cts. per cu. yd; Kinser Construction Co., 40 cts., with shrinkish and 33 cts. without shrinkish; Gist Bros. Construction Co. bid 55 cts.

Marsch, Cleary, White Construction Co. have 100,000 yds. of embankment of good sand and gravel drag line work, together with gravel roadway, vitrified pipe and about 15,000 sq. yds. of concrete rip-rap to let on their levee job at Indianapolis. Contractors interested in this work write or wire them to their Indianpolis office. A. B. Koenig.

PERSONALS

Mr. Walter W. Kraft has been appointed superintendent of streets of Evanston, Ill. Mr. Kraft is a graduate of Northwestern University, civil engineering class of 1915.

Mr. Frank Le Cocq has been appointed city engineer of Aberdeen, S. D., serving also as superintendent of water works and sewers. Mr. Le Cocq has been assistant city engineer since 1911. Prior to that he was draftsman for a time with the Chicago, Milwaukee & St. Paul Railway.

Mr. Louis P. Wolff, consulting engineer, 1000 Germania Life Building, St. Paul, Minn., has been appointed a member of the Minnesota State Board of Public Health, succeeding Dr. C. L. Green, resigned. Mr. Wolff is a member of the American Society of Civil Engineers and in his practice specializes in water works, sewerage, water power, concrete and steel structures.

Mr. Frank O. Lee has been appointed city engineer and superintendent of the water department at Barre, Vt. Mr. Lee was assistant engineer with McIntosh & Crandall, civil engineers, from 1910 to 1912. For a time he was designer for the Vermont Construction Co., and for the past three years he has been assistant engineer with F. O. Sinclair, consulting engineer of Burlington, Vt.

Mr. Henry Welles Durham, C. E., recently chief engineer of highways, Manhattan Borough of New York, and formerly resident engineer on Panama municipal improvements and on the Cape Cod Canal, announced his association with Mr. Percival Robert Moses, consulting electrical and mechanical engineer, 366 Fifth avenue, New York city, for highway and municipal engineering work.

Edmund T. Perkins Engineering Co. announces the opening of a branch office in the Illinois State Bank Building, Quincy, Ill., under the supervision of Mr. A. H. Beitmann. The Chicago office remains in the First National Bank Building, but has been removed from room 1110 to room 1211. The extension of the office facilities is due to the large amount of drainage work, involving many thousand acres of land in Missouri and Illinois, which has recently been placed with the firm.

Mr. George A. Reed has been appointed city engineer of Montpelier, Vt. Mr. Reed has been city engineer of Barre, Vt., for the past eight years. He was engineer for Gilley & Bidwell on real estate development in New England in 1904. The following year he was assistant city engineer of Barre, and in 1906 was engineering aid in the U. S. Reclamation Service at Klamath Falls, Ore., where he was in charge of construction on a portion of the main canal. He was appointed city engineer of Barre in 1907.

Mr. H. B. Emerson has been appointed as chief engineer for the Curtis-Ward Co., general contractors of Chicago, with headquarters in the Law & Commerce Building, Bluefield, W. Va. Mr. Emerson has been superintendent of construction for the company for some time past, and has had ten years of experience in engineering and construction work. The Curtis-Ward Co. has county road work, including macadam and grade work in Mercer county, W. Va., and Greene county, Tennessee, and railroad work in Ohio.

Mr. Walter H. Oliver has been appointed division engineer at San Bernardino, Cal., for the Santa Fe. Mr. Oliver has been division engineer at Needles, Cal., for some time past, and has been in the service of the Santa Fe since 1902 as transitman, assistant engineer and division engineer. Prior to that he was for two years in Mexico as draftsman and transitman for the Mexico Central. He also spent several years in hydraulic and dam and tunnel work as assistant engineer with the Arrowhead Reservoir Co. of California.

Mr. Sutton Van Pelt, consulting engineer, has opened an office at La Porte, Ind., where he will specialize in municipal and hydraulic engineering. Mr. Van Pelt is a member of the American Society of Civil Engineers and has had long and varied experience in engineering work, his career covering twenty years of active practice. He has done considerable paving and municipal work in Indiana and was for a time in United States service on river and canal work. He was one of the contractor's engineers on the Chicago Drainage Canal; as manager and engineer in the contractor's service has superintended the construction of paving, sewers, curbing, paving plants, stone crushing plants, docks, bridge foundations, dredging and harbor work in many states. He was at one time engineer in the Chicago Parks.

Contractors.

Mr. M. J. Cole, Jr., contractor for 28.3 miles of gravel roads in Grant county, Arkansas, at a cost of about $150,000, has been in the road building work as contractor for the past twenty years. His headquarters are at 2416 W. 13th street, Little Rock, Ark.

Mr. H. L. Tilley has been appointed superintendent for Thomas Kelley & Sons of Winnipeg, on construction of the Brokenhead section of the Winnipeg Aqueduct. This section is 17.75 miles in length and will involve steam shovel excavation and the building of a concrete conduit, including Brokenhead river pressure pipe and muskeg bog crossings. Mr. Tilley was formerly with the U. S. Reclamation Service on the Roosevelt project in Arizona and North Platte, Wyo. From 1906 to the outbreak of the Mexican revolution, he was superintendent under L. H. Taylor, chief engineer on construction of a 400,000-acre irrigation project in Sonora. From there he went to Los Angeles as superintendent of construction on the Olanche and Lone Pine divisions of the Aqueduct. He remained there until the completion of the project in 1913 and the following season built the Rolling Hills headgates and the Lake Newell Reservoir dam for the Canadian Pacific Railroad in the Alberta irrigation system. From February, 1914, until accepting his present position, Mr. Tilley has been superintendent of construction for Threet Bros. & Jolley, on the Milk River irrigation project in Montana.

INDUSTRIAL NOTES

A charter has been issued under the laws of Maine incorporating the Hager Portland Cement Co., projected by Edward M. Hagar, who lately resigned the presidency of the Universal Portland Cement Co. for the purpose of organizing a company to acquire and operate a chain of cement plants to cover the territory between the Atlantic seaboard and the Rocky Mountains. The capital stock is $20,000,000, all common. Mr. Hagar announces the election and appointment of the following list of officers and assistants: Edward M. Hagar, President; Morris Metcalf, Vice President; B. H. Radow, Vice President and Sales Manager; Gordon Wilson, Secretary and in charge of cost accounting; Leonard Wasson, Assistant to President in Operation and Construction; J. P. Beck, Assistant to President in Extension Work; C. W. Lyon, Engineer of Economies; J. H. Barbazette, Superintendent of Construction. Pending the election of a permanent Treasurer, the office will be filled by Gordon Wilson. The general offices of the company are located at 208 South La Salle St., Chicago.

CIVIL SERVICE NEWS

The U. S. Civil Service Commission announces the following examinations:

Metallurgical Chemist, $1,800 per annum; July 27.

Instrument Maker, Qualified as Mechanician; $900 to $1,020 per annum; July 27.

The New York State Civil Service Commission announces an examination for the position of Assistant Engineer on Water Power, Storage, Drainage and Conservation Commission, July 31; salary $3,000. Applications from residents of New York State only and must be made before July 19.

NEW CATALOGUES

In the review of the "Hy-Rib" Handbook, published in this column June 23, the address of the Trussed Concrete Steel Co., Youngstown, Ohio, was omitted. A copy of the handbook can be obtained by addressing the company at Detroit, Mich.

CULVERTS.—Paper, 4x6 ins.; 24 pp. Schulz & Hodgson, agents, 918 Association Building, Chicago.

Handbook explaining and illustrating the manufacture of Hall Interlocking Concrete Culverts, patented by O. S. Hall. Gives explicit directions as to materials, quantities, molding, placing, removing of forms, etc.

WAGONS.—Paper, 5x7 ins.; 30 pp.; The Troy Wagon Works Co., Troy, Ohio.

"Income Facts" is the title of this booklet which gives data on the economy of using Troy reversible hauling wagons. Shows the wagons in service and the various models. Gives specifications and calls special attention to the Troy winding and closing device and to the Troy drawhead and coupler.

INDUSTRIAL EQUIPMENT AND QUARRY SUPPLIES.—Paper, 6x3½ ins.; 2 booklets, 16 pp. each. H. B. Sackett Screen & Chute Co., 1679 Elston Ave., Chicago.

Catalogues and price lists of Sackett industrial supplies, including portable track switches, turntables, frogs, wheels, axles, dump, gable bottom and quarry cars, hoppers, revolving screens, elevating and conveying machinery, etc. Illustrated.

AIR COMPRESSORS.—Paper, 6x9 ins.; 24 pp.: Ingersoll-Rand Co., 11 Broadway, New York City.

Form No. 3031, descriptive of the new "Ingersoll-Rogler," class "F R-1," steam-driven single-stage, straight line air compressors. Special features of construction are the "Ingersoll-Rogler" air valves and the balanced piston steam valve, with automatic cut-off control. Illustrated.

ADDING MACHINES.—Paper circulars. Automatic Adding Machine Co., 115 N. Broadway, New York.

The "Golden Gem" adding machine and "Gancher" hand-tally are described in these circulars. The "Golden Gem" is a low-priced portable machine of simple construction and easily operated. The hand-tally is small enough to be concealed in the hand and is a new type of counter. Illustrated.

CATALOGUE REVIEWS

"NATIONAL" PRODUCTS.—Cloth, 5x7¾ ins.; 450 pp. National Tube Co., Frick Building, Pittsburgh, Pa.

The National Tube Co. has recently issued Catalogue J-1915, embracing in detail the complete line of pipe fittings, valves and specialties manufactured at the Kewanee Works, and in general other products manufactured by the company.

The vast list of "National" products is very carefully classified and indexed, the first 45 pages of the book being devoted to an elaborate index and a summary of other "National" publications descriptive of special products. It is said that the index alone comprises approximately 1,800 entries, which gives an idea of the scope of the book.

The major divisions of the book are headed as follows: National Pipe for Steam, Gas, Water and Air, Drive Well Points and Well Supplies; "N. T. C." Malleable Iron Fittings; "Kewanee" Unions and "Kewanee" Specialties; "N. T. C." Cast Iron Fittings; Standard Brass Valves; Radiator Valves; Brass Cocks and Fittings; Blast Furnace Fittings; Standard Iron Body Valves; Iron Body Gate or Straight-Way Valves; Wrought Tube Radiators.

The Products are well illustrated with halftone and duotone cuts. Details of construction are plainly shown and all the requisite data are given in conveniently arranged tables. The book is compiled for serviceableness, with strong binding and printed on heavy coated stock.

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